May 26, 1964 L. D. PETEE 3,134,310

METHOD AND APPARATUS FOR MAKING PAPER TUBES

Filed Dec. 8, 1960 7 Sheets-Sheet 1

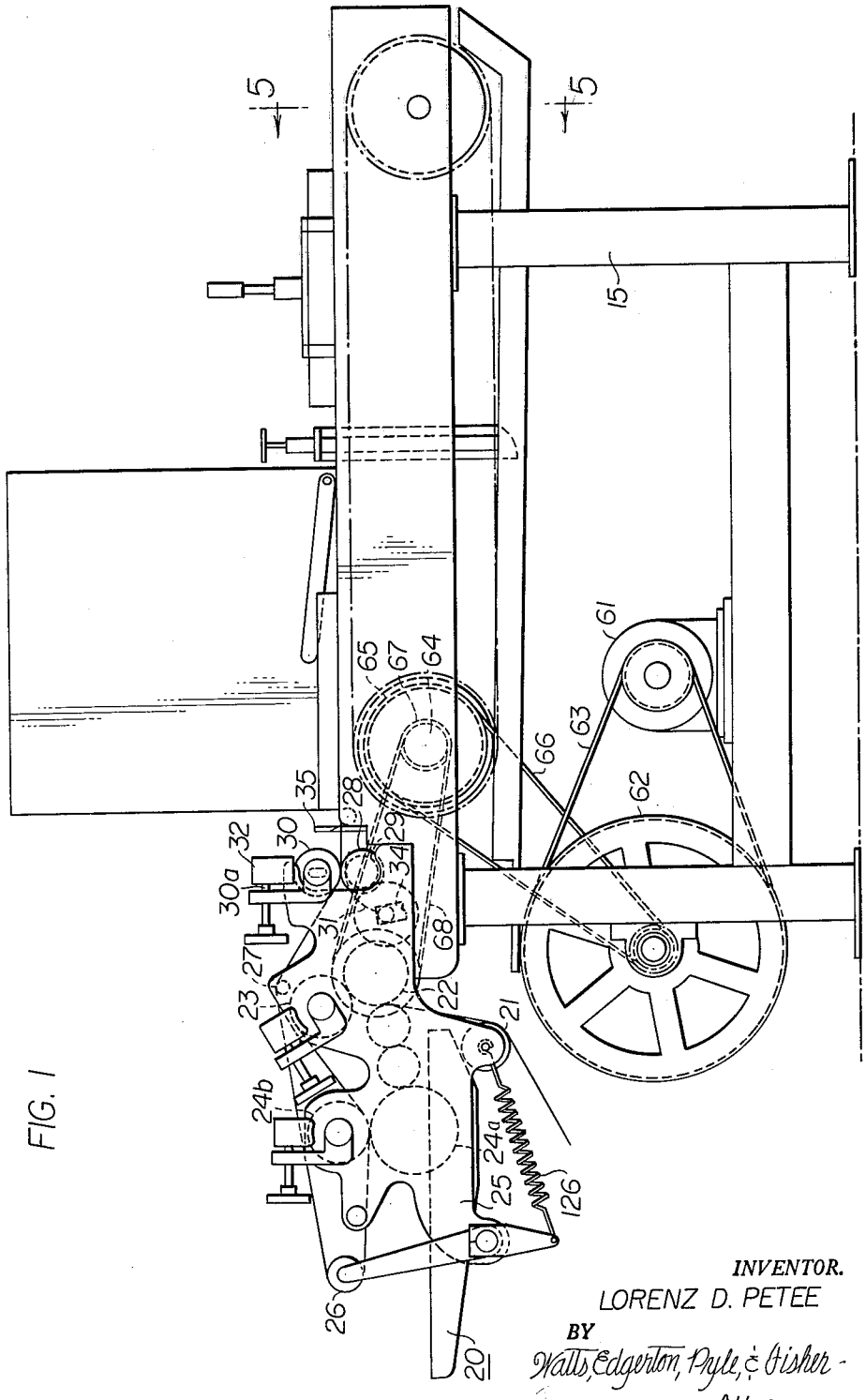


FIG. 1

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METHOD AND APPARATUS FOR MAKING PAPER TUBES

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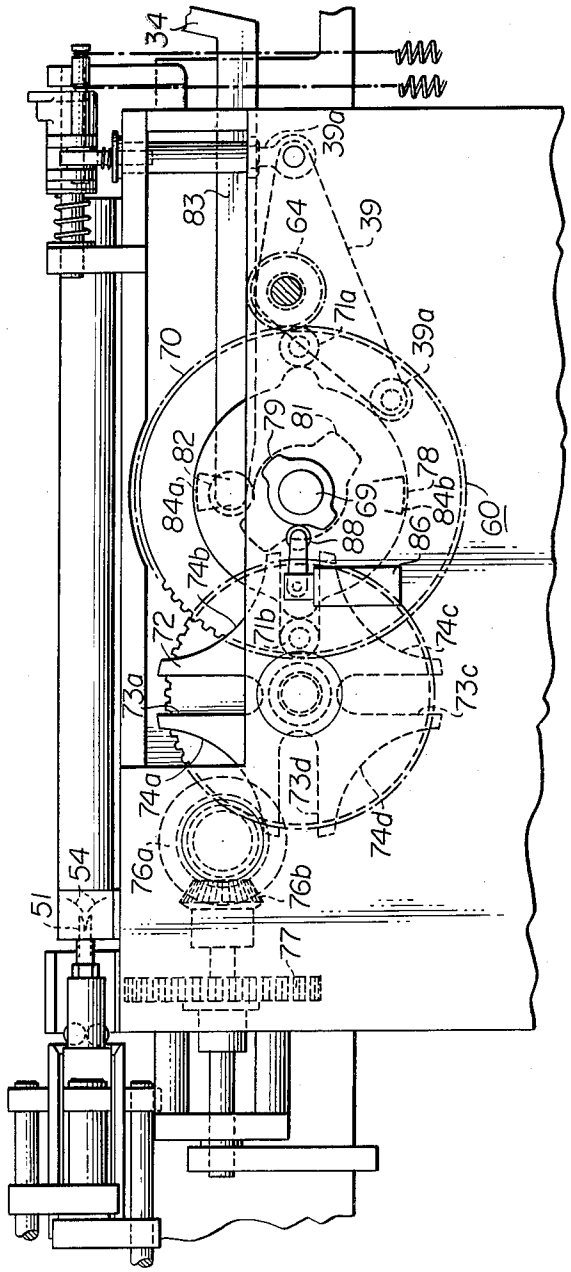


FIG. 2

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METHOD AND APPARATUS FOR MAKING PAPER TUBES

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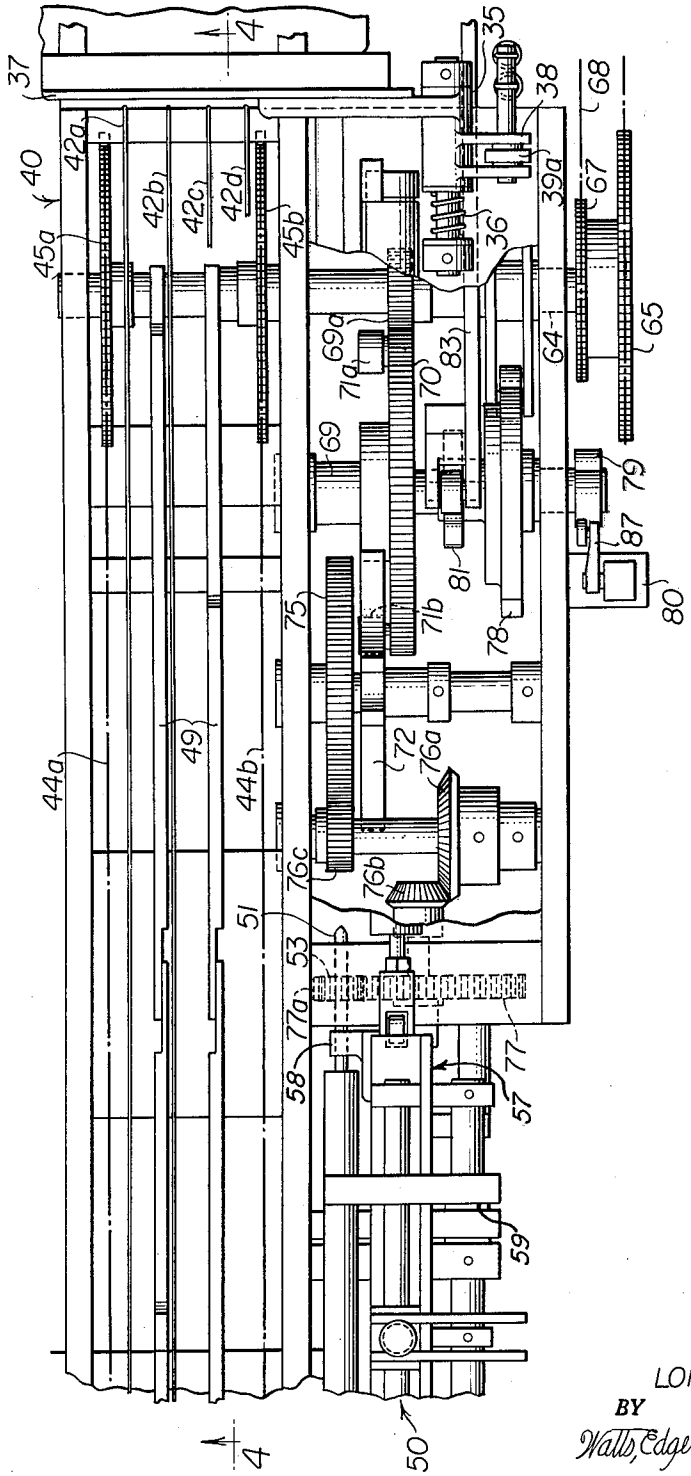


FIG. 3

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METHOD AND APPARATUS FOR MAKING PAPER TUBES

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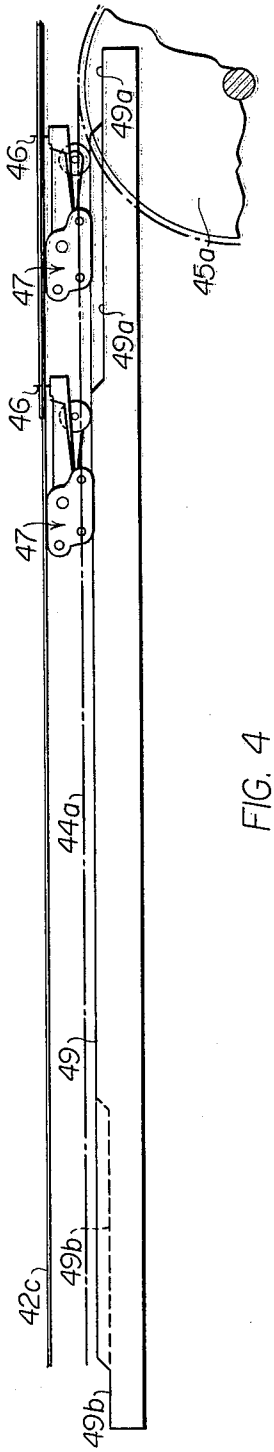


FIG. 4

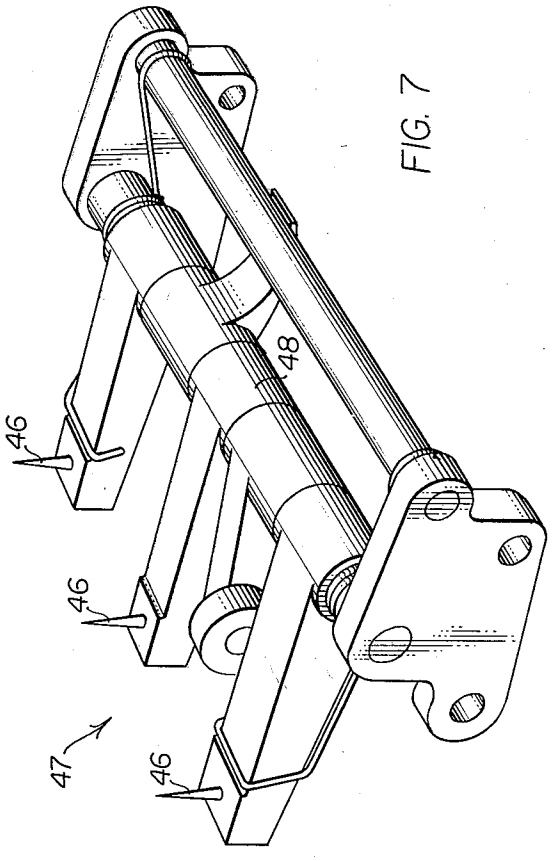


FIG. 7

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METHOD AND APPARATUS FOR MAKING PAPER TUBES

Filed Dec. 8, 1960 7 Sheets-Sheet 5

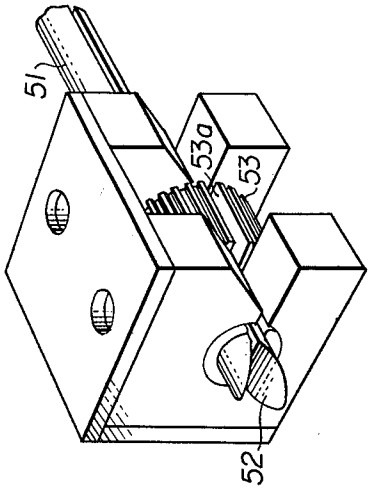


FIG. 6

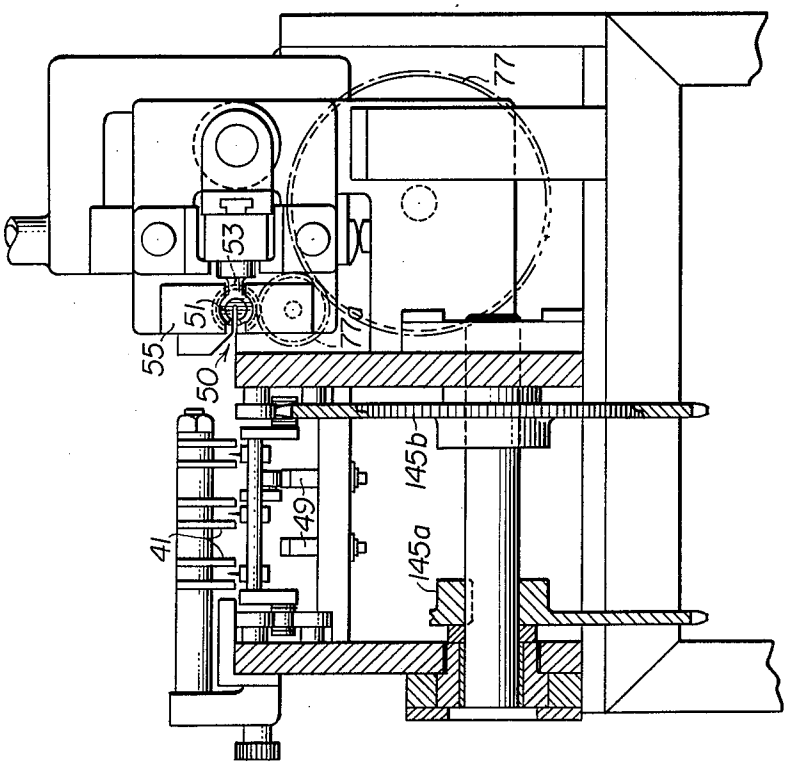


FIG. 5

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METHOD AND APPARATUS FOR MAKING PAPER TUBES

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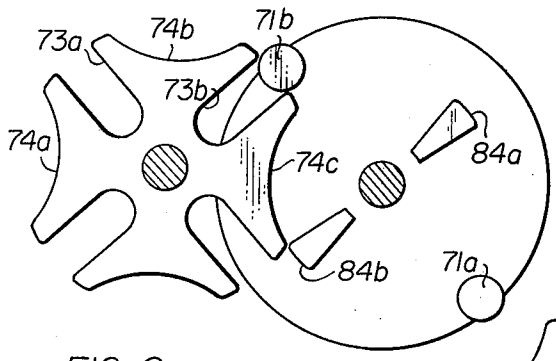


FIG. 8a

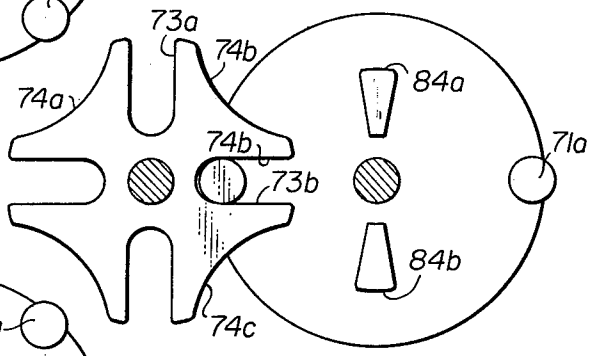


FIG. 8b

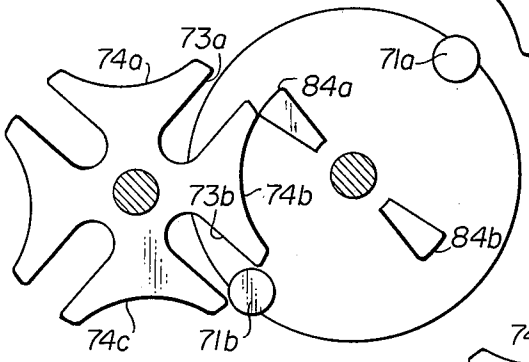


FIG. 8c

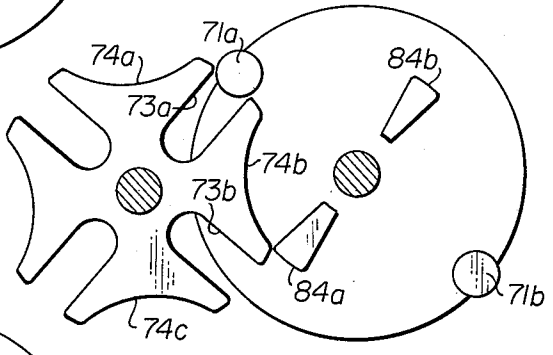


FIG. 8e

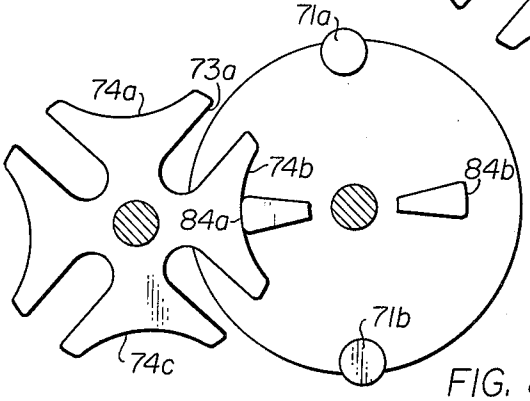


FIG. 8d

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May 26, 1964 L. D. PETEE 3,134,310

METHOD AND APPARATUS FOR MAKING PAPER TUBES

Filed Dec. 8, 1960 7 Sheets-Sheet 7

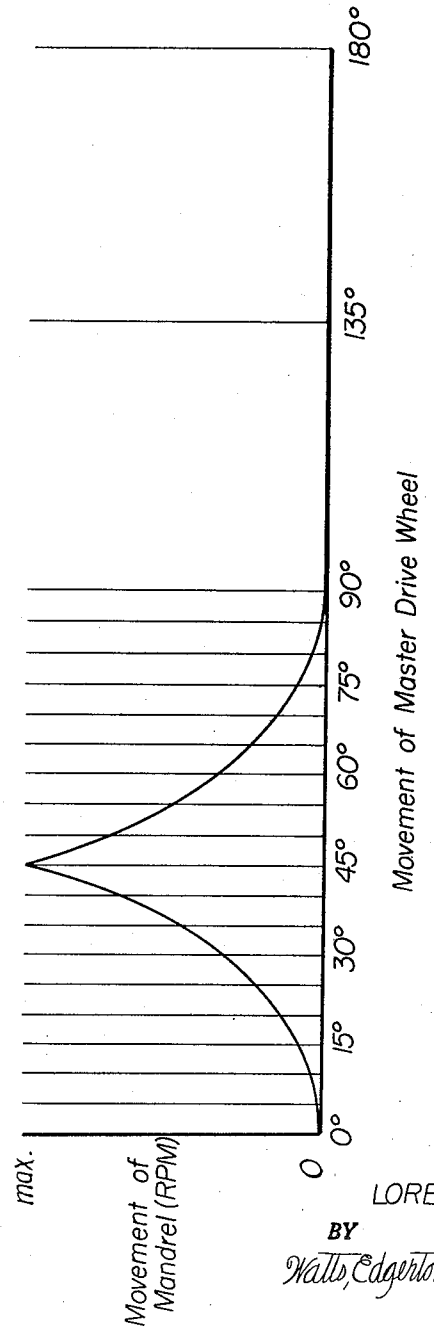


FIG. 9

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United States Patent Office 3,134,310 Patented May 26, 1964

3,134,310
METHOD AND APPARATUS FOR MAKING PAPER TUBES

Lorenz D. Petee, Avon Lake, Ohio, assignor, by mesne assignments, to Small Business Administration, Washington, D.C., an agency of the United States of America

Filed Dec. 8, 1960, Ser. No. 74,603
12 Claims. (Cl. 93—81)

This invention relates to tube forming machines and more particularly to high speed paper tube forming machines.

The side edge strips of paper rolls conventionally are of inferior quality and thus are trimmed from the roll. This inferior quality trim side edge of paper is formed into rolled paper tubes used as support bars on wire clothes hangers. The trimmed edges vary in width from coil to coil and even in the same coil. With this invention it is possible to use the varying widths to form high quality tubes.

A principal object of this invention is to provide a paper tube forming machine which will wrap paper tubes at a high rate of speed without tending to tear or rip paper being wrapped into a tube form.

Another of the principal objects of this invention is to provide a paper tube forming machine having a high production rate capacity.

A related object of this invention is to provide a paper tube forming machine drive mechanism for synchronizing the various parts of the machine to permit high production rate of tubes.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a front elevational view of the tube forming machine showing the feeding and gluing unit in some detail;

FIGURE 2 is a back elevational view, on a somewhat enlarged scale from FIGURE 1, of a portion of the transmission system of the paper wrapping machine;

FIGURE 3 is a plan view of a portion of the machine showing the transmission in some detail;

FIGURE 4 is a sectional view as seen along the plane designated by line 4—4 of FIGURE 3;

FIGURE 5 is a sectional view as seen along the plane designated by line 5—5 of FIGURE 1;

FIGURE 6 is a perspective view of the tube forming mandrel;

FIGURE 7 is a perspective view of a paper pick-up station;

FIGURES 8A through 8E are schematic representations of the various positions of the star wheel and master drive gear, and

FIGURE 9 is a graphic representation of the speed curve of a mandrel.

The basic operation of the machine can be broken down into several steps. The first step—a strip of paper is fed from a coil through a feeding and gluing unit which drives the strip and applies an adhesive glue to one surface. Next, the shear knife cuts a sheet from the strip. A conveyor assembly then picks up the cut sheet and conveys it onto a tube wrapping mandrel. The tube wrapping mandrel wraps each sheet of paper into a tube. Finally a tube ejector ejects the wrapped tube from the mandrel.

The operation proceeds with the strip of paper being continuously fed into the machine by the feeding and gluing unit with the shear knife cutting the paper into predetermined sheet lengths after the proper amount of the strip has passed the knife.

Immediately after it is sheared, the sheet is picked up by the conveyor and delivered to the mandrel. The mandrel is placed adjacent the conveyor so that the cut length of the paper is fed to the mandrel and becomes the length of the tube. Thus, the tube lengths can be accurately controlled irrespective of the width variation of the strip. The mandrel rotates a predetermined number of times to wrap the sheet of paper into a tube and thereafter stops. During the time the mandrel is stopped the tube is ejected and a new sheet is put on the mandrel.

Referring now to the drawings and with particular reference to FIGURE 1, each unit and its operation will be discussed separately and thereafter the method of synchronization will be described.

The paper is introduced into the machine at one end. The mechanism generally referred to as the feeding and gluing unit is at this end and generally identified by the reference character **20**. Paper from a coil is fed around a guide roll **21** and then upwardly into the main mechanism of the feeding and gluing unit. Essentially the feeding and gluing unit is a system of driven rolls with cooperating idler rolls. A power roll **22** is driven at a uniform speed from a motor **61**. The power roll **22** and the idler roll **23** grip and pull the paper strip from the supply coil. The strip then loops over the idler roll **23** and extends back between a pair of glue applying rolls **24***a* and **24***b*. The roll **24***a* is rotated by a pair of gears interconnected with the power roll **22**.

The roll **24***b* is driven by frictional engagement with roll **24***a*. Roll **24***a* is partially immersed into a bath of glue contained in a glue pot **25**. Hence the device as thus far explained will pull a strip of paper from a coil and then draw the strip between two mated glue applying rolls where glue is applied to the surface.

From the glue applying position the strip is looped around a slack take-up roll **26**. The strip is fed from the roll **26** over guide bar **27** and then between a drive roll **28** and an idler roll **30**. A spring device **32** urges the roll **30** against the surface of roll **28**. The roll **28** is dirven by means of a gear **28***a* from the power roll **22**. In order to shear the strip into sheets, it is advanced a predetermined distance beyond rolls **28** and **30** and brought to a momentary halt until a shear knife **35** can shear off a sheet. Thus, rolls **28** and **30** produce an intermittent drive. The intermittent drive is accomplished by a cam apparatus designed to lift the roll **30** from the surface of the roll **28** at predetermined intervals during a shearing portion of a tube forming cycle. This lifting of the idler roll **30** is accomplished by clamping fingers **31** which clamp the paper strip against the roll and lift the strip and roll **30** out of contact with the drive roll **28**. During the strip feeding portion of the cycle, the fingers are each disposed in one of a plurality of grooves **29** formed in the roll **28**. The fingers **31** are disposed in these grooves to allow **30** to come into feeding engagement and feed the paper between them. Hence, by lifting the frictionally driven roll **30** from the continuously rotating drive roll **28** and clamping the paper strip against the roll **30**, the drive action and the forward motion of the paper are halted for a shearing operation.

Because the original feed through the glue station is continuous and the feed through the rolls **28** and **30** is intermittent the slack take-up roll **26** is called upon to take up the slack of the material being fed from the glue station while the strip is in a stationary position at the roll **30**. The slack take-up roll is mounted on a pivoted rocker arm which is biased by spring **126** to provide the necessary action to take up the slack.

As can best be seen in FIGURE 2, the idler roll **30** is spring mounted. When the clamping fingers **31** are

urged against the roll 30 by a lifting bar 34, the force of the fingers overcomes the spring biasing force and lifts the roll 30 out of contact with the roll 28. The lifting bar 34 is intermittently actuated to lift the idler roll 30 out of contact with the roll 28. The shear knife 35, as can best be seen in FIGURE 3, is pivotally mounted on pivot pin 36 adjacent the rolls 28 and 30 and positioned to shear the paper after it has passed beyond the roll 30. The shear knife includes a blade portion 37 and an actuation portion 38 on opposite sides of the pivot pin 36. A rocker arm 39 drives the shear knife 35 through an actuation rod 39*a*. The cam actuation of the rocker arm will be described presently.

The shear knife 35 and actuating rocker arm 39 are synchronized with the feeding and gluing unit such that the shear knife 35 is actuated into cutting movement when the strip is stationary at roll 30. The mechanism of the method of synchronism will be described more fully hereinafter.

Each sheet of paper having been first sheared is carried along a conveyor assembly 40 to a paper winding unit 50. The conveyor assembly includes a plurality of spaced paper support rails 42*a*, 42*b*, 42*c* and 42*d*. A paper pick-up mechanism 43 is provided as a part of the assembly 40 which has a pair of laterally spaced chains 44*a* and 44*b* below the support rails 42. Chain 44*a* is reaved over a pair of sprockets 45*a* and 145*a*, and chain 44*b* is reaved over a pair of sprockets 45*b* and 145*b*. The sprockets 45*a* and 45*b* are carried by a common shaft and driven together. The chains 44*a*, 44*b* have a plurality of paper pick-up assemblies 47 mounted between and secured to the chains. The pick-up assemblies each include a cam follower bar 48. Each cam follower bar has three pointed pick-up fingers 46. The chains 44*a*, 44*b* are driven together by the sprockets 45*a*, 45*b* and the connected paper pick-up assemblies move with the chain.

The cam bars of the pick-up assemblies each have a follower which rides on a cam track 49 positioned below the paper supporting rails 42. The cam track 49 has depressed ends 39*a*, 49*b*. After a sheet of paper has been sheared by the blade, one of the pick-up assemblies emerges from the lower run to the upper run and is cammed onto the camming track 49 by depressed end 49*a*. This drives the pick-up fingers 46 through the sheet of paper. The paper is held down by top guides 41 which allow the fingers 46 to pierce the sheet. The pick-up assembly, moving with the chain, conveys the picked up sheet of paper along the support rails 42 to the paper winding unit 50.

The paper winding unit 50, which is best seen in FIGURES 5 and 6, includes a cylindrical winding mandrel 51 positioned adjacent the support rails 42. The mandril 51 has a paper receiving groove 52 formed along its entire length. The groove 52 is positioned to receive the side edge of a sheet moving along the rails 42. A toothed gear 53 is mounted on and surrounds the mandrel 51 to provide rotative movement to the mandrel. The gear 53 has a split 53*a* coinciding with the groove 52 to allow the edge of the sheet of paper to slide into the groove. Upper and lower paper guides 54 are provided adjacent the end of the groove 52 to guide the edge of a sheet of paper, carried by the conveyor assembly, into the groove 52.

The pick-up fingers 46, having pierced the sheet of paper, carry it along the paper support rails 42. The side edge of the sheet is guided into the paper receiving groove 52 by the guides 54. The side edge of the paper is moved along in this groove until its entire length is disposed in the groove 52. At this point the cam follower bar 48 of the pick-up station reaches the depressed portion 49*b* of the cam track, and the pick-up fingers 46 fall out of the paper. The driving force having been removed the movement of the paper ceases. The paper, as thus positioned after the pick-up fingers 46 have dropped out, is ready to be wrapped into a paper tube.

In order to prevent twisting of the paper as it is conveyed by the pick-up assemblies, the pick-up assemblies can be arranged to operate in pairs as can best be seen in FIGURES 3, 4 and 7. In this case the camming track 49 is formed such that a pair of cooperating pick-up assemblies are simultaneously cammed onto the camming track to pierce the sheet and simultaneously drop out of the sheet at the end of the camming track. With this arrangement the camming track 49 is really two laterally adjacent camming tracks with the depressed portions 49*a* of each being longitudinally spaced and also the depressed portions 49*b* of each being longitudinally spaced. Any tendency toward twisting is prevented by the fingers of the two stations piercing the paper simultaneously and together carrying it to the mandrel and thereafter simultaneously dropping out of the paper.

Immediately after the pick-up fingers 46 have dropped out of the sheet of paper the mandrel is caused to rotate a predetermined number of times to form a paper tube and then is stopped. A pair of irons 55 are positioned adjacent the mandrel and biased into smoothing abutment with the paper to assist in forming a smooth paper tube.

After the tube has been wound and the rotating ceases, a pneumatic ejector 57, FIGURE 3, is activated which ejects the tube from the mandrel. The ejector moves in its ejection cycle until it comes into contact with an ejector return 59 which returns it to its position ready to eject another tube. The ejector 57 includes an iron separating head 58. As the ejector 57 commences its ejecting movement, the iron separating head 58 wedges between the irons 55 and urges them apart and out of contact with the wrapped tube. This permits the tube to be stripped from the mandrel with the irons being moved out of contact with the tube to permit easy stripping from the mandrel. After the ejector has returned to its normal position the irons are biased into contact with the mandrel thus being positioned to assist in the next wrapping cycle.

It is readily apparent that in order to operate at a high cyclic rate capability the synchronization of each of the units must be accurate and precise so that the whole machine will function smoothly to rapidly produce paper tubes. A power and transmission unit 60 serves the function of providing synchronized movement and power to the various units.

The overall synchronization can best be observed in FIGURES 2 and 3. The power and transmission unit includes the motor 61 as the sole source of power for all of the various units. The motor 61 is connected to a sheave 62 by a drive belt 63. The sheave 62 in turn is connected to a main shaft unit 64 by a chain 66 reaved over a sprocket 65 mounted on the main shaft 64. The main shaft 64 has a power takeoff sprocket 67 mounted thereon. A chain 68 is reaved over the power takeoff sprocket 67 and is drivingly interconnected with the power roll 22 of the feeding and gluing unit. During operation of the machine the motor 61 is continuously driving the sheave 62 which in turn drives the main shaft 64 at a constant speed. Hence, the power roll 22 is being continuously driven which affords a constant feed of the paper through the power roll 22 and the driven roll 23.

The main shaft also continuously drives the sprockets 45*a*, 45*b* which in turn drive the chains 44*a* and 44*b*.

A master drive gear or wheel 70 is mounted on an auxiliary shaft 69 which is continuously driven by a gear 69*a* carried by the main shaft 64. The master drive gear 70 has a pair of camming lugs 71*a*, 71*b* mounted thereon and circumferentially spaced 180°. A star wheel 72 is provided to coact with the camming lugs 71*a*, 71*b* to produce alternately a mandrel rotating condition and a mandrel stationary condition. The star wheel 72 has four circumferentially spaced radial slots 73*a*, 73*b*, 73*c*, 73*d*. As the master drive gear 70 rotates, one of the slots 73 will be engaged by one of the camming lugs 71. The engagement thus effected will cause the star wheel 72 to

commence rotating and the engagement will continue until the star wheel has been rotated 90° at which point the camming lug and slot will become disengaged and movement of the star wheel wil cease. The rotating engagement of the camming lug and the radial slot will have been effected during 90° rotation of the master drive gear 70. Because of the positioning of the two camming lugs 71*a*, 71*b* the master drive gear 70 will continue to rotate 90° after one of the camming lugs 71 has disengaged the radial slot before the other of the camming lugs will engage another radial slot. The star wheel 72 has four arcuate surfaces 74*a*, 74*b*, 74*c* and 74*d* each extending between two adjacent radial slots 73. The master drive gear 70 includes a pair of arcuate shaped locking surfaces 84*a*, 84*b* positioned to coact with the arcuate surface 74 of the star wheel in the following manner:

As the camming lug 71 disengages the radial slot 73 one of the locking surfaces 84*a*, 84*b* commences sliding contact with one of the arcuate surfaces 74 on the star wheel. This sliding contact will prevent any unintended rotation of the star wheel during the cycle in which the star wheel is stationary.

As the locking surface 84 breaks contact with the arcuate surface 74 which it had engaged, the other camming lug engages the next radial slot 73 and the next rotation cycle of the star wheel commences. A schematic representation of the inter-action and the movement of the star wheel and master drive gear 70 is shown through FIGURES 8*a* to 8*e*.

In FIGURE 8*a* the camming lug 71b is just starting to engage the radial slot 73*b* and the locking surface 84*b* has just disengaged the arcuate surface 74*c*. The star wheel is then rotated by the coaction of the camming lug 74*b* and the radial slot 73*b* through the position shown in FIGURE 8*b* at which point in the rotating cycle the star wheel is at maximum speed to the position shown in FIGURE 8*c* where the camming lug 71*b* is just disengaging the radial slot 73*b* and the locking surface 84*a* is just engaging the arcuate surface 74*b*. The rotation of the star wheel from FIGURE 8*a* to FIGURE 8*b* is 45° and from FIGURE 8*b* to 8*c* is also 45° thus giving a 90° rotation during the engagement of the camming lug 71*b* with the radial slot 73*b*.

FIGURE 8*d* shows the master drive gear 70 rotated 45° from the position shown in FIGURE 8*c* with the locking surface 84*a* in contact with the arcuate surface 74*b*. It can be seen that the star wheel has not moved during this 45° rotation. FIGURE 8*e* shows the master drive gear 70 rotated another 45° from the FIGURE 8*d* with the locking surface 84 just breaking contact with the arcuate surface 74*b* and the camming lug 71*a* positioned to commerce engagement with the radial slot 73*a*.

Thus it can be seen that during the 90° rotation of the master gear 70 from FIGURE 8*c* to 8*e* the star wheel has not moved. Hence, during the 90° rotation when the locking surface 84*a* was in contact with the arcuate surface 74*b* no rotation of the star wheel has taken place. As the camming lug 71*a* engages the radial slot 73*a* another rotational cycle will occur during 90° rotation of the master drive gear 70 similar to the cycle described above which will be followed by a 90° cycle wherein the star wheel is stationary when the locking surface 84*b* engages the arcuate surface 74*a*.

Thus it can be seen that the cyclic operation of the star wheel is alternately a moving cycle during 90° rotation of the master drive gear 70 and a stationary cycle during 90° rotation of the master drive gear 70.

There are alternately 90° of revolution of the master gear wherein it is not driving the star wheel and the star wheel is stationary and 90° of revolution of the master gear 70 wherein it is driving the star wheel. Reference to FIGURES 2, 3 and 5 show how this alternating movement is carried to the mandrel. The star wheel 72 includes a plurality of circumferentially spaced teeth 75.

The gear teeth 75 drive bevel gears 76*a*, 76*b* through gear 76*c* which in turn drives a mandrel driving gear 77 which is in driving engagement with reversing gear 77*a* which in turn is engaged with the split gear 53 carried by the mandrel.

The characteristic speed curve of the mandrel is shown in FIGURE 9. Examination of this figure reveals that there is a gradual acceleration of the speed of the star wheel from a dead stop position through the first half of its 90° rotation cycle at which point the speed reaches a maximum and thereafter decreases during the last half of its 90° rotation cycle.

Because of this gradual increase in speed a sudden high tensile load on the sheet at the start of the rotation cycle is avoided. Heretofore, the speed of the mandrel rotation has been limited to a value below that which would cause a high enough sudden tensile load to tear the sheet of paper. It has been discovered that if the speed of the mandrel is commenced at a low speed and then increased, a very high wrapping speed can be attained without tearing the paper. Because of the provision of the star wheel and camming lug arrangement a low starting speed increasing to a high speed is provided. This permits a high rate of tube formation without tearing the paper.

Because of this power transmission interconnection the mandrel will rotate during the 90° cycle of the master drive gear 70 in which it is driving the star wheel 72 and will be stationary during each 90° cycle of the master drive gear 70 during which it is not driving the star wheel. Relating this to the operation of the mandrel, during the stationary period the paper is being slid into the slot of the mandrel and the pick-up fingers 46 drop out just before the rotating cycle of the mandrel commences. The paper is rolled into a tube during the rotating cycle of the mandrel and immediately upon the cessation of the rotating cycle and the commencement of the stationary cycle the ejector 57 ejects the formed tube.

In the preferred and disclosed embodiment the gear ratio is such that a 90° revolution of the star wheel will produce 12 revolutions of the mandrel. Expressed another way, the gear ratio of the star wheel 72 to the split gear 52 through the gear train is 48 to 1.

The auxiliary shaft 69 has a tube ejector actuator camming surface 79. The tube ejector camming surface 79 is positioned to actuate a solenoid ejector actuator 86. The solenoid ejector actuator 86 has a solenoid arm 87 including a cam follower surface 88. The cam follower surface 88 rides on the tube ejector actuator camming surface 79 and is actuated thereby every 180° of revolution of the master drive gear 70.

The auxiliary shaft 69 also includes a shear blade actuator camming surface 78. The shear blade actuating camming surface 78 coacts with the shear knife actuating rocker arm 39 which is connected to the actuation portion 38 of the shear blade 37 by a rocker arm 39 and actuating rod 39*a*. The actuating rod 39*a* is spring loaded, biasing the shear blade 37 into a position ready to shear, which spring load is overcome when the camming surface 78 actuates the rocker arm 39.

The auxiliary shaft 69 also includes an idler clamping finger actuating cam surface 81. A cam follower 82 is positioned to coact with the camming surface 81 and is connected to the clamping fingers 31 through a transmission rod 83 which is connected to the lifting bar 34. When the cam follower 82 is actuated by the camming surface 81 the lifting bar 34 moves the clamping fingers 31 into contact with the roll 30, which fingers in turn clamp the sheet and urge the roll 30 out of contact with the roll 28.

Mechanism Synchronization

A smooth, rapid cyclic operation is provided by the synchronization of the units with the power transmission unit 60. This synchronization is obviously extremely important and must be provided within extremely close limits.

The following is a general description of the synchronization of the various units with the power transmission. The paper is paid off the paper stand by passing it between the power roll 22 and roll 23 which are in contact with each other and continuously drive the paper, introducing it into the machine. After the glue is applied the driven roll 28 and idler roll 30 feed the paper past the shear knife to a preselected distance. After the paper has been fed to a preselected distance the cam follower 82 is lifted by the camming surface 81 which raises the clamping fingers 31 to clamp the paper between the clamping fingers 31 and the idler roll 30 and raises the roll 30 out of contact with the roll 28. Immediately after the paper is clamped and the roll 30 lifted, the shear blade actuation camming surface 78 actuates the rocker arm 39 which causes the shear blade 37 to sever a sheet of paper from the remainder of the strip. As the paper is being clamped by the clamping fingers 31 against the idler roll 30 the continuously fed paper is being taken up by the slack take-up roll 26.

The conveyor assembly 40 is so synchronized that just prior to the return of the shear knife 35 to its normal position after shearing, the pick-up fingers 46 of a cooperating pair of pick-up stations 47 pierce the sheared sheet of paper. The pick-up fingers 46 move the paper along the paper support rails 42.

The rotation of the mandrel is so synchronized that it is stationary as the edge of the sheet of paper enters the paper receiving slot 52. The edge of the paper is moved along in the slot until the pick-up fingers drop out of the paper. Immediately after the pick-up fingers drop out of the paper, synchronization is such that one of the camming lugs 71 engages one of the radial slots 73 on the star wheel which commences rotation of the mandrel.

After the star wheel has rotated 90° causing the mandrel to wrap the tube, the camming surface 79 actuates the solenoid ejection actuator 86 which in turn actuates the pneumatic ejector 57. The ejector 57 ejects the formed tube from the mandrel during the stationary cycle of the star wheel and hence the stationary cycle of the mandrel. The pneumatic ejector is a very rapid acting ejector which quickly strips the tube from the mandrel making it ready for the introduction of the next sheet of paper onto the mandrel. As the ejector strikes the ejection return 59 it starts its return movement and during its return movement another sheet of paper is being placed in the groove of the mandrel by the conveyor assembly 40. The ejector returns before the next sheet of paper is ready for wrapping.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A paper tube forming machine having a frame comprising in combination:

(*a*) gluing and shear means on the frame to draw a strip of paper into the machine and to apply adhesive to at least one surface of the strip and shear the strip into selected sheet lengths,

(*b*) a rotatable paper tube wrapping mandrel mounted on the frame,

(*c*) conveyor means connected to the frame between the gluing means and the mandrel to convey sheared paper sheets onto said mandrel,

(*d*) drive means drivingly connected to said mandrel to rotate the mandrel about its axis for a predetermined period of time once each tube forming cycle, said drive means being variable to cause the mandrel to rotate slowly initially and thereafter smoothly increase the speed of rotation to a speed in excess of that which could be withstood by the paper at the commencement of a cycle,

(*e*) said conveyor means being synchronized with said drive means to convey the sheet onto the mandrel when the mandrel is in a stationary condition at another time each cycle; and,

(*f*) ejection means to eject a rolled paper tube from said mandrel.

2. The combination of claim 1 wherein said drive means causes the speed of mandrel rotation to increase throughout about one-half of said predetermined period of time in the tube forming cycle and thereafter to decrease.

3. In the combination of claim 1, said drive means including a star wheel having a plurality of circumferentially spaced radial slots and a drive wheel having at least one camming lug, each lug being positioned to intermittently coact with said slots to impart a rotative movement to said star wheel when coacting with said slots, said star wheel being drivingly connected to said mandrel.

4. In the comibnation of claim 3, wherein there are twice as many slots as lugs.

5. A paper tube forming machine comprising, in combination, means to draw a strip of paper into the machine and to apply adhesive to at least one surface of said paper and to shear the strip of paper to selected sheet lengths, a paper tube wrapping mandrel having alternately a rotating condition and a stationary condition, means to convey sheared paper sheets to said mandrel one at a time, said means to convey the sheared paper sheets including an endless continuously driven chain, said chain carrying a plurality of pointed pick-up fingers, said chain and fingers positioned to pierce and move a sheared paper sheet after it has been sheared, drive means drivingly interconnected to said endless chain and to said mandrel and to said means to draw the strip, said drive means including a star wheel and a camming wheel to produce the conditions in the mandrel, said star wheel having a plurality of radial slots, said cam wheel having at least one camming lug positioned to coact with said slot of said star wheel, said camming wheel being continuously driven, each lug and said slots being positioned such that one lug is engaged with one of said slots and rotates the star wheel for an amount of time equal to one half the revolution time of the camming wheel and for a period of time equal to one half of the revoltuion time of the camming wheel no lug is engaged with any of said slots and said star wheel is stationary, said star wheel being drivingly connected to said mandrel to provide the driving connection between the mandrel and the drive means, said drive means being synchronized to convey said paper onto said mandrel when said mandrel is in its stationary condition, and means to eject a rolled paper tube from said mandrel.

6. The combination of claim 5 wherein there are twice as many slots as lugs.

7. In the combination of claim 5, said means to draw the strip into the machine including a driven roll and an idler roll normally biased into contact therewith, said strip passing between said rolls, and means coactable with said idler roll to intermittently move said idler roll out of contact with said driven roll and clamp the strip to prevent movement thereof.

8. A paper tube forming machine, comprising in combination, means to draw a strip of paper into the machine, means to apply adhesive to one surface of the paper, a pair of strip advancing rolls, one of said advancing rolls having at least one groove therein, a paper clamping arm positioned in each groove, means to continuously drive said one advancing roll, biasing means urging the other paper advancing roll into contact with said one paper advancing roll, means to intermittently urge each arm toward said other paper advancing roll whereby to clamp the strip between each finger and said other advancing roll and move said other advancing roll out of contact

with said one advancing roll, a shear blade positioned adjacent said paper advancing rolls, second lever means coactable with said shear blade and synchronized to cause the shear blade to shear a fed strip of paper when the paper is clamped against said other paper advancing roll, a conveyor assembly, said conveyor assembly including a continuously moving endless chain, said chain having at least one pick-up station, said conveyor assembly including cam track means, each pick-up station including paper pick-up fingers, each pick-up station and said cam track means being positioned to urge the fingers of the pick-up station into a sheet of paper after the shear blade has sheared the sheet from the strip, said cam track being positioned to allow the pick-up fingers to drop out of said sheet after a preselected distance of travel, said conveyor assembly having a paper conveying track, a paper tube winding unit positioned adjacent said conveyor assembly, said paper winding unit including a mandrel having an elongated paper receiving groove, said mandrel being positionable to receive the side edge of a sheet of paper being carried by the conveyor assembly, said mandrel having a rotating condition and a stationary condition, drive means operably connected to said mandrel, said drive means including a star wheel and a master drive gear coactable therewith, said star wheel having a plurality of radial slots, said master drive gear having a plurality of circumferential, equally spaced camming lugs, means to continuously rotate said master drive gear, said lugs being positioned such that one of said lugs is coacting with one of said slots for an amount of time equal to one-half the rotation time of the master drive gear, and for an amount of time equal to one-half of the rotation time of the master drive gear no lug is engaged with any slot and the star wheel is stationary, the number of slots on the star wheel being twice the number of lugs on the master drive gear, whereby the star wheel is intermittently driven by said camming lugs, said star wheel being drivingly connected to said mandrel to provide the driving connection between the mandrel and the drive means, said interconnection including means to position said slot to receive a sheet of paper when said mandrel is in its stationary condition, synchronizing means to cause a sheared sheet of paper to be positioned on the mandrel while said mandrel is in its stationary condition, and means to eject a wrapped tube of paper from the mandrel.

9. In a tube forming machine the combination of a frame, a conveyor on the frame for transporting pieces of paper along a path from a pickup station to a delivery station, means connected to the frame for supplying pieces of paper to the conveyor one at a time, a mandrel positioned along one side of the conveyor at the delivery station with its axis generally paralleling said path, drive means connected to the mandrel and operably connected to the conveyor to cause the mandrel to rotate and wind a piece of paper into a tube each time a piece of paper is

delivered to the mandrel, thereby to draw the paper laterally off the side of the conveyor, said drive means driving the mandrel at varying speeds commencing with a slow speed and thereafter smoothly increasing each time a piece of paper is wound on the mandrel, and means to strip a wound tube from the mandrel.

10. The device of claim 9 wherein the drive means causes the mandrel speed to increase non-linearly.

11. The method of forming paper tubes with a mandrel and a strip of scrap paper sheared along one side edge and having an opposite edge comprising:

(*a*) applying glue to one face of the paper;

(*b*) cutting a piece from the glued strip to provide a piece with end edges and of a length equal to the length of the tube to be formed;

(*c*) feeding the one side edge of the piece onto the mandrel; and,

(*d*) rotating the mandrel slowly initially and thereafter at a smoothly increased speed of rotation to draw the piece onto the mandrel opposite edge last to form the tube with its ends defined by the cut end edges of the piece.

12. In a paper tube forming machine the combination of, a paper tube wrapping mandrel having alternately a rotating condition and a stationary condition, means to convey sheared paper sheets to said mandrel one at a time, drive means drivingly connected to said conveyor means and to said mandrel, said drive means including a star wheel and a camming wheel to produce the conditions in the mandrel, said star wheel having a plurality of radial slots, said cam wheel having at least one camming lug positioned to coact with said slot of said star wheel, said camming wheel being continuously driven, each lug and said slots being positioned such that one lug is engaged with one of said slots and rotates the star wheel for an amount of time equal to one-half the revolution time of the camming wheel and for a period of time equal to one-half of the revolution time of the camming wheel no lug is engaged with any of said slots and said star wheel is stationary, said star wheel being drivingly connected to said mandrel to provide the driving connection between the mandrel and the drive means, said drive means being synchronized to convey said paper onto said mandrel when said mandrel is in its stationary condition, and means to eject a rolled paper tube from said mandrel.

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