Oct. 7, 1958 H. GANZ ET AL 2,855,161

TAPE WINDING APPARATUS

Filed May 21. 1954 5 Sheets-Sheet 1

Fig. 1.

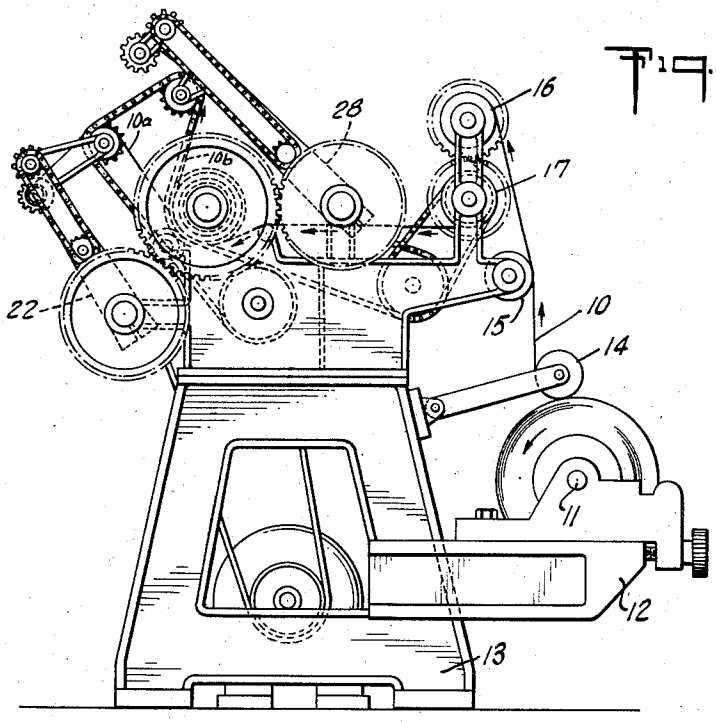
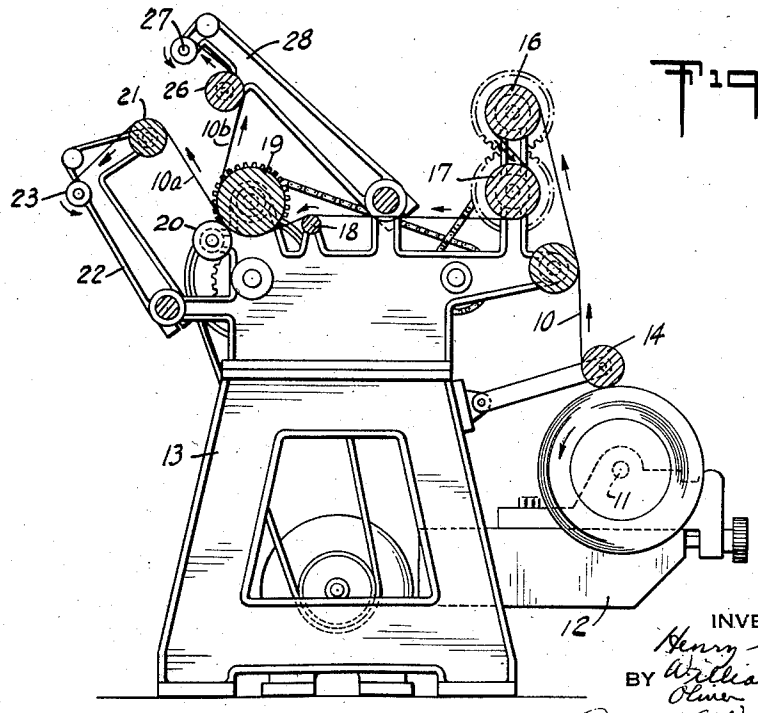


Fig. 2.



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TAPE WINDING APPARATUS

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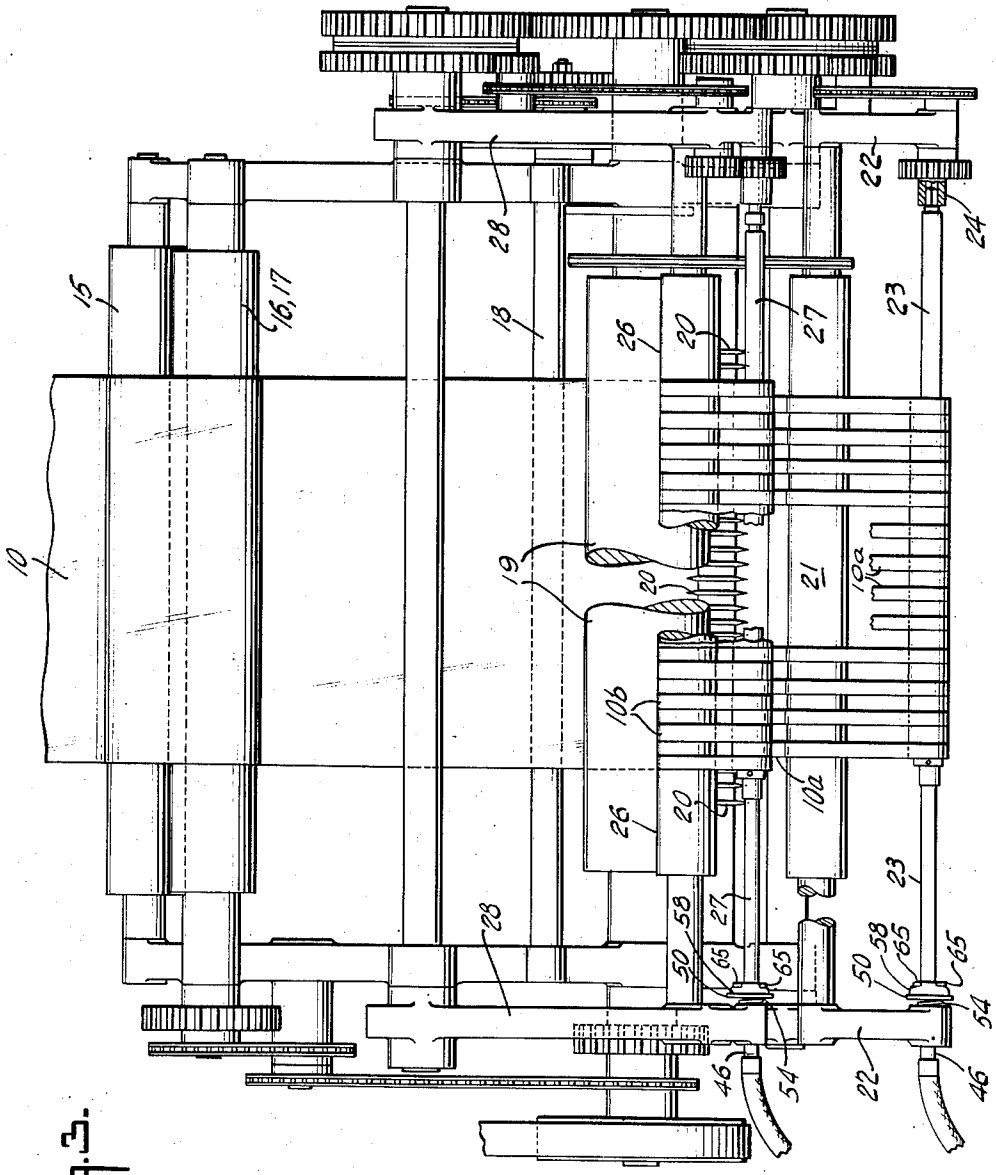


FIG. 3.

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TAPE WINDING APPARATUS

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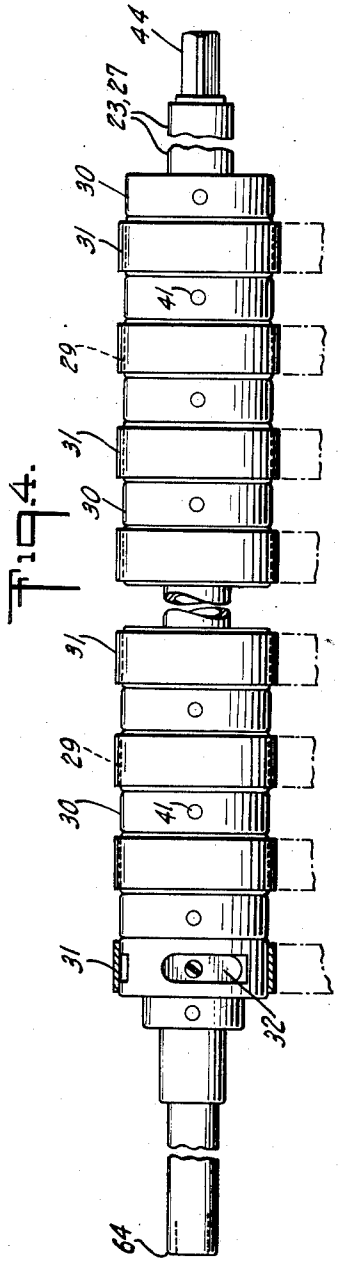


Fig. 4.

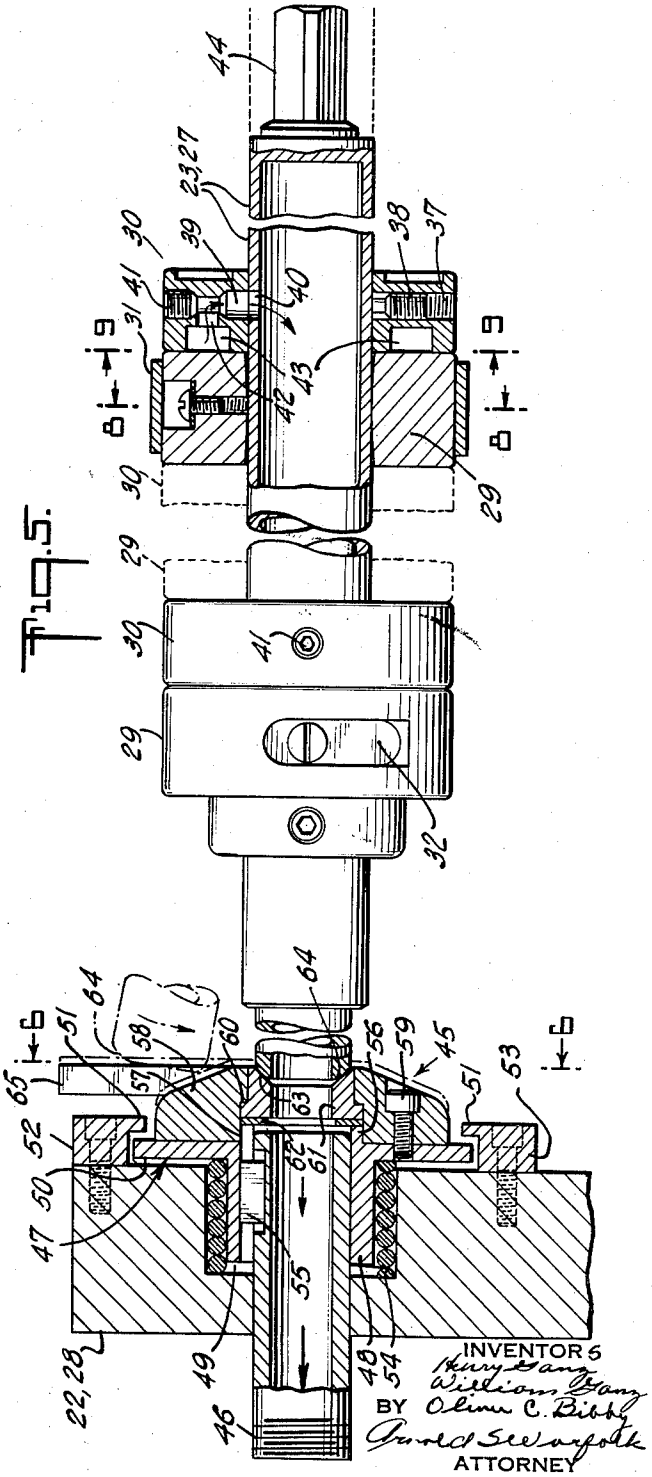


Fig. 5.

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TAPE WINDING APPARATUS

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Fig. 6.

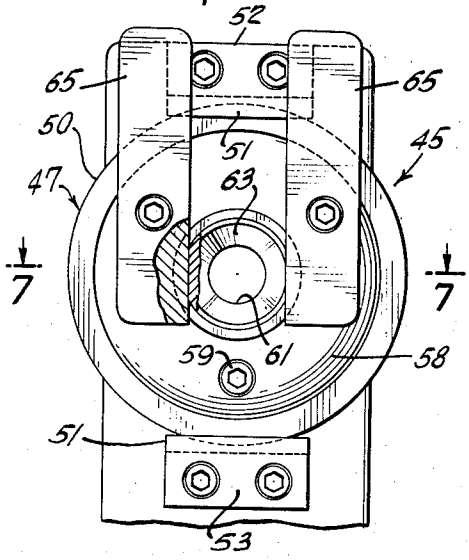


Fig. 7.

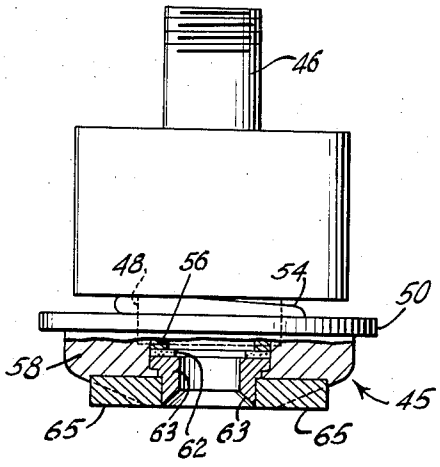


Fig. 8.

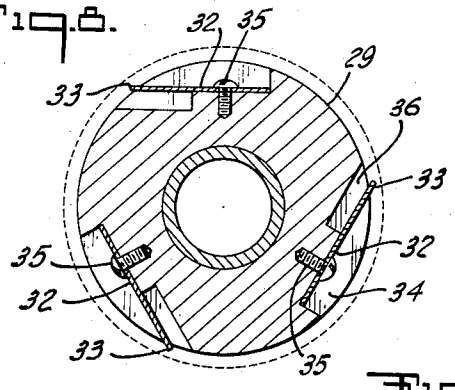


Fig. 9.

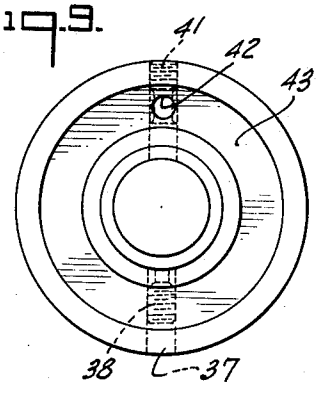


Fig. 10.

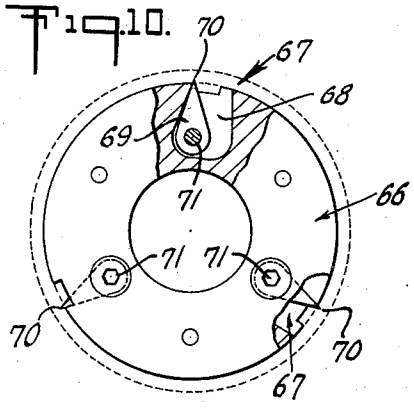
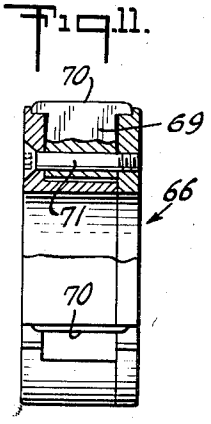


Fig. 11.



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TAPE WINDING APPARATUS

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Fig. 12.

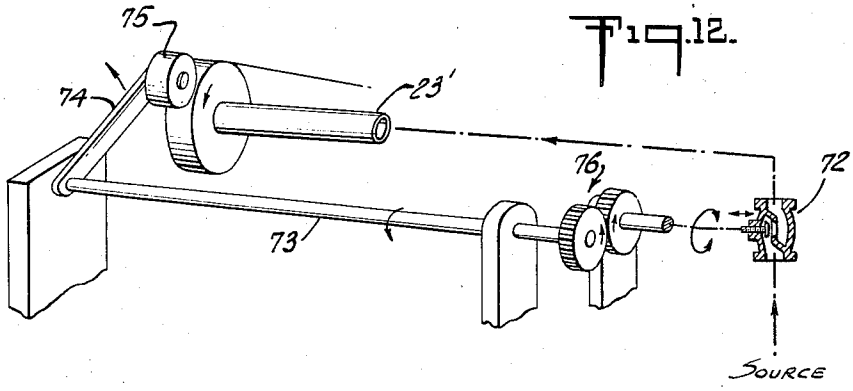


Fig. 13.

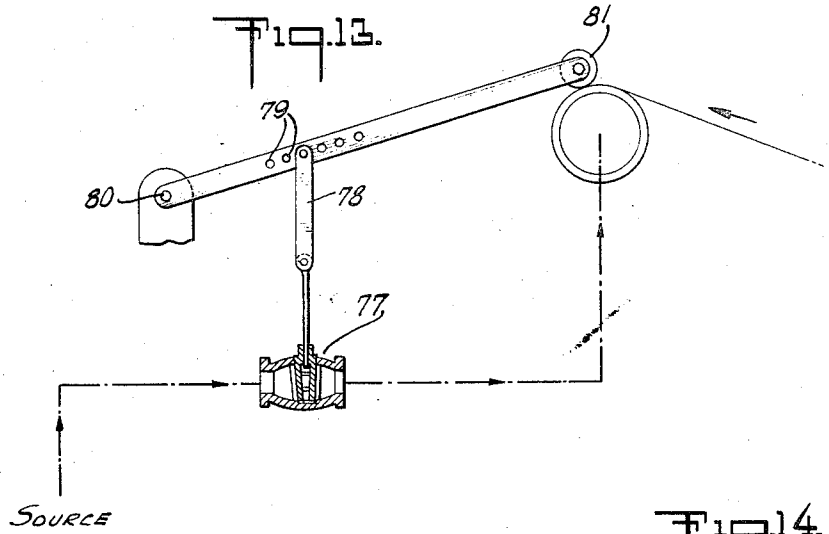
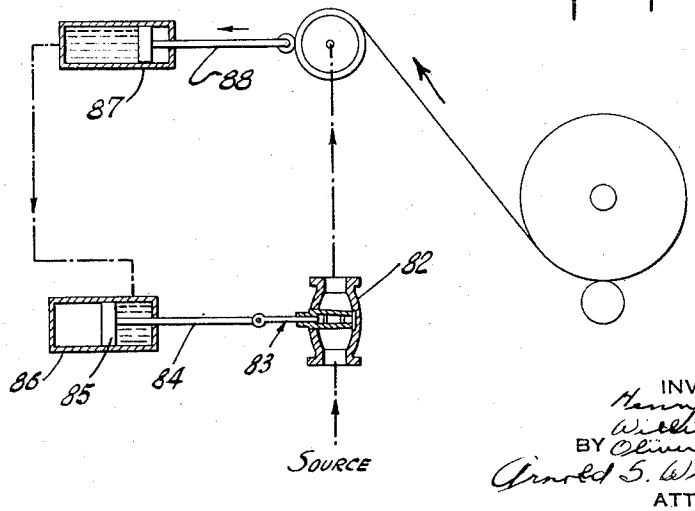


Fig. 14.



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United States Patent Office 2,855,161 Patented Oct. 7, 1958

2,855,161

TAPE WINDING APPARATUS

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Application May 21, 1954, Serial No. 431,562

5 Claims. (Cl. 242—68)

This invention relates to method and apparatus for controlling winding tension in rolls of strip material, particularly rolls that are simultaneously wound up as strips thereof slit from a master roll.

Products, such as surgical tape, masking tape, cellophane tape, and the like, are manufactured in the form of large master or bundle rolls which are slit into strips of desired width and wound in appropriate length on individual cores. It is customary to arrange the individual cores for a number of rolls on a common mandrel which is rotated to wind the strips on the cores as they are slit from the bundle roll. The mandrel is positively driven at a speed which, if the tension of wind in the bundle roll were substantially uniform over its entire width, would render the individual rolls quite satisfactory. But the tension in a bundle roll is not uniform over its entire width. For example, in a bundle roll of paper made by a wet process, the sheet at the edges is frequently looser than at the center so that a roll of tape slit from the edge portion of such a roll is actually appreciably longer than a roll slit from the center portion thereof. In a bundle roll of cloth on the other hand the sheet at the selvaged edges is somewhat shorter than at the center of the roll so that the reverse situation holds true. Somewhat similar situations exist in films of regenerated cellulose or cellulose acetate for example whose gauge cannot possibly be controlled precisely across a wide sheet. In such cases, if the mandrel is set to rotate at a speed to produce rolls of average tension, rolls cut from thin portions of the sheet will appear loose and sloppy, whereas rolls cut from thick portions of the sheet may be wound so tightly as to cause the cores to collapse or the rolls to become misshaped and telescoped.

The effects just mentioned are magnified when the webs are coated with an adhesive as in the manufacture of pressure-sensitive adhesive tape. It is difficult to apply an absolutely uniform film or coating across the entire width of the sheet even when the coating machinery is precisely adjusted. Such difficulties are magnified when the equipment is worn, out of adjustment, or carelessly operated. Variations in thickness over the width of a web being slit, even if slight, may nevertheless cause considerable variation in tension as among a group of rolls wound up therefrom after slitting as such rolls increase in size. To state it differently, variations in roll tension among a group of rolls slitted and wound up from the same bundle roll and resulting from variations in thickness over the width of such bundle roll are increased as the convolutions are increased in the wound up rolls of slitted tape.

In accordance with the present invention, the wind-up tension in a series of rolls of slitted tape is maintained at substantially the same value by applying the same torque to effect the winding of each of such rolls. It is true that despite use of the same winding torque, differences in diameter of the respective rolls at any instant resulting from variations in the thickness of the web being wound may produce some variation in wind-up tension, but such

variation in tension as between the rolls will have no significant effect.

Also in accordance with the present invention, the driving torque on the respective rolls may be controlled during the wind up operation in a manner to maintain tension throughout the length of such rolls substantially constant.

In the preferred embodiment of the invention, the cores on which the respective rolls of tape are wound are driven through individual clutch devices comprising each a member adapted to accommodate a core on which the tape is to be wound and arranged for rotation freely upon a mandrel and a second clutch member arranged adjacent the first and which is fixed on the mandrel. A drive between the respective clutch members is effected preferably through pneumatic pressure occasioned either by establishing a vacuum through that clutch member which is fixed upon the mandrel whereby atmospheric pressure presses the clutch member which is rotatable relatively to the mandrel up against the fixed clutch member, or by pressure in excess of atmospheric occasioned by forcing air under pressure against the movable clutch member so as to cause it frictionally to engage a fixed clutch member on the mandrel.

Whichever type mechanism is used, it is preferred that throughout the winding operation some slippage be permitted between the driving member of the clutch which is fixed on the mandrel and the driven member thereof which is rotatable on the mandrel. This relative movement between the clutch members throughout the winding operation enables a constant driving torque to be established more accurately since it eliminates a variable which otherwise might be introduced due to the difference between stationary and sliding friction. In other words, since the drive between the two clutch members is through surfaces that frictionally engage one another, driving torque transmitted through frictional engagement of the parts can be more accurately regulated if the friction involved is always sliding friction.

A better understanding of the invention may be had from the following description in conjunction with the accompanying drawings wherein:

Fig. 1 is a right end elevation of a machine equipped with the present improvements;

Fig. 2 is a vertical central section on a fore and aft plane through the machine shown in Fig. 1 looking at the parts from the right;

Fig. 3 is a plan view of the machine shown in Fig. 1;

Fig. 4 illustrates a mandrel which has been removed from a machine to facilitate loading thereof with cores and which is equipped with a full complement of clutch members through which the respective cores are rotated to facilitate the winding operation;

Fig. 5 illustrates a mandrel in position in a slitting and winding machine and, in vertical section, a clutch member and a fixture permitting a source of vacuum readily to be established with the end of the mandrel and which facilitates the removal and replacement of the mandrel in the machine;

Fig. 6 is a vertical sectional view on line 6—6 of Fig. 5;

Fig. 7 is a view partly in plan and partly in horizontal section on line 7—7 of Fig. 6;

Fig. 8 is a vertical sectional view on line 8—8 of Fig. 5;

Fig. 9 is a vertical sectional view on line 9—9 of Fig. 5;

Fig. 10 is a view partly in elevation and partly in vertical section of a modification of that part of the clutch member on which the tape core is mounted;

Fig. 11 is an end view partly in section of the clutch member shown in Fig. 10;

Fig. 12 is a perspective view, partly diagrammatic, of mechanism for varying torque to maintain wind-up tension constant regardless of the diameter at any instant of the roll of tape being wound; and

Figs. 13 and 14 are diagrammatic views showing alternate devices for accomplishing the same purpose as the mechanism shown in Fig. 12.

In the embodiment of the invention illustrated, a bundle roll of adhesive sheet material **10** is supported on a mandrel **11** arranged in fixed brackets **12** supported on the machine frame **13** at the rear (Figs. 1, 2 and 3). The sheet material or web **10** is pulled upwardly off the bundle roll, past guide rolls **14** and **15** and thence over and around the upper of a pair of vertically spaced horizontally disposed **S** rolls **16** and thence to the rear of and below the other of said pair of **S** rolls **17** whereby the web is caused to move in an **S** path as it tracks around said rolls. Both the rolls **16** and **17** which are arranged one directly above the other, are positively driven and since the adhesive side of the web **10** is in contact with the upper roll **16** for about three-quarters of its periphery, the tension exerted on the adhesive web is sufficient to pull it with facility off the bundle roll. After leaving the surface of the upper roll **16**, the web passes through the space between it and the lower roll **17**, toward the rear of the latter, and then around the lower roll which it leaves traveling in a forward direction toward the front of the machine.

From the roll **17** the web passes over a guide roll **18** and then under a platen roll **19** where the sheet is slit longitudinally into a plurality of tapes of narrow width **10***a* and **10***b* by a gang of circular knives **20** spaced along the platen roll with which the knives are in edgewise engagement (Figs. 1, 2, and 3). After the slitting operation, every other strip of tape **10***a* passes over a guide roll **21** supported at its opposite ends for rotation in bearings presented at the upper ends of a pair of arms **22** which are mounted one at each side of the machine frame at the front. From the guide roll **21** the tapes **10***a* travel to one or another of the series of cores which are spaced along a mandrel **23** which is detachably mounted at one end on a short stub shaft **24**, which is journalled for rotation in a bearing presented by the arm **22**. The mandrel **23** at its other end is mounted by means permitting its rotation but through which air pressure or a vacuum can be established in a manner presently to be described. A guide roll **26** and a core supporting mandrel **27** provide a similar disposition for the intermediate strips of tape **10***b*. The guide roll **26** and mandrel **27** are mounted in the same fashion as the guide roll **21** and mandrel **23** in a pair of arms **28**. The arms **28** are likewise arranged one on each side of the machine frame.

The **S** rolls **16** and **17** adjacent the rear of the machine, the platen roll **19**, the two guide rolls **21** and **26**, and the two mandrels **23** and **27** on which the tape cores are mounted, are all driven by a mechanism which is a standard on the particular type of slitting machine illustrated. Since it forms no part of the instant invention it need not be described here in detail except to say that contrary to its usual manner of operation it rotates the mandrels at a speed which even during the initial wind of the tape upon the cores is higher than that necessary to wind up the tape at the speed it is delivered from the slitting knives.

A mandrel arrangement which is typical of both the mandrels **23** and **27** is illustrated in detail in Figs. 4 and 5.

For each roll of tape on the mandrel there is a clutch element consisting of two parts **29** and **30**, of which the part **29** is arranged for rotation on the mandrel and accommodates a core **31** on which tape is to be wound, whereas the other part **30** is fixed on the mandrel in manner and for a purpose subsequently described.

The clutch member **29** that accommodates the core **31** is cylindrical in shape with an outer diameter substantially the same as the internal diameter of the core on which the tape is to be wound, a central diameter adapted to permit the member rotatably to fit upon the mandrel **23**, and two flat sides located in parallel planes disposed at right angles to the axis of the mandrel. To prevent the core **31** from turning with respect to the clutch member **29** on which it is mounted as the tape is wound up, such member may be equipped with a series of blades **32** (Figs. 5 and 8) whose ends **33** extend outwardly beyond the periphery of the member **29** so as to bite into the material of which the core **31** is made. The blades **32** may actually be flat leaf springs rounded at their ends **33** and of a width somewhat less than the thickness of the core holding member **29**. The leaf springs are accommodated in a series of recesses **34** formed in the holding member. These recesses are just wide enough to accommodate the leaf springs and their bottoms are flat and so disposed as to be tangent to a pitch circle concentric with the mandrel and of diameter somewhat less than the diameter of the core holding member in which the spring elements are mounted (see Fig. 8). Each spring element is held in its recess by suitable means such as a screw **35** passing through the spring element and threaded radially into the core holding member.

As previously stated, the spring elements **32** at their outer ends extend beyond the periphery of the core holding member so as to bite into the material of the core. The recesses **34** which accommodate the springs are deeper toward their outer ends as at **36** so as to leave the springs unsupported in this region. The depth of the recesses here is such as to permit the ends of the springs to be depressed below the peripheral surface of the core holding member so as to facilitate mounting the core thereon. When a core is mounted on a holding member, and the latter wound in a counterclockwise direction (see Fig. 8), the normal tendency of the spring elements is to dig into the core to prevent relative rotation between the core and its holding member.

The core holding members **29** are designed for rotation with respect to the mandrel on which they are mounted with as little friction as possible and this may be accomplished either by careful machining or by anti-friction bushings or ball or roller bearings if necessary. The exact mounting of the members **29** with respect to the mandrel is such also that it has a limited movement longitudinally of the mandrel as permitted by the other elements **30** of the clutch members between which it is mounted, and for this purpose also its mounting on the mandrel **23** is such as to permit a certain degree of facewise adjustment permitting it to rest flush against the adjacent face of the clutch member in contact with it.

For each of the core holding elements **29** rotatably mounted on the mandrel there is an adjacent driving element **30** which is fixedly mounted on the mandrel. These driving elements are circular in shape with outside diameter slightly less than that of the core holding elements **29** so as not to interfere with the loading of the cores thereon. The driving elements **30** are formed each with a radially drilled hole **37** tapped to accommodate a set screw **38** which is threaded up tightly against the outer surface of the mandrel to hold them fixed with respect to each other. At a point which may be diametrically opposite the radially drilled hole **37**, the driving element is also drilled radially to form a passageway **39** registering at its inner end with an aperture **40** opening into the hollow interior of the mandrel **23**. The radially disposed passageway **39** is closed at its outer end by a plug **41** threaded therein, but the central portion of the passageway is connected by an aperture **42** with an annular channel **43** concentrically disposed with respect to the axis of the mandrel and which is recessed into the face of the fixed clutch element that lies adjacent to and in contact with a face of the associated rotatable clutch element **29**. According to this arrangement, when a source of vacuum is connected to the hollow interior of the mandrel **23, 27** a vacuum is also established in the annular channel **43** of the fixed clutch element which is adjacent the associated movable element on which the core **31** is mounted. By maintaining this vacuum at a constant value while the mandrel is rotated a constant

torque is established which is operative to cause the movable element 29 of the clutch to turn with the fixed element 30 and wind the tape up on the core. Furthermore since the vacuum established in each of the fixed clutch elements is the same by virtue of the similarity of their mounting upon the mandrel, the torque acting upon all of the clutch elements 29 movable on the mandrel is the same. The result is that the winding tension in all of the rolls of tape being wound upon the mandrel likewise will be the same.

The area of contact of the adjacent surfaces of the fixed and movable clutch element and the character of their surfaces are such that there will exist a driving engagement between the parts on the establishment of a vacuum in the annular chamber. Preferably this driving connection is such as always to permit the mandrel to rotate at a speed slightly in excess of the speed at which the movable clutch members are driven so that their drive is always through sliding friction. When the clutches are operated in this fashion, the driving torque acting upon the movable clutch elements will be far steadier than if there were relative movement between the clutch members during some phases of the drive and an absence of relative movement during other phases of the drive.

When one series of rolls of tape have been completed, the mandrels 23, 27 with the rolls of tape thereon are removed from the machine, the rolls removed from the mandrels, and the mandrels then provided with another series of cores 31 and reinserted in the machine to repeat the operation. To facilitate mounting of the cores, a core box of well-known type is used which so locates the cores that when a mandrel with clutches thereon is passed through the series of cores in the core box, one core will be disposed centrally with respect to each of the movable clutch sections 29. In this connection it may be noted that the external diameter of the fixed members 30 of the clutches is slightly less than the external diameter of the clutch members 29 loose on the mandrel so that such fixed clutch members will not interfere with passing the mandrel through the cores so as properly to locate the latter.

When the cores have been properly located on the mandrel, the mandrel is reinserted in the machine by locating the right end 44 thereof which is formed square for the purpose, endwise into a recess of the same shape presented in the inner end of the driven stub-shaft 24 at the right of the machine.

Where the mandrel fits into the machine at its other end, a device 45 is provided which not only holds the mandrel in position and permits its turning but which also establishes an airtight connection between the hollow interior of the mandrel shaft and a source of vacuum not shown but which is connected with a pipe 46 fixed in the supporting frame of the machine in longitudinal alignment with the mandrel. This device 45 comprises a member 47 having a sleeve 48 encircling the pipe through which connection is established with the vacuum source and which is disposed in a recess 49 in the inner face of the frame of the machine through which the pipe projects. The sleeve 48 is formed with a relatively large circular flange 50 near its outer end and is arranged for limited longitudinal movement along the pipe 46 as determined by the engagement on the one hand of the rear face of the flange with the opposed bottom of the machine frame recess 49 and on the other hand by the engagement of the front face of the flange 50 with a pair of lips 51 projecting, one downwardly from a block 52 fixed to the machine frame adjacent the top of the flange and the other upwardly from a block 53 fixed to the machine frame adjacent the bottom edge of the flange. The sleeve member 48 is held in its outermost position wherein the flange engages the opposed lips 51 by a compression spring 54 which encircles the sleeve and reacts between the inner face of the flange 50 and the bottom of the recess 49 in which the sleeve is housed. The sleeve 48 is held against rotational movement by a key 55 engaging in opposed keyways presented one by the outer face of the pipe 46 and the other by the inner face of the sleeve 48.

The sleeve element beyond the outer face of the flange has an extension 56 whose diameter or thickness is somewhat less than the thickness of the main portion of the sleeve (Fig. 5). This extended sleeve section of reduced thickness fits into a hole 57 of substantially the same diameter centrally located in another element 58 fixed to the outer face of the sleeve flange. The member 58 has an outside diameter slightly less than the diameter of the sleeve flange 50 to which it is secured by means of headed screw elements 59 which pass through holes in said element and which are threaded into corresponding holes drilled in the flange.

The centrally located hole in the facing element 58 secured to the sleeve flange is reduced in diameter toward its outer end where the hole portions of different diameter meet a shoulder 60 which serves as the seat for the flange of a hollow nylon tubular member 61. A washer 62 located between the end of the flange member 47 and the nylon tubular member 61 holds the latter member in place when the outer facing member 58 is screwed up tight to the flange. A central hole in the nylon tubular member terminates at its outer end in a beveled portion which serves as a seat 63 to accommodate the rounded end portion 64 of the mandrel. The outer facing element 58 is thickest at the center portion where the nylon tubular member is located. From a region adjacent this thicker central portion, the outer face of the member slopes away toward a thinner outer edge portion. A pair of spaced parallel bars 65 is secured to the facing member 58 adjacent its outer face and which extends upwardly for a distance beyond the incline face of the facing member (Fig. 6). These bars 65 present inner opposed edges which are spaced apart a distance slightly greater than the diameter of the mandrel 23. These bars constitute guide ways which facilitate the insertion of the left end of the mandrel into engagement with the nylon seat. To state it differently, the mandrel is replaced in the machine, first by inserting the squared right end 44 in the socket shaped to receive it and then the rounded left end in between the guide ways 65. Then, by pressing down on the left end of the mandrel, the rounded end 64 thereof is caused to slide along the inclined surface of the facing member 58 which thereby is cammed inwardly against the force of the compression spring 54 until the end of the mandrel slips into a position of rest on the nylon seat. When the mandrel is thus positioned, the spring 54 urges the nylon seat up tight against the end of the mandrel to maintain an airtight seal enabling a vacuum to be established within the hollow interior of the mandrel for operation of the clutch elements in the manner previously described.

It will also be observed that the arrangement just described facilitates removal of the mandrel from the machine merely by pressing the vertical guide bars 65 inwardly against the force of the compression spring 54 so as to permit the mandrel to be slid upwardly off its seat.

A modified form of rotatable clutch member 66 is illustrated in Figs. 10 and 11. This member is the same as the one previously described and which is illustrated in Fig. 8 except for different devices 67 by which the cardboard core elements are held in place. There are three of such devices which are located at positions spaced equally around the periphery of the clutch element. At each of these equally spaced positions there is a recess 68 having a relatively deep portion of lesser width and an outer shallower portion of greater width. These recesses accommodate each a wedge-shaped element 69 whose intersecting faces define a knife edge 70 disposed parallel with the axis of the clutch member. The wedge-shaped elements are pivotally mounted on

studs 71 passing through the walls of the clutch member which define the recess 68 and through the wedge-shaped elements 69 along a line parallel with the knife edge 70 presented thereby. The wedge-shaped elements pivot about the studs on which they are mounted to present the knife edge outside the peripheral contour of the clutch element in one extreme position and to present said knife edge inside the peripheral contour of the clutch element in another extreme position.

According to this arrangement when the wedge-shaped elements are turned to present the knife edges inside the peripheral contour of the clutch element, tape cores may be placed thereon without interference. With the cores in position, rotation of the appropriate clutch members to position the wedge-shaped elements with their knife edges outside the peripheral contour of the clutch members will cause the knife edges to dig into the internal peripheral walls of the cores so as to hold the cores against relative rotation with respect to their clutch members during winding up of the tape.

It is true that when wind-up torque is maintained constant in winding up a given roll of tape, tension in that roll will decrease to a certain extent as the roll becomes larger. Should it be desirable to maintain the tension constant throughout the winding of the roll or even increase the tension as the roll becomes larger that may be done by devices similar to those shown in Figs. 12, 13, or 14.

In Fig. 12 a hollow mandrel 23' on which cores are mounted as in the embodiment previously described is connected with a source of vacuum through say a globe valve 72 which can be opened or closed to produce a greater or a lesser degree of vacuum in the mandrel as desired. A rock shaft 73 rotatably mounted near its ends in a fixed part of the machine and parallel with the mandrel may be arranged for rotation by an arm 74 fixed to the shaft and which has a roller 75 at its outer end adapted to engage the periphery of a roll of tape on the mandrel. As the roll of tape increases in size, the shaft is rocked in a counter clockwise direction looking at the parts from the right. As the shaft is thus rocked, intermeshing gears 76 fixed one on the shaft and the other on the stem of the valve 72 will open the valve and increase the vacuum, and thereby increase the torque. The ratio between the gears can be selected to give any desired increase in torque and consequently tension in the tape as it is wound up for any increase in diameter of the roll of tape.

Another arrangement for accomplishing the same purpose is illustrated in Fig. 13. According to this arrangement, a gate valve 77 is connected between a source of vacuum and a hollow mandrel equipped with individual clutches for the cores as previously described. The rate at which the valve is opened can be made to depend upon the position of a link 78 connecting its gate with a lever 79 having a fixed pivot 80 at one end and a roller 81 at its other end which tracks along the periphery of a roll of tape being wound up. By adjusting the upper end of the link 78 along the lever to the right, a given increase in the diameter of the roll of tape will effect a greater opening of the valve for a given increase in the size of the roll, whereas adjustment of the link to the left will cause a smaller opening of the valve for a given increase in the diameter of the roll. Since the degree of vacuum can be made to depend upon the degree of valve opening, it is apparent that this arrangement can be used to vary the wind-up torque and consequently the wind-up tension in the tape in accordance with the increase in the diameter of the roll of tape.

Still another arrangement for accomplishing the same result is illustrated diagrammatically in Fig. 14. In this arrangement a hollow mandrel on which rolls of tape are wound as previously described is connected with a source of vacuum likewise through a gate valve 82. A link 83 that facilitates the opening of the valve is connected with a piston rod 84 attached to a piston 85 in a hydraulic cylinder 86 so arranged that as fluid is forced into the cylinder on one side of the piston, a greater opening of the gate valve is effected. This cylinder has a connection with another hydraulic cylinder 87 having a piston and piston rod 88 whose outer end has a friction roller 89 arranged to track along the periphery of a roll of tape as it is wound up. As the roll of tape increases in diameter, the piston is moved to the left to transfer the fluid from the second cylinder into the cylinder first described in a manner to effect opening of the gate valve. With this arrangement, variation in wind-up torque and consequently in tension of the tape being wound may be secured depending upon the increase in diameter of the roll of tape.

The invention has been described in connection with a limited number of modifications, but many other modifications are included within its spirit. It should be limited therefore only by the scope of the appended claims.

What is claimed is:

1. Apparatus for winding strips of material slit from sheet material of greater width each on individual cores, including a hollow mandrel, a plurality of devices mounted for independent rotation on the mandrel and adapted to accommodate the cores on which the respective strips are to be wound, a corresponding plurality of means positively driven by the mandrel and associated one with each of said devices for individually driving the same, each said means including a connection with a common passageway in the mandrel for establishing pneumatically and simultaneously a driving relationship between the driven devices and their corresponding driving means, whereby substantially the same driving torque is simultaneously imparted to all of said devices by their respective driving means.

2. Apparatus for winding strips of material slit from sheet material of greater width each on individual cores, which apparatus includes a hollow mandrel, a plurality of devices mounted for independent rotation on the mandrel and adapted to accommodate the cores on which the respective strips are to be wound, and means individual to the respective devices and positively driven by the mandrel for driving said devices, each said means including instrumentalities for establishing a vacuum connection between the corresponding device it drives and a common passageway in the mandrel through which the vacuum is established, whereby substantially the same driving torque is simultaneously imparted to all of said devices by their respective driving means.

3. Apparatus according to claim 1 which includes further a hollow bearing to accommodate and rotatably support at one end the mandrel which likewise is hollow, said bearing being yieldable endwise of the mandrel to facilitate the latter's removal from and reinsertion in the machine and being adapted, when the mandrel is in the machine, to establish an air-tight connection between the hollow mandrel and the hollow bearing.

4. Apparatus according to claim 1 wherein means are provided for varying the air pressure through which the driving connection is established substantially in accordance with variations in the diameter of the roll of tape being wound whereby substantially to maintain tension in the strip material constant throughout the roll.

5. Apparatus according to claim 3 wherein the hollow bearing is connected with a source of vacuum.

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