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van Meijel et al.

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[54] **WEB TRANSPORT SYSTEMS FOR COPYING MACHINES**

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[51] **Int. Cl.**.....**F03b 27/10,** G03g 15/00

[58] **Field of Search**.....355/16, 17, 14, 111; 242/67.3 R, 67.4

[56] **References Cited**

UNITED STATES PATENTS

3,480,361	11/1969	Doi et al.	355/16
3,417,934	12/1968	Palm	242/67.3 R
3,380,679	4/1968	Komas et al.	242/67.3 R

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[57] **ABSTRACT**

A copying apparatus having a processing zone in which images are formed on a continuous light-sensitive web and then transferred from it to copy material is provided with two such webs which extend and are moved simultaneously between holding means, e.g., one or two rotary winding spools or other web storage devices, and take-up means such as one or two rotary spools, and with displaceable means which engage leads of said webs so as to guide one of them through the processing zone and thence to the take-up means or the holding means while the other web is being moved directly to the latter and which, upon being displaced to a second working position with reversal of the direction of movement of the webs, will guide the other web through the processing zone and thence to the holding means or the take-up means while passing the one web directly back to the latter. The displaceable guide means may be constituted by a hollow structure, such as a slotted cylindrical drum or a series of rollers in an angular arrangement, which has a lateral opening for the web leads, is rotatable through an angle of at most 360°, has rotary spool means mounted therewithin, and has the processing zone disposed about its outer periphery. In apparatus having a rectilinear or slightly curved processing zone, the guide means may comprise a set of rollers displaceable between working positions at opposite ends of such zone.

11 Claims, 5 Drawing Figures

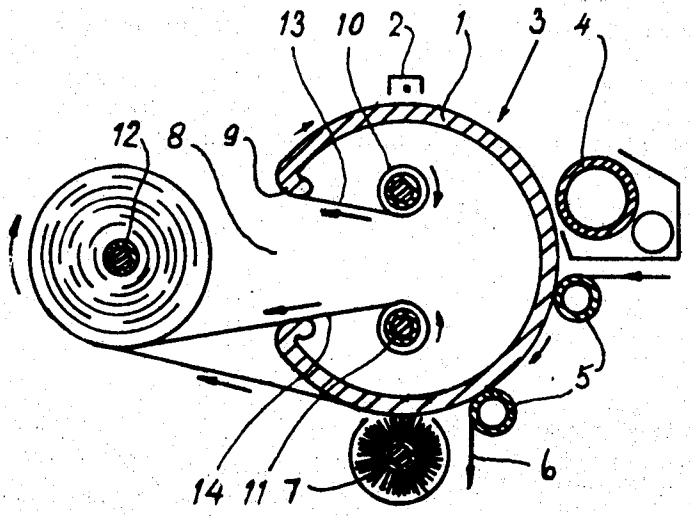


FIG. 1

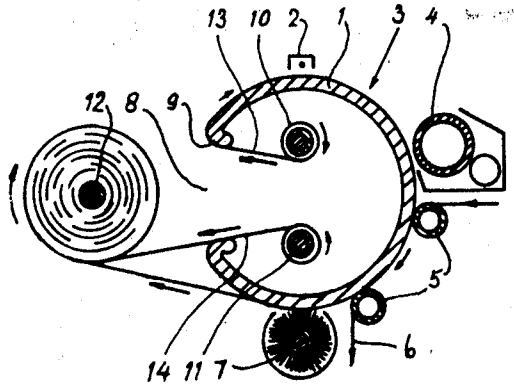


FIG. 2

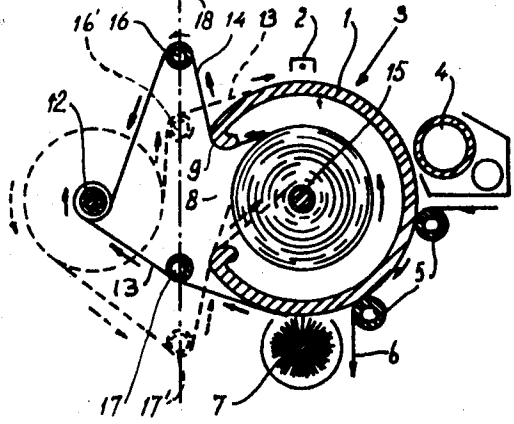


FIG. 3

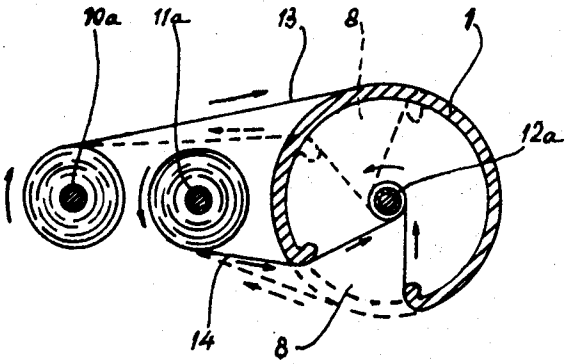


FIG. 4

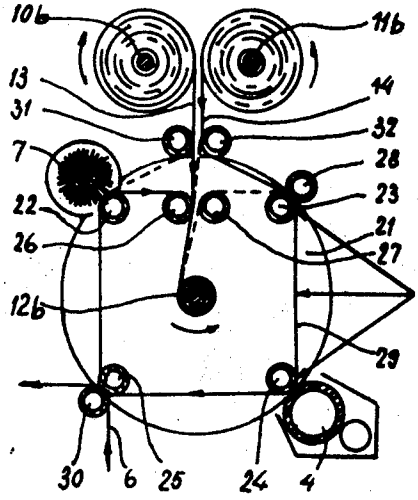
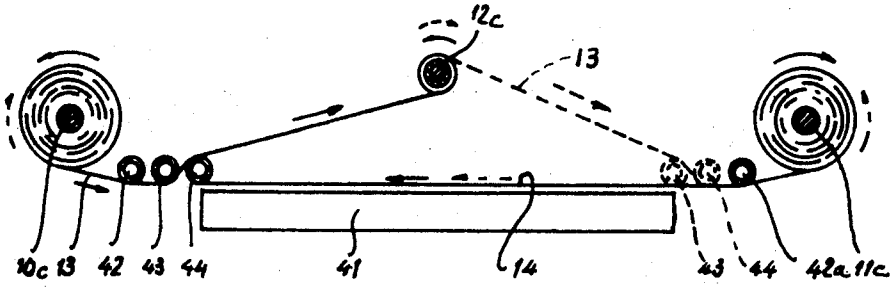


FIG. 5



WEB TRANSPORT SYSTEMS FOR COPYING MACHINES

This invention relates to a web transport system for copying machines of the kind provided with a stock of light-sensitive or sensitizable material in web form, with processing stations to form images from originals on the web and transfer these images onto copy material, and with a conveyor system operable either to feed the web from the stock to a take-up spool or the like or to return it from the take-up spool to the stock.

In known machines of this kind, as described e.g. in German Gebrauchsmuster 1 757 938 and German Offenlegungsschrift 1 597 832, the web material after being transported from the storage spool and wound on the take-up spool is returned to the storage spool by reversing the direction of the conveying mechanism. The web then moves in reverse direction through the machine and passes the various processing stations in a sequence which is unsuitable for making copies. Hence the machine cannot be used during rewinding of the web. When the stock of web material is relatively large, and usually a large stock will be employed because it enables longer operation of the machine without replacement of the web, the waiting period required for rewinding the web may be costly and/or highly annoying to the user of the machine. Moreover, the web may be adversely affected by being moved along the processing stations during rewinding.

The object of the present invention is to provide an improved system for transporting webs of light-sensitive or sensitizable material in a copying machine, by which the above mentioned objectionable features of known machines of the kind described are alleviated or overcome.

According to this invention, the stock of web material provided in the machine consists of two light-sensitive webs which are driven simultaneously by the conveying means and the conveying means comprise displaceable web guiding means which, when the webs are being delivered from the stock, are disposed in a position such that only one of the webs is passed through the processing stations and which, when the webs are to be returned to the source of the stock, are displaced to another position in which they cause only the other web to be passed through the processing stations.

In this way one web forming a portion of the stock of light-sensitive material passes the processing stations when being drawn from the stock, and the portion of the stock formed by the other web passes the processing stations when being returned to the stock source.

The displacement of the guiding means also makes it possible to have the web that is to be used for the copying process always passing the processing stations in the direction required for copying. Thus the machine can be used for almost continuous operation. A pause may be necessary only for displacing the guiding means; but this need only be of very short duration, so that no objectionable waiting period is involved.

Moreover, the invention makes it possible, e.g. with the aid of a device scanning the diameter of a storage spool or the height of a stored pile, to reverse automatically the conveying direction and the web being processed in such a way that the user of the machine does not notice the transition.

Machines embodying the invention can be designed in many ways. In a particularly useful construction, a separate storage spool is provided for each web and the machine is provided with one take-up spool onto which both webs are concentrically wound and unwound together.

According to another feature of the invention, which is advantageous for many uses, the displaceable guiding means comprise a rotatable structure having within its outline a space in which the take-up spool or spools or the storage spools are arranged, while the other spool or spools for storage or take-up, respectively, are arranged outside that space. This rotatable structure can be locked in the above-mentioned positions and can be brought from one to the other of them by being rotated through an angle of at most 360°, or can be brought to its original position by being turned through an arc of 360°. It is provided with an opening or slot through which the webs are directed into the space within it or are pulled out of it, respectively, when the webs are moving from the storage spool or spools or are being returned to the same. And means are provided which in one position of said rotatable structure direct the one web along the processing stations by guiding it over a peripheral portion of said structure then located opposite to the processing stations, and which in the other position of said structure guide the other web over its peripheral portion then located opposite to the processing stations.

By virtue of such an arrangement, the processing stations can be disposed circumferentially about the space enclosed by the rotatable structure, so that a compact machine construction can be obtained.

Moreover, in that arrangement, web engaging borders of the opening or slot of said structure may be provided by web-engaging surfaces of two transport rollers running side by side in bearings.

In a desirable embodiment of the invention, a rotatable structure as mentioned above is constituted by a slotted hollow cylindrical drum having its outer surface formed to offer little friction against movement of the web material thereover. In another very desirable embodiment the rotatable structure has an angular form the corners of which are formed by guide rollers, and the processing stations are arranged opposite to these guide rollers.

In an embodiment of the invention especially suitable for processing webs moved through a straight or slightly curved processing zone, the displaceable guiding means comprise a set of guide rollers which can be shifted from one to the other of the above-mentioned positions along the front of a straight or slightly curved assembly of exposure and processing elements.

The invention will be further understood from the following detailed description and the accompanying drawings of illustrative embodiments thereof which are designed especially for making copies by electrophotography.

FIG. 1 is a schematic view of an embodiment of the invention in which the displaceable guiding means comprise a slotted cylindrical drum;

FIG. 2 is a schematic view of similar apparatus having a different arrangement of parts;

FIG. 3 shows schematically a third embodiment making use of a slotted cylindrical drum;

FIG. 4 is a schematic view of an embodiment of the invention in which the displaceable web guiding means

comprise a rotatable structure of substantially angular form; and

FIG. 5 shows schematically a simple embodiment in which the guiding means comprise a set of rollers slidable substantially rectilinearly along the front of a straight assembly of processing elements.

Referring more particularly to FIG. 1, the embodiment shown makes use of displaceable web guiding means constituted by a slotted drum 1 having a smooth outer surface. This drum normally is stationary but can be rotated about its center on the axis of the cylindrical outer surface. The various elements required for processing the light-sensitive web material are arranged at fixed locations about the periphery of the drum 1 so that they do not rotate with the drum. The drawing schematically shows as such processing elements an electrostatic charging device 2, an exposure zone 3, a developing device 4, a transfer means comprising peripherally spaced rollers 5 which press a piece or web 6 of copy paper against a peripheral portion of the drum, and a web cleaning device 7.

The drum 1 is provided with a wide opening or slot 8, formed as a gap or interruption in the drum wall. The axial borders or edges of this opening are rounded as shown at 9 or, instead of being so rounded, they may be formed by rollers to reduce further the friction on the web material drawn over them. The rounded edges 9, or rollers used in their place, extend axially over the whole axial length of the opening 8 in the drum 1.

The drum 1 houses two web storage spools 10 and 11. A web take-up spool 12 is situated outside the drum in front of the opening 8.

The arrows in the figure indicate the movement of the light-sensitive web 13 as it is unwound from the storage spool 10 during the copying operation and the movement of the web 14 which is then being drawn simultaneously from spool 11. The web 13 passes over the upper rounded edge 9, then along the processing stations over a major portion of the outer periphery of the drum, and thence to the take-up spool 12. The web 14 passes simultaneously from spool 11 through the opening 8 directly to the take-up spool 12.

The drum 1 is made with a smooth outer surface so that the web material can be drawn over it without much friction.

The operation of the apparatus of FIG. 1 is as follows: At the outset, each of the two storage spools 10 and 11 may have a load of the web material wound upon it and extending to the take-up spool 12 in the manner described. During the copying operations the webs 13 and 14 are drawn onto the take-up spool 12, which is driven in the direction indicated by the arrow. The spools 10 and 11 may also be driven as indicated by arrows. The speed of the webs is selected as desired for the copying process. As the web 13 passes about the drum 1 through the processing stations it is charged, exposed, developed and caused to transfer the image, after which the web 13 is cleaned at 7 and then is wound upon the take-up spool 12 in doubled relation to the web 14 which is drawn simultaneously onto spool 12 from storage spool 11.

When the supply of the web 13 on storage spool 10 comes to an end, the web 14 is used as soon as possible for exposure, etc. To enable this, drum 1 is turned clockwise by one full revolution, i.e., through 360°. The storage spools 10 and 11 are rotated with the drum, but the web processing means remain stationary. It will be evident that while the drum has returned to its original position shown in the drawing, the web 13 now extends directly from the storage spool 10 to the take-up spool 12, while the web 14 now extends from the storage spool 11 about the outer surface of drum 1 along the processing stations and thence to the take-up spool 12.

During the rotation of the drum 1 the direction of rotation of the spools 10, 11 and 12 is reversed, so that on further copying the double-wound webs are pulled from the supply thereof accumulated on spool 12 and each of them is returned to its own storage spool 10 or 11. This reversal of the direction of rotation causes web 14 to pass the processing stations in the correct direction and sequence. Thus the copying operations can be continued immediately after the storage spools 10 and 11 have been unloaded, but now via web 14, whereas during this period of the copying web 13 is rewound onto storage spool 10. The rewinding is effected slowly, at a speed equal to the copying speed, but since this does not affect the copying operation it involves no inconvenience. Thus the webs 13 and 14 can be used alternately for exposure, etc. with no loss of time other than the brief interruption required for rotating drum 1 and reversing the direction of rotation of the spools.

FIG. 2 shows an embodiment of the invention making use of a single storage spool 15 and a single take-up spool 12. Here two webs are double-wound on the same spool 15 inside the drum 1. The processing stations, the form of the drum, etc. may be as described in reference to the embodiment of FIG. 1. When the spools 12 and 15 rotate in the direction of the solid-lined arrows, web 13 passes around drum 1 and web 14 is led directly to the take-up spool 12. When the webs come to their end on the storage spool 15, the drum 1 is turned clockwise through 360°, which results in a disposition of the webs as indicated by dotted lines, and the direction of rotation of the spools 12 and 15 is reversed.

The arrangement of FIG. 2 would, without further provisions, normally require a shifting of the positions of the webs 13 and 14 on the spools during the reversion, because the path of web 13 from the storage spool 15 to the take-up spool 12 is different from that of web 14, so that the path of web 13 is longer than that of web 14 in one position of drum 1, whereas just the reverse condition exists in the other position of drum 1. To compensate for this difference in length, guide rollers 16 and 17 are provided which are movable, e.g. on slide rails (not shown), along a path 18 transverse to the web paths between the drum and spool 12. The rollers 16 and 17 can be held at one end of their path, for example, by one or more springs pressing or pulling them towards this one working position, and can be shifted to another position at the other end of their path by a suitable mechanism acting against the springs. When the webs 13 and 14 are in the paths shown in full lines, roller 16 increases the length of the path followed by web 14 from spool 15 to spool 12, and roller 17 is then located so that web 13 travels in a much shorter path between drum 1 and spool 12. When drum 1 is turned through 360° and the direction of rotation of the spools 12 and 15 is reversed, roller 16 is brought into position 16′ and roller 17 into position 17′, so that the path of web 13 between drum 1 and spool 12 is lengthened and that of web 14 is shortened.

FIG. 3 illustrates an embodiment making use of two storage spools 10*a* and 11*a* located outside a rotatable

web guiding drum **1**, and a take-up spool **12***a* arranged centrally inside that drum. Solid lines and solid arrows indicate the disposition and the paths of the two webs **13** and **14** during the unwinding from the storage spools. Broken lines and broken arrows indicate the reverse operating condition, for rewinding the webs **13** and **14** onto the storage spools **10***a* and **11***a* after the take-up spool **12***a* has been entirely loaded. As is apparent from the drawing, in this embodiment the drum **1** is turned counterclockwise through approximately 210°, instead of clockwise through 360° as in FIG. **1** and FIG. **2**, at the time of shifting the apparatus for the use of web **14** instead of web **13**. A smaller extent of rotation of the drum is of course also possible.

From the foregoing examples it is apparent that a rotatable slotted drum can be employed with two webs according to the invention in any of a great variety of ways, whether with one or two take-up spools or with one or two storage spools, and whether the storage spool or spools or the take-up spool or spools are located inside the drum.

FIG. **4** illustrates a further embodiment of the invention, in which the displaceable web guiding means are constituted by a rotatable assembly of rollers. Two rotatable end flanges **21** have rollers **22, 23, 24** and **25** extending between them adjacent to their periphery. The rollers are mounted in bearings for free rotation or, if required, some or all of them can be driven. In addition, transport rollers **26** and **27**, which may be driven or not, extend between the end flanges and are arranged to provide a passageway or slot through which two webs **13** and **14** pass to and from a take-up spool **12b** which extends between the end flanges on the axis of the assembly.

Opposite to roller **23** lies a roller **28** for electrostatically charging the web material. The straight lead **29** of the web material between the rollers **23** and **24** is situated in an exposure zone indicated by three arrows. The developing means **4** is situated opposite to roller **24**, and opposite to roller **25** is situated a roller **30** which presses the copy paper **6** against the web material on roller **25** for transferring the image. A cleaning unit **7** is situated opposite to roller **22**.

Two storage spools **10***b* and **11***b* are provided outside the described assembly of rollers, with the webs **13** and **14** running from them to the take-up spool **12b** located at its center. For guiding the webs, two further rollers **31** and **32** are provided above the rollers **26** and **27** in fixed positions exterior to the end flanges.

During copying operations with the assembly in the position illustrated, the take-up spool **12***b* is driven in the direction indicated by an arrow, by a drive journal or shaft extending through one of the end flanges **21**, while the storage spools **10***b* and **11***b* rotate in the directions indicated by their arrows; so the webs **13** and **14** move along paths shown in full lines. Thus, web **13** passes directly over rollers **31** and **26** to the take-up spool **12***b*, while web **14** passes over guide roller **32** to roller **23**, thence over rollers **24, 25** and **22** and finally via roller **26** to take-up spool **12***b*. A large flat region for exposure of the web is obtained in the exposure zone **29**, which makes it possible to project an original properly in full size by a momentary flash exposure. This may be of great utility, e.g. in copying books, since a good copy of a stationary original can thus be obtained during continuous movement of the light-sensitive web.

The end flanges **21** can be rotated in any desired manner. For instance, one or both of them may have peripheral gear teeth engaging with a drive pinion.

When the webs are drawn off to their ends on the storage spools **10***b* and **11***b*, the take-up spool **12***b* then being loaded, the flanges **21** with all the rollers supported by them are turned counterclockwise through 360°, as viewed in FIG. **4**, and the directions of rotation of the spools are reversed. Web **13** is now returned from take-up spool **12***b* over roller **27** and about the rollers **23, 24, 25, 22** and **31** to storage spool **10***b*, while web **14** is led from take-up spool **12***b* in contact with roller **26** and over roller **32** to storage spool **11***b*. When the flanges **21** are rotated, the rollers **31** and **32** and the processing units **28, 4, 30, 7**, etc. remain in their original positions.

A rotatable assembly of rollers such as illustrated in FIG. **4**, as well as the apparatus making use of a slotted drum, can have the spool or spools upon which the webs are stored at the outset of the copying operations located optionally either outside or inside the end flanges **21**.

FIG. **5** shows an apparatus according to the invention in which the web processing elements are situated one beyond another in a rectilinear arrangement schematically indicated at **41**. Web storage spools **10***c* and **11***c* are located beyond the opposite ends of the array **41** of processing elements, and a take-up spool **12***c* is situated in the middle above this array. Stationary guide rollers **42** and **42***a* are provided near the storage spools **10***c* and **11***c*. These rollers can rotate freely when the storage spools are driven, or can be driven with mating rollers to effect driving of the webs.

The displaceable web guiding means in this embodiment comprise a pair of guide rollers **43** and **44** which are mounted, as on a suitable carriage, for sliding movement along the front of the processing stations at **41** from one end to the other end thereof. As shown in full lines in FIG. **5**, the pair of guide rollers **43** and **44** is situated near roller **42**, and the spools **10***c*, **11***c* and **12***c* are rotated in the direction indicated by full arrows. Consequently, web **13** travels from spool **10***c* over roller **42** and between the rollers **43** and **44** directly to the take-up spool **12**, while web **14** passes from storage spool **11c** via guide roller **42a** through each processing station of the apparatus, from the right end to the left end of array **41** as viewed in the drawing, whence the web **14** is drawn about roller **44** and then onto the take-up spool **12***c* on which it is wound together with web **13**.

When the webs are fully unwound from the storage spools **10***c* and **11***c*, the take-up spool **12***c* then being loaded, the direction of rotation of these spools, or of the rollers **42** and **42***a* if they are being used for driving the webs, is reversed and the set of rollers **43** and **44** is moved to the right entirely along the line of processing elements to the position of these rollers shown in broken lines, in which they are situated adjacent to roller **42***a*. The webs **13** and **14** now leave the take-up spool **12***c*, with the web **13** being drawn first over the roller **43** as shown in broken lines, then along the processing stations at **41** in the same direction as previously was the case in the use of web **14**, and then via the left-hand roller **42** onto spool **10***c*. Web **14** travels simultaneously from spool **12***c* between the rollers **43** and **44** and via the right-hand roller **42***a* directly to its storage spool **11***c*.

Embodiments of the invention similar to those illustrated can readily be employed for copying methods other than electrostatic photocopying.

The webs are preferably driven in such a way that the web speed is kept constant during the copying operations. This can be achieved by using a suitable drive for one or more of the spools, by which the rotational speed is varied as the diameter of the winding web roll increases. As generally recognized, however, it is often desirable in this regard to use independently driven web transport rollers, such as the rollers **31, 32** and/or **26, 27** in FIG. **4** or roller pairs including the rollers **42** and **42a** in FIG. **5.**

A desired moment for displacement of the web guiding means and reversal of the direction of movement of the webs can be determined by use of a scanning device acting on one or more of the web spools, which will emit a reversing signal as soon as the relevant spool is desirably loaded or empty.

What is claimed is:

1. A copying apparatus comprising a processing zone having disposed therealong processing means for forming images on a continuous web of light-sensitive or sensitizable material and for transferring such images to copy material, means for holding a stock of two such webs, means disposed away from said holding means for taking up said two webs, means respectively for feeding said webs simultaneously from said holding means to said take-up means and for feeding them simultaneously in the return direction, and displaceable guide means to engage leads of said webs between said holding means and said take-up means and having two working positions in one of which it guides one only of said webs through said processing zone and in the other of which it guides only the other of said webs through said processing zone.

2. Apparatus according to claim **1,** said web feeding means being operative to draw both of said webs to said take-up means while said guide means is in said one position and to draw both of said webs to said holding means while said guide means is in said other position, whereby said other web is moved to a position for being used while said one web is being used for copying and said one web is returned to a position for reuse while said other web is being used for copying.

3. Apparatus according to claim **1,** said displaceable guide means comprising a rotatable hollow structure having mounted therewithin rotary spool means constituting said holding means or said take-up means, having said processing zone disposed about the outer periphery thereof, and having a lateral opening through which respective leads of said webs extend from said spool means, said structure being rotatable through an angle of at most 360° between two fixed positions thereof in one of which only said one web, and in the other of which only said other web, extends from said opening about said periphery and thence to said take-up means on said holding means.

4. Apparatus according to claim **3,** said opening being bounded along opposite sides thereof by rounded surfaces of said structure, upon which surfaces said web leads pass during movement thereof between said holding means and said take-up means.

5. Apparatus according to claim **3,** said opening being bounded along opposite sides thereof by rollers rotatably mounted in said structure, upon which rollers said web leads pass during movement thereof between said holding means and said take-up means.

6. Apparatus according to claim **3,** said rotatable hollow structure being a cylindrical drum having a smooth outer surface exerting little frictional resistance to movement of said webs thereover.

7. Apparatus according to claim **3,** said rotatable hollow structure having an angular cross-section and being defined by web guiding rollers at the corners thereof, at least some of the elements of said processing means being disposed opposite to said rollers.

8. Apparatus according to claim **3,** said spool means being a single spool for taking up said two webs simultaneously, said holding means being disposed outside said rotatable hollow structure.

9. Apparatus according to claim **3,** said spool means comprising two spools inside said structure, one for holding and unwinding or winding each of said webs, said take-up means comprising a single spool outside said structure for simultaneously winding or unwinding said webs in concentric relation thereon.

10. Apparatus according to claim **1,** said processing zone having a substantially rectilinear or slightly curved disposition, said displaceable guide means comprising a set of rollers movable along said zone between said working positions which are located respectively at opposite ends of said zone.

11. Apparatus according to claim **1,** said holding means and said take-up means each comprising a single rotary spool for winding or unwinding said two webs simultaneously in concentric relation, and web positioning rollers respectively engaging said web leads between said guide means and one of said spools, said rollers being displaceable from one to another of two positions to compensate for differences of the lengths of said web leads which exist in said two positions of said guide means.

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