

[54] **APPARATUS TO EFFECT REMOTE
AUTOMATIC POSITIONING OF WEB
SLITTER**

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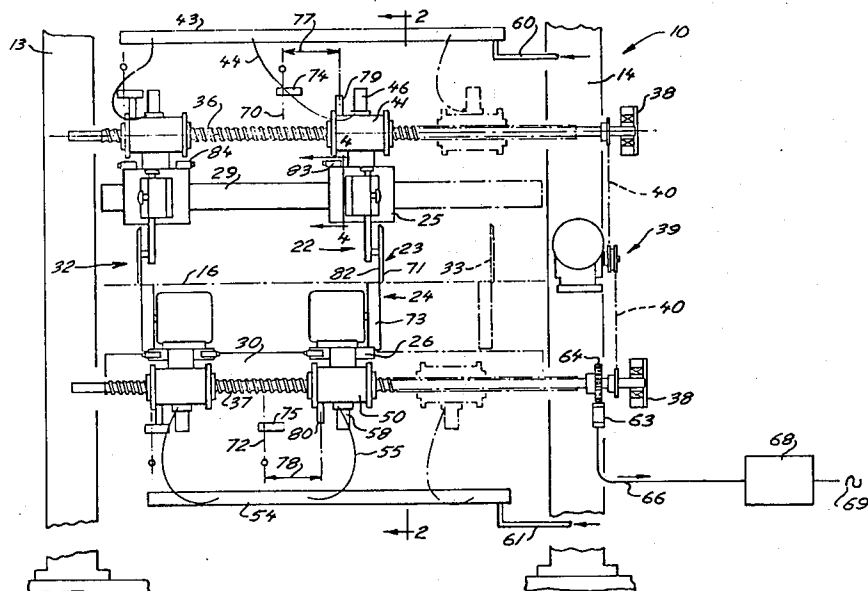
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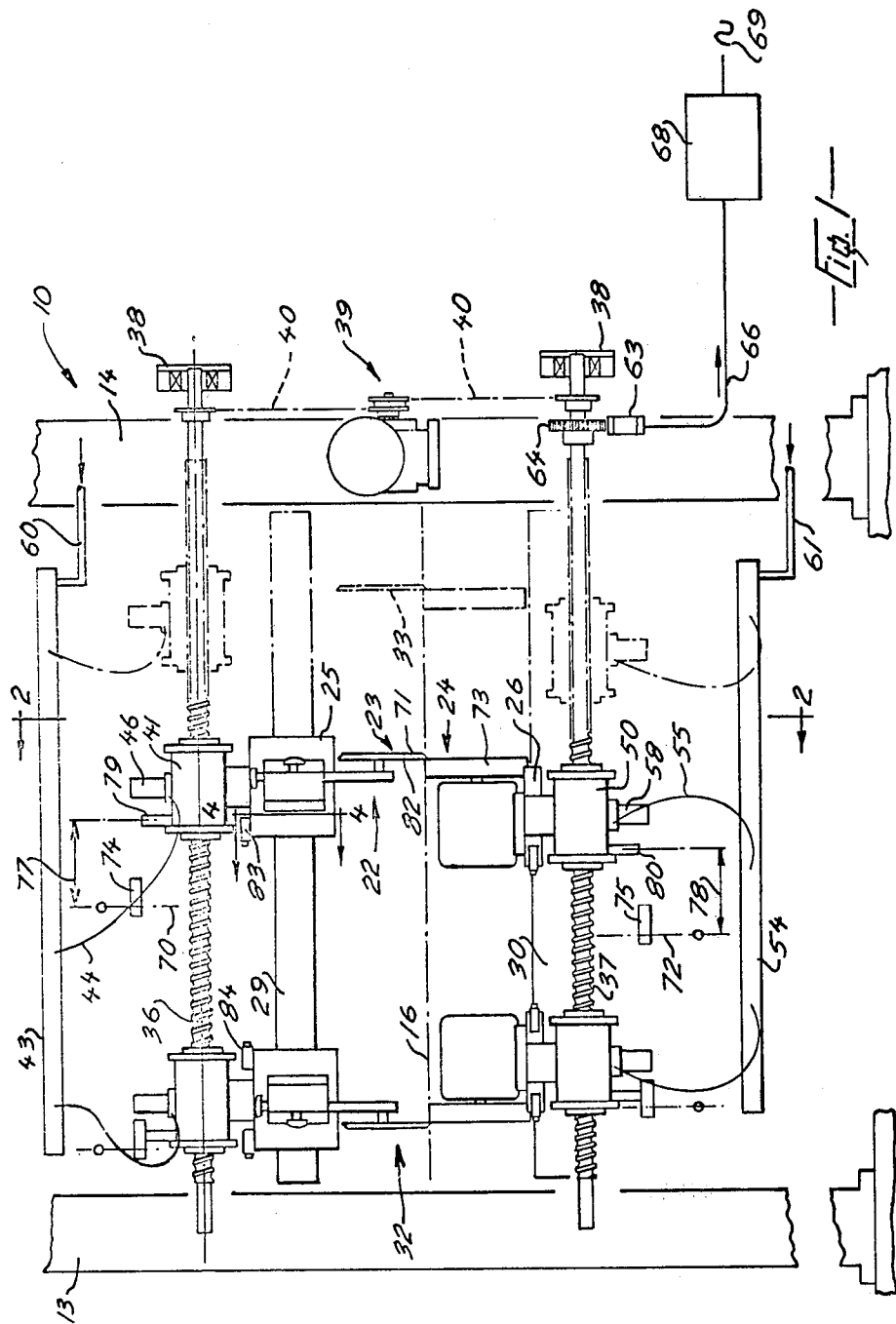
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ABSTRACT

Positioning apparatus to position automatically slitting devices of a slitting machine. Web of sheet material passing through machine is slit to required width by slitting devices, bases of which are mounted on rails extending transversely across web. Transmission means for moving slitting devices along rails includes a feed screw mounted for rotation adjacent to each rail and parallel therewith, a feed nut engaging the feed screw and cooperating with slitter base, a clutch means permitting relative rotation between nut and slitter base in freewheeling mode and preventing relative rotation in feed mode, and a brake means cooperating with slitter base and respective rail to lock slitter base to rail in freewheeling mode. Reversible drive means rotate the feed screws so that both slitter bases move together in feed mode. Electrical datum switch means is provided adjacent rail for each slitter base, and counter counts revolutions of feed screw from particular instant to determine position of particular slitter from respective datum. Electronic control means connected to clutch means, brake means, drive means, datum switch means and counter, processes and verifies signals for actuating the brake and clutch means and feed screws to attain desired position of slitters.

14 Claims, 7 Drawing Figures





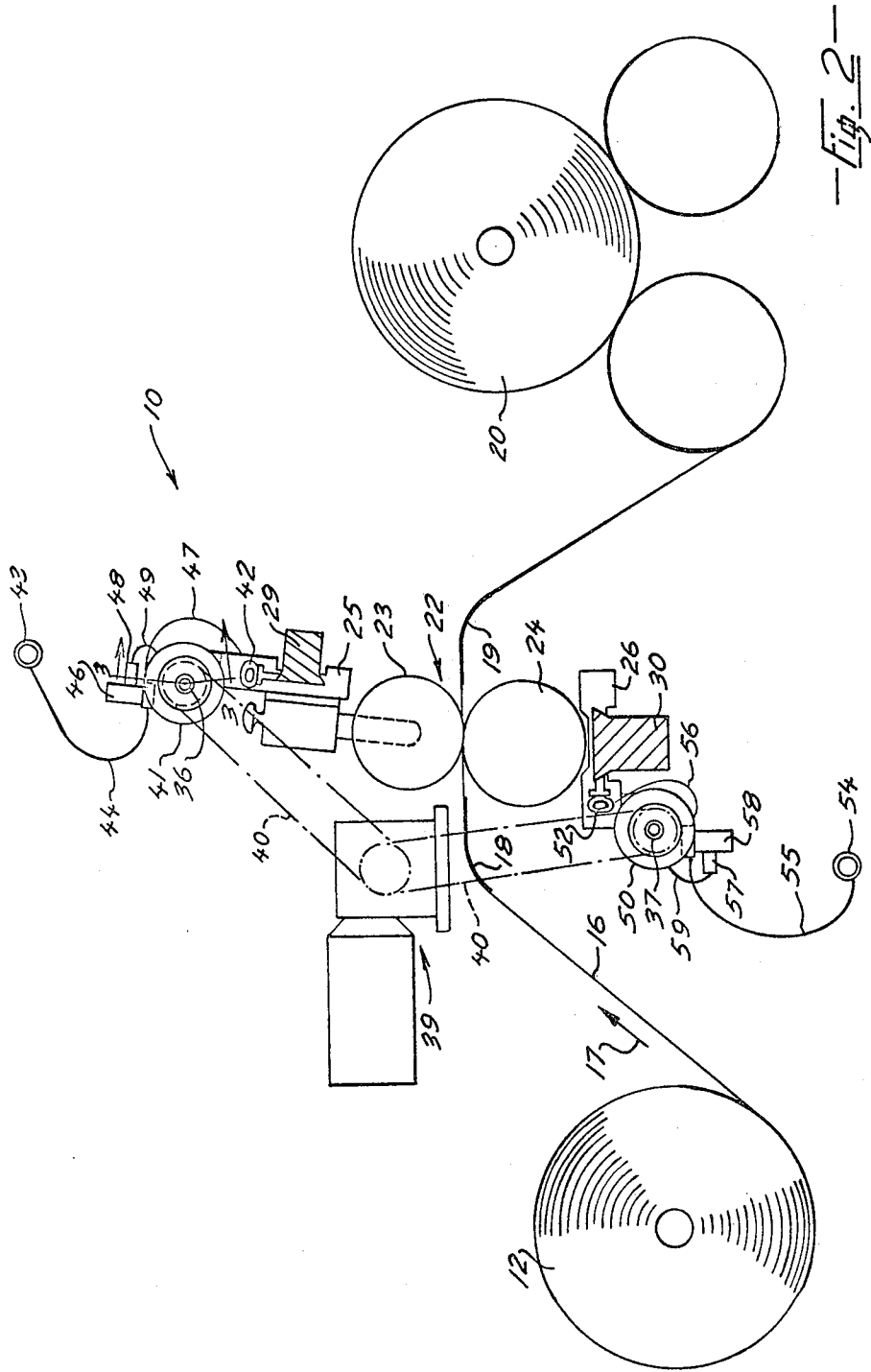
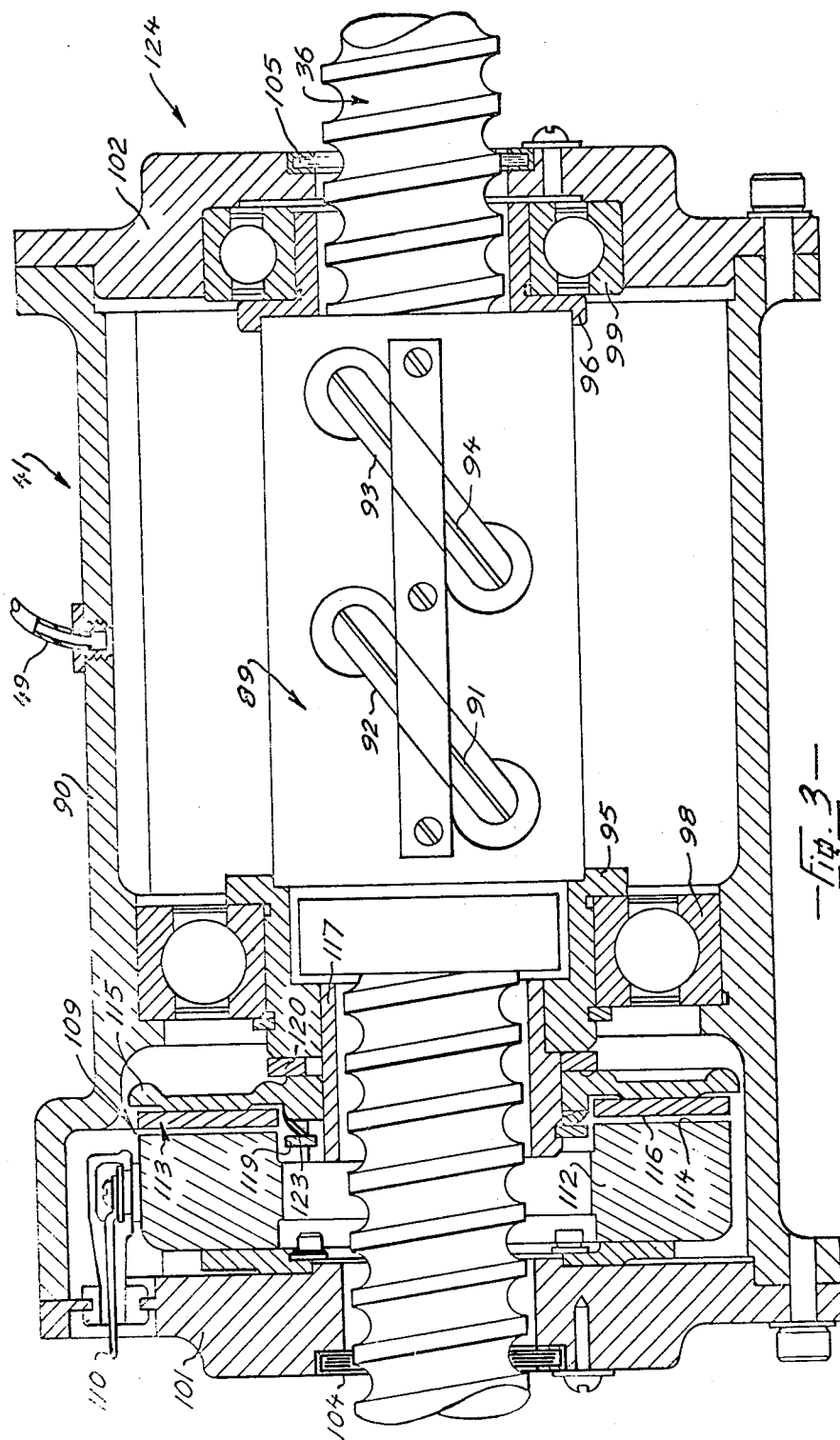
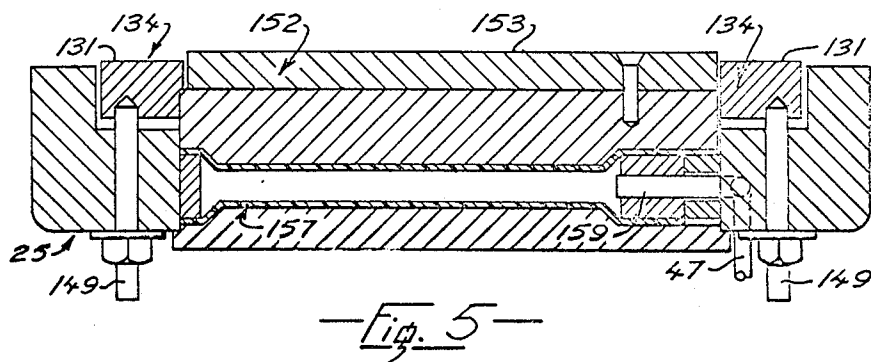
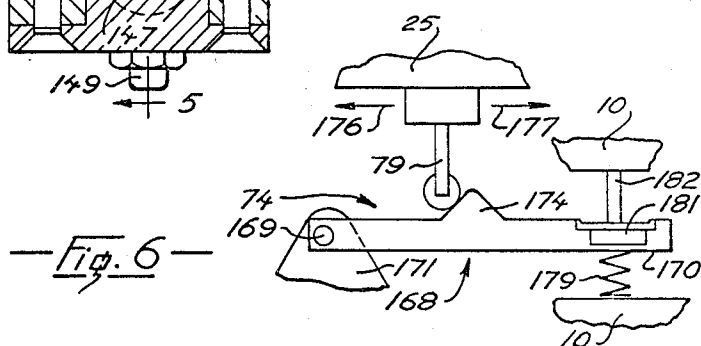
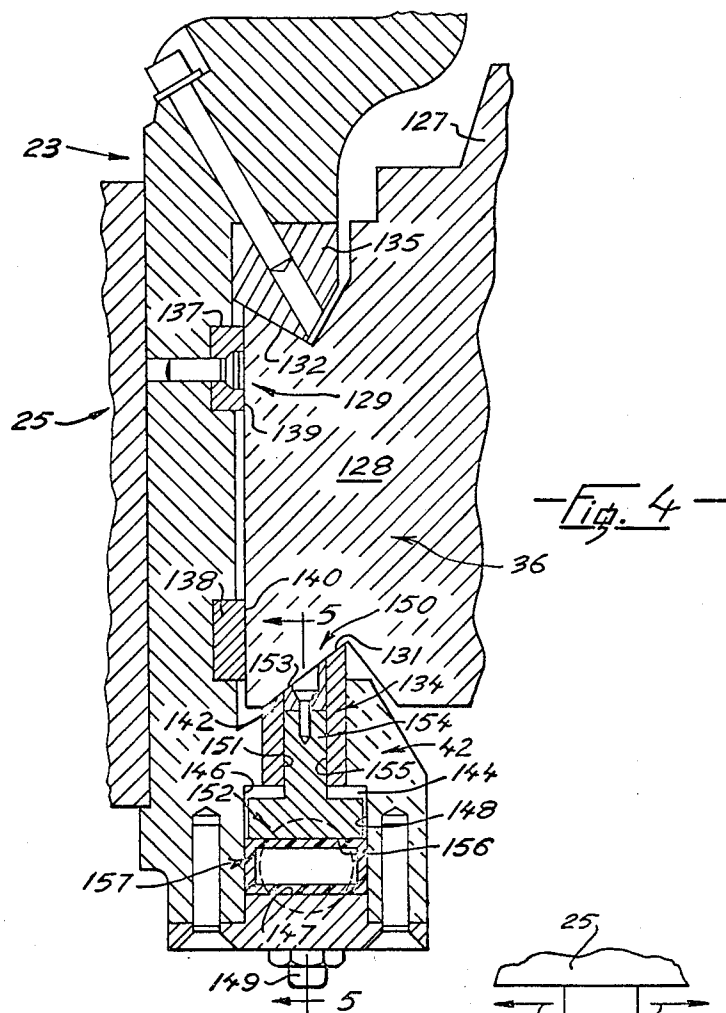
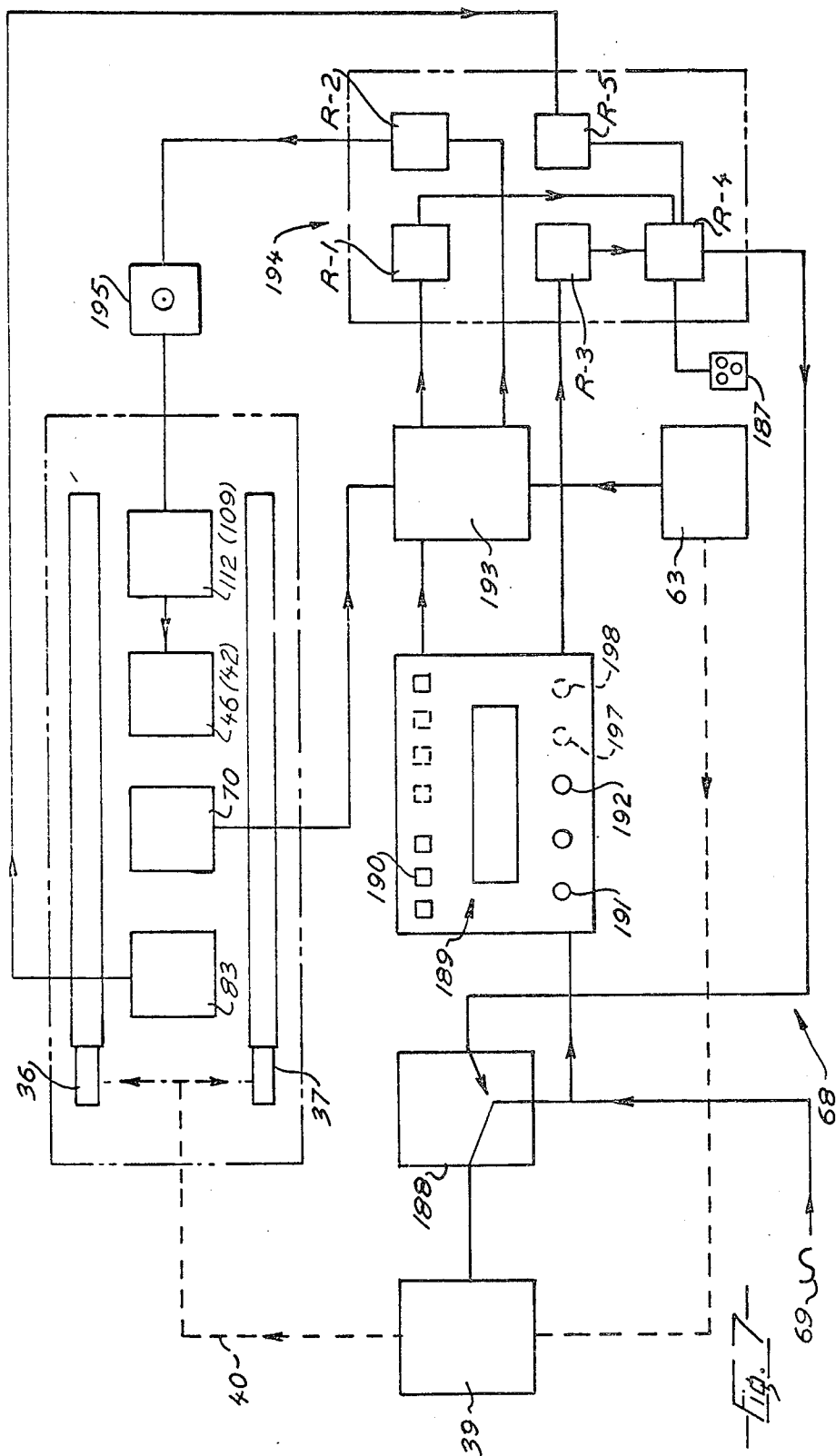


Fig. 2







APPARATUS TO EFFECT REMOTE AUTOMATIC POSITIONING OF WEB SLITTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an apparatus for positioning automatically slitter devices used for slitting a running web of sheet material, being particularly adapted for but not limited to automatic slitter networks of a paper winding machine.

2. Prior Art

Paper making machines produce a web of paper which is usually too wide for most purposes. Thus the web requires slitting to a more practical width, such slitting generally being effected on a winding machine. A winding machine journals a roll of paper to be split, a web of the paper from the roll passing through the machine where it is slit into narrower slit webs, which are then rewound onto separate narrower rolls. Commonly, a plurality of slitting devices are used, and for changing width of the slit webs, the slitting devices require repositioning. The slitting devices are usually carried on rails extending transversely across the web and are clamped thereon at a particular spacing from adjacent slitting devices. As most web slitters are manually set and clamped on the rails, repositioning is time consuming. Whilst automatic slitter positioning or setting devices are known, such devices are generally unsatisfactory and have not been widely accepted in the trade.

SUMMARY OF THE INVENTION

The invention reduces difficulties of previous slitting machines by providing an automatic means of positioning the slitting devices for cutting the web, which means can be operated remotely from the machine to an acceptable repeatability. The apparatus is adapted to be fitted to a common existing web slitting and winding machine to convert the machine from manual to automatic setting. The apparatus has an electronic control means which permits an operator to program selected web widths whilst the machine is operating at previously selected widths, and also permits verification of the new program to eliminate non-valid programs.

The positioning apparatus according to the invention is for use in a slitting machine and effects remote automatic positioning of at least one slitter device. The slitting machine slits longitudinally to a required width a web of sheet material passing through the machine and has at least one slitting device having upper and lower complementary slitter portions which cooperate so that when the web passes between the slitter portions the web is slit. The machine further includes two rails extending transversely across the web, one rail being mounted on each side of the web. A slitter base of each slitter portion is mounted on each rail for sliding along the respective rail. The positioning apparatus has transmission means cooperating with each slitter portion for moving the slitter portions along the rails. The transmission means include two rotatable feed screws extending transversely across the web, each screw being disposed parallel with and adjacent a respective rail. The transmission means related to a particular slitter base includes a feed nut, a clutch means and a brake means. The feed nut engages the feed screw and cooperates with the respective slitter base so as to be free to rotate with the feed screw and relative to the slitter

base in a freewheeling mode, and to be locked relative to the slitter base in a feed mode. The clutch means cooperates with the respective slitter base and feed nut and is adapted to be operated remotely. When disengaged the clutch means permits relative rotation between the nut and the slitter base in the freewheeling mode, and when engaged prevents relative rotation between the nut and the slitter base in the feed mode. The brake means cooperates with the slitter base and a respective rail and is adapted to be operated remotely so as to lock the slitter base relative to the rail in the freewheeling mode. The positioning apparatus further includes reversible drive means to rotate the two feed screws so that, in the feed mode, a complementary pair of slitter bases are driven at equal speeds in the same direction. An electrical datum switch means is fixed relative to and adjacent a respective rail and adjacent a datum of a particular slitting device, the switch being adapted to be actuated by a respective slitter base as the slitter base traverses the rail. A counter cooperating with a feed screw counts revolutions of the feed screw from a particular instant so as to permit determination of position of a particular slitter base from a particular datum thereof. An electronic control means cooperates with the clutch means, the brake means, the drive means, the datum switch means and the counter and has an input to receive instructions relating to desired slitter position relative to the datum switch thereof.

To effect remote positioning of the slitter devices the feed screws are driven with the clutch of each slitter portion engaged so as to traverse the slitter portions concurrently from an old position towards a respective datum thereof, the clutch means being disengaged and the brake means engaged when the datum switch is actuated. The slitter portion is thus stopped at the datum thereof and, when the feed screws are driven in an opposite direction with the clutch re-engaged, revolutions of the feed screw are counted by the counter and the slitter portions are traversed along the rails. The position of the slitter portion from its datum is determined from the number of revolutions of the feed screw. Thus when the new setting of the slitter portion is reached, the clutch is disengaged and the brake means is actuated thus stopping the slitter portion.

A detailed disclosure following, related to drawings, described preferred embodiment of the invention, which however is capable of expression and structure other than that particularly described and illustrated.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmented, simplified diagrammatic front elevation of a slitting machine provided with a positioning apparatus according to the invention, some portions omitted,

FIG. 2 is a simplified diagrammatic section on 2—2 of FIG. 1, showing portions of the positioning apparatus and relative disposition of a web roll and a wound roll,

FIG. 3 is a simplified fragmented longitudinal section of a transmission means as seen on 3—3 of FIG. 2, some portions omitted.

FIG. 4 is a fragmented simplified transverse section through a slitter base as seen on 4—4 of FIG. 1, some portions being omitted,

FIG. 5 is a simplified section at enlarged scale on 5—5 of FIG. 4, showing a portion of a braking means, some portions being omitted,

FIG. 6 is a diagrammatic top plan of a datum switch means for use with the invention,

FIG. 7 is a simplified schematic of an electronic control means for use with the invention.

DETAILED DISCLOSURE

FIGS. 1 and 2

A slitter machine 10 journals a web roll 12 as received from a paper making machine, the roll containing paper that is too wide for practical purposes. The machine 10 has side supports 13 and 14 which support the roll 12 and additional structure to be described. To slit the paper longitudinally to a required width a web 16 of paper is unwound from the web roll 12 and is fed through the machine in a direction of an arrow 17 over guides 18 and 19 and onto a wound roll 20. The machine has a slitting device or slitter 22 having upper and lower complementary slitter portions 23 and 24 respectively. The slitter portions have complementary slitter bases 25 and 26, the bases supporting the slitter portions and serving other purposes as will be described. The machine has two parallel rails 29 and 30 extending transversely across the web, one rail being mounted on each side of the web as shown. The rails have male dovetail sections as shown, and the slitter bases have complementary female dovetailed-sectioned grooves to accept the rail, so that the slitter bases can be slid longitudinally along the rail, that is transversely across the web.

The above description relates to a common winding and slitting machine associated with a paper machine. At least one slitter is mounted on the rails, although usually a plurality of slitters are mounted, three being shown in FIG. 1, a second slitter 32 being shown in full outline, and a third slitter 33 being shown in broken line. In a prior art machine, to change width of web fed onto the wound roll 20 the operator unclamps each portion of a slitter, moves it manually along the rail and clamps it in a desired position to obtain a desired width as measured on a standard rule. Sometimes there are many slitters, to be adjusted and each requires a relatively accurate setting from an adjacent slitter. Clearly, with a prior art machine, re-setting is a time consuming process.

Apparatus according to the invention effects remote automatic positioning of the slitters, and can be designed to accommodate as many slitters as are used on a particular machine. The positioning apparatus has a transmission means cooperating with each slitter portion to move the slitter portions along the rails to permit positioning of the slitter portion at required locations. The transmission means includes upper and lower rotatable feed screws 36 and 37 extending transversely across the web and disposed parallel to the rails, each screw being adjacent a respective rail. Right hand ends of the screws are journaled for rotation in bearings 38 in the side support 14 and are powered by drive means 39 as will be described, the remaining portions of the screws being supported by the transmission means of each slitter portion. If required bearings can be provided at left hand ends of the feed screws. Each feed screw has a sprocket, and chain and sprocket means 40 rotate the feed screws. The means 39 includes a reversible electric motor having an output shaft having output sprockets mounted thereon. Loops of chain extend between the output sprockets and the feed screw sprockets so that the feed screws rotate at

equal speeds. Thus the slitter bases are driven at equal speeds in the same direction. Each slitter base is generally similar, and thus the slitter base 25 only will be described.

The base 25 is secured to a transmission housing 41 enclosing a feed nut and clutch, to be described with reference to FIG. 3. The base 25 has a brake means 42 cooperating with the rail 29, to be described with reference to FIGS. 4 and 5. As will be described, when the feed screw 36 rotates with the clutch engaged, the slitter base 25 traverses the rail, and when the clutch is disengaged and the brake applied the slitter base is clamped or locked onto the rail. The brake is pneumatic and is fed with pressurized air or gas from an air manifold 43, an air hose 44 connecting the manifold to an electrically controlled, two-position, four-way pneumatic valve 46, which is connected to the brake through an air hose 47. An air flow restrictor 48 communicates with the valve 46 and an air hose 49 connects the restrictor to the housing 41. The restrictor meters air from the valve to the housing to purge the housing 41 with air to substantially eliminate entry of dirt. When the housing moves along the rail flow of air is increased from normal purge flow to assist in cleaning the screw prior to entering the housing, increasing from 50 cubic feet per hour to 100 cubic feet per hour.

The complementary slitter portion 24 has a similar transmission housing 50 and a similar pneumatic brake 52 operated by air from an air manifold 54 through hoses 55 and 56 and a pneumatic valve 58. A flow restrictor 57 and air hose 59 is similarly used for purging the housing 50. Pneumatic conduits 60 and 61 supply the manifolds 43 and 54 with compressed air from a pressurized gas supply (not shown) at sufficient pressure, suitably about 80 psi, to actuate the pneumatic brakes as will be described. Undesignated hoses extend from the manifolds to the other slitter portions, all the hoses having sufficient slack to permit lateral travel of the devices on the rails to limit of ranges of the devices as will be described.

A counter 63 counts revolutions and fractions thereof of a toothed wheel 64 secured to feed screw 37 which, through the chain and sprocket means 40, reflects also revolutions of the feed screw 36. The counter is a roto-pulser type and counts pulses from each tooth of the wheel 64, a suitable counter being an Airpax Model 4-0001, as supplied by Airpax Electronic Controls Division of Florida, USA. Thus, for equal pitches on the feed screws, when the drive means 39 rotates the two feed screws both slitter bases are driven at equal speeds in the same direction. The counter 63 is connected by a wire 66 to an electronic control means 68 connected to A/C mains power supply 69.

Each slitter base has a respective datum, the base 25 having a datum 70, which corresponds to a datum 72 of the base 26. Electrical datum switch means 74 and 75 for the data 70 and 72 are fixed relative to and adjacent the rail, and as the slitter traverses the rail and approaches the datum, are adapted to be actuated by a respective striker portion 79 or 80 extending from the respective transmission housing. The strikers 79 and 80 are spaced at equal spacing 77 and 78 from respective data 70 and 72 so as to be actuated substantially simultaneously as the slitter portions traverse the rails towards their respective data. A common shear slitter as illustrated has an upper disc or knife portion 71 urged

against a complementary lower cylindrical portion or band 73 so as to slit the web at a point of contact between the portions, the point being within a vertical cutting plane 82. If the spacing of the cutting plane 82 of the slitter 22 from either the datum 70 or 72 is known, together with the corresponding spacing from an adjacent slitter, width of the slit web can be determined.

The strikers 79 and 80 are adjustable laterally relative to the transmission housings 41 and 50, i.e. parallel to the rail. Such lateral adjustment is convenient for initial setting up and further accommodates effective lateral displacement of the cutting plane 82 relative to the strikers that arises when the lower slitter portion or band is reground, or when slitter portions of different dimensions are fitted. Such adjustment of a striker results in effective repositioning of the respective slitter datum which can be compensated in the electronic control means. Position of each slitter on the rail and its spacing from adjacent slitters is known from the rotations of the feed screw that were required to move each slitter from its datum to its new position on the rail.

To reduce damage that might occur should adjacent first and second slitters 22 and 32 collide, a collision switch 83 and a complementary collision switch striker 84 are fitted on adjacent sides of the slitters 22 and 32 as shown. The switch 83 is an electrical contact switch that is activated by the striker 84 before other portions of the two slitters contact each other. The switch is connected to the control means to stop both feed screws and prevent a total collision between slitters as will be described with reference to FIG. 7.

FIG. 3

The transmission housing 41 has a tubular casing 90 containing a feed nut 89 engaging the feed screw 36, the feed nut being journaled within the casing which is secured to the slitter base 25. The feed nut 89 is a recirculating ball nut having ball return conduits 92 and 93, and the feed screw 36 is a ball screw complementary to the feed nut. The conduits 92 and 93 are provided with longitudinal slots 91 and 94 respectively, and the air hose 49 feeds purge air into the casing 90, the air passing through the slots 91 and 94 into the feed nut 89.

The nut 89 is mounted at either end on bearing sleeves 95 and 96, which sleeves are journaled by bearings 98 and 99 in the casing. The housing has end plates 101 and 102 closing ends of the casing 90, the end plates having annular seals 104 and 105 which cooperate with the ball screw to essentially prevent entry of dust from paper slitting and other foreign matter. Each seal has many radially inclined bristles secured to an annular ring held in the end plate, the bristles being inclined radially inwards and having a length sufficient to engage crests and troughs of the screw. The bristles have sufficient flexibility to permit relatively unrestricted passage of the crests and troughs of the screw through the bristles as the screw rotates relative thereto. Excessively stiff bristles tend to act as a nut and drag the housing along the rail against the brake which is undesirable in the freewheeling mode. Further ingress of dirt past the seals is reduced and the screw is further cleaned by purging the housing with air as previously described. The purge air enters the housing

through the hose 49 and leaves past the seals 104 and 105.

A clutch means 109 is provided within the housing and is adapted to be operated remotely through electrical conductors 110. The clutch means is an electromagnetic clutch which includes an electrical field coil 112 secured to the end plate 101. The field coil is a clutch actuating means and is connected electrically to the control means 68 (FIG. 1) to produce a magnetic field when energized. The field coil 112 is an annular coil enclosing the feed screw and is wound on a core having a central opening providing clearance for the feed screw. The core has a plane engaging face 114 disposed in a plane normal to the screw. The clutch also includes an armature 113 secured to a drive plate 115 which is keyed loosely to a drive sleeve 117, the key restricting relative rotation but permitting axial sliding between the plate 115 and the sleeve 117. The drive sleeve 117 is secured to the bearing sleeve 95 and carries a pair of spaced ring-shaped spring clips 119 and 120 which serve as stops to limit axial movement of the drive plate 115. The armature is an annular member enclosing the feed screw and having a central opening to provide clearance for the feed screw. The armature has a plane annular engaging face 116 generally complementary and spaced closely from the engaging face 114 of the core.

Thus the armature cooperates with the feed nut so as to rotate therewith and simultaneously is free for limited axial movement into and out of engagement with the core. A ring-shaped disengaging spring 123 extends between the clip 119 and the driving disc 115 and serves as a resilient means tending to force the engaging faces 114 and 116 out of engagement. When the field (oil is energized and the engaging faces are in contact, the spring is strained in compression. When the coil is de-energized the spring forces the engaging faces 114 and 116 out of engagement, thus permitting relative rotation between the field coil and the armature with negligible rubbing between the engaging faces.

Thus the clutch means has two complementary clutch portions, one clutch portion being fixed rotationally relative to the slitter base and the other clutch portion being fixed rotationally relative to the feed nut. One of the clutch portions is moveable into engagement with the other clutch portion in response to the electrical signal to effectively restrain the clutch portions against relative movement. When so restrained, rotation of the feed screw 36 translates the housing 41, and with it the slitter base, along the feed screw, and thus is termed feed mode. When the clutch is disengaged and the slitter base is lightly restrained against movement along the rail, rotation of the feed screw causes free rotation of the feed nut and armature and thus is termed freewheeling mode. The slitter base is restrained against movement by the pneumatic brake 42 as will be described, which brake is required only to overcome a tendency of the slitter base to shift slightly due to low bearing and seal drag which occurs when the device is in the freewheeling mode. The structure above within the housing 41 is termed transmission means 124.

FIGS. 4 and 5

The pneumatic brake 42 cooperates with the respective slitter base 25 and the rail 36 and is adapted to be

operated remotely so as to lock the slitler base relative to the rail as described. The rail has a cross section shape complementary to a cooperating portion of the slitler base so as to permit free sliding therealong and to prevent essentially relative rotation or lateral movement therebetween. Because many existing slitting machines have a rail having a male dovetail-sectioned member, a rail of this type is described — however other rail sections can be used equivalently. The male dovetail-section is designated 128 and is supported on transverse support 127. The slitler base 25 has a complementary female dovetail-sectioned groove 129 engaging the rail, the groove being defined in part by a pair of opposed inclined faces 131 and 132 of inserts 134 and 135 secured to the base. A pair of parallel strip inserts 137 and 138 are secured to the base and have coplanar faces 139 and 140 defining in part a further portion of the groove. The four faces enclose the dovetail-sectioned rail to permit smooth sliding of the slitler base along the rail.

The brake 42 is provided adjacent the insert 134 and cooperates with a braking surface 142 of the rail. The slitler base has an elongated cavity 144 for the brake, the cavity being defined in part by side walls 146 through 148, the cavity having an open end adjacent to the rail. The insert 134 is a sliding fit in the open end of the cavity and has an elongated opening 150 extending therethrough, the opening communicating the cavity 144 with the braking surface 142. A pair of set screws 149 cooperate with the insert 134 and the slitler base to provide transverse adjustment of the insert 134 relative to the base for attaining a snug sliding fit of the base on the rails.

The opening 150 is defined in part by spaced parallel side walls 151 and 155. A brake member 152 has a braking surface 153 complementary to and adapted to contact the braking surface 142 of the rail. The braking member is a T-sectioned as shown and is effectively a piston having a guide portion 154 slideable within the opening 150 transversely of the insert 134. The brake member is an elongated strip having the braking surface 153 on an outer sidewall of the guide portion 154, the braking surface being generally coplanar with the outer surface of the insert when the brake is released. Thus the insert 134 and associated brake member 152 control the critical fit of the base on the rail, which fit can be finely adjusted by the set screws 149. An inner sidewall 156 of the brake member serves as a piston crown and effectively closes the cavity in the slitler body. Removal of the insert 135 permits easy removal of the base 25 from the rail for servicing the brake means as required.

An extensible and retractable pneumatic bladder 157 is provided in the cavity 144 between the side wall 156 of the brake member and the cavity side walls. Inflation of the pneumatic bladder forces the brake member 152 outwards of the cavity so that the surface 153 is forced against the rail. Thus inflation of the bladder applies the brake to lock the slitler body relative to the rail, and deflation of the bladder releases the brake. An input port 159 is connected to the hose 47 and receives pressurized air from the valve 46 (FIG. 2) in response to a signal from the control means as will be described. The valve 46 is thus the brake actuating means. The bladder 157 is one embodiment of a pneumatic brake means for forcing the braking member against the rail. Other types of extensible and retractable pneumatic

chambers can be substituted such as a simple piston and cylinder combination or a bellows (not shown). Air pressure for inflating the bladder is typically about 80 pounds per square inch which is sufficient to restrain the slitler base from movement along the rail when in the freewheeling mode using metal-to-metal contact between the braking member and the rail.

The lower slitler base 26 is substantially similar to the base 25, but is disposed differently to accommodate disposition of the rail.

FIG. 6

The electrical datum switch means 74 is adapted to be contacted by the striker portion 79 secured to the slitler base 25 as the base approaches the datum thereof. The switch means 74 has a mounting arm 168 having inner and outer ends 169 and 170. The inner end is hinged to a portion 171 of the machine adjacent the rail (not shown) and is thus fixed relative to the rail. A cam 174 is mounted on the arm and is adapted to be contacted by the striker portion 79 as the slitler base traverses the rail in either direction as shown by arrows 176 and 177. A compression spring 179, serving as a resilient member, cooperates with the arm 168 so as to force the arm into path of the striker to contact the cam, which swings the arm about the inner end 169. A normally-open, two-way electrical contact switch 181 is held closed by force from the spring 179 holding the switch against a pin 182 secured relative to the rail. Thus when the striker contacts the cam 174, the spring deflects and the switch 181 disengages from the pin 182 and the switch is opened. Each datum switch means for a particular rail is positioned relative to the rail so as to be contacted only by the striker of the slitler base corresponding to that datum switch. This permits a slitler to enter the range of an adjacent slitler without actuating the datum switch of adjacent slitler. The switches and strikers can be spaced laterally from the rail at different spacings from the rail so as to provide the necessary clearance to prevent actuation.

The switch is a sealed unit, pressure-sensitive switch in which internal contacts are closed when in contact with the pin 182 and open when out of contact. A suitable pressure switch is supplied by Wild Rover Corporation of New Jersey, U.S.A., under part number TC/1/Sl. The switch activated by a relatively small movement, e.g. less than 0.005 inch. Such movement is required to open or close the contacts, which movement is essentially constant so as to ensure that the switch opens or closes when the slitler base is at a particular position on the rail. Repeatability of slitler position to about 0.010 inch is attainable. Other types of switches can be provided, which switches are actuated as the slitler base approaches the datum thereof. Note that over-run of the slitler base after contacting the cam and actuating the switch is immaterial as the arm can swing away from the striker with no damage to the switch, and the count commences at essentially the same slitler position each time.

FIG. 7

The electronic control means 68 includes an input control unit 189 having a plurality of digital thumb-wheel switches 190 upon which a desired slitler position from its respective datum can be dialed. The control unit also has indicator lights to indicate program status and a visual display means. Most slitting ma-

chines have a plurality of slitters, and thus each slitter has a set of such thumb-wheel swithes. The number dialed is an instruction to the electronic control and represents a new distance for that particular slitter from a new position of the immediately adjacent left hand slitter, as viewed in FIG. 1. Thus the number dialled is a direct reading of the width of webs produced by that slitter and the slitter on the left hand side thereof. This instruction is independent of the previous settings or instructions of that slitter, and the actual number dialled is independent of instructions, i.e. the program, dialled on the remaining thumb wheels. Note that a change in position of any slitter except an extreme right hand side slitter results in a corresponding change in positions of all slitters to the right hand side of that slitter.

Each slitter has a particular range to which it is normally confined, which range extends from one side of, and is defined by reference to, its particular datum. Thus, for example, the spacing 77 from the datum 70 measured rightwards as viewed in FIG. 1, covers a fraction of the range of the slitter portion 23. Because the range of a slitter can be selected to overlap to a limited extent an adjacent range of an adjacent slitter, a collision switch and complementary striker are provided on each slitter base. The collision switch reduces damage that might result from a collision between adjacent slitters and, if such a collision occurred, the control means is actuated by the collision switch to stop rotation of the feed screws as will be described.

The input control unit 189 has a pre-set button 191 which is depressed before input of desired settings into the control means, and a set button 192 which is depressed for initiation of setting of the slitter. The electronic control means 68 also has a logic circuit 193 which, apart from other functions, verifies instructions from the input means so as to eliminate essentially collisions between adjacent slitter devices. Thus the collision switches as previously described are a part of a back-up system, which would only operate should there be failure in the logic panel, or if a situation resulting from manual over-ride of the control means produced a slitter arrangement in which the logic circuit was disconnected or was otherwise inoperative.

The description following relates to an electronic components and switching devices for one slitter base, that is an upper or lower slitter base. As each slitter has a pair of complementary slitter bases, for a single slitter there will be duplication of some of the switching components described below. As most slitting machines have a plurality of slitting devices, essentially two sets of electrical switching devices as disclose below are required for each slitter device.

A relay panel 194 contains a plurality of relays interconnected as required with the switches on the slitter machine and the logic panel. A drive control means 188 is connected to the relay panel 194 to receive signals relating to direction of operation of the drive means 39. The means 188 is connected to the AC mains source 69 and has known means to provide voltage and current requirements for the means 39. A manual over-ride control unit 187 is also provided for non-automatic operations and is connected indirectly through the relay panel to the control means 188. The unit 187 is a hand control unit connected by a flexible cable and has forward and reverse buttons and a rheostat for controlling direction and speed of the feed

screw rotation. When this control is used the feed screws rotate and the slitters remain stationary. Each slitter base has a push button 195 which actuates the clutch and brake means simultaneously as required and is usually used in conjunction with the manual over-ride control unit 187 for individual positioning of slitter-bases which is sometimes required.

The logic circuit 193 is connected to the datum switch of each slitter device and the counter 63 so as to be supplied with data relating to the position of each slitter device. The relay panel has a datum switch relay R-1 connected to the logic circuit and to the datum switch 74 which is actuated when the datum is attained. A clutch and brake relay R-2 is connected to the logic circuit and to the actuating means of the clutch and brake means, so as to actuate the clutch and brake means simultaneously in response to a signal from the logic circuit. Thus either the brake is on and the clutch is disengaged or vice versa. A set relay R-3 is connected to the set button 192 and is connected to a drive control relay R-4. The relay R-4 is also connected to the datum switch relay R-1 and the drive control means 188 so as to be responsive to drive direction signals. A collision switch relay R-5 is connected to the collision switch 83 on the slitter base 25 and the drive control relay R-4 so that, when the collision switch is actuated the drive control means is actuated to stop the drive means to prevent essentially further damage to the apparatus.

The logic circuit is designed to accept and store instructions whilst the winding machine is in motion and to respond to those stored instructions when the machine has completed a previous set of instructions. Further the logic circuit verifies instructions so as to eliminate non-valid programs that might arise due to an incorrect dialling on the thumb wheels. One example of a non-valid program is one in which an impossible automatic positioning of slitters is dialled, i.e. an interchanging of positions of slitters on a rail. Further examples of non-valid programs include positioning slitters beyond limits of a particular slitter range. This would include positions too far right of its datum and also includes moving the slitter to the left of its datum. Movement left of the datum is impossible as the slitter automatically disengages from the feed screw as it approaches the datum from the right as will be described. Fourth and fifth non-valid programs include positioning slitters too close to each other so as to result in a collision between adjacent slitters, and instructing the extreme right-hand slitter to move to a position beyond the end of the feed screw rail. Valid and non-valid indicator lights 197 and 198 are provided to indicate program status.

OPERATION

The description following relates to the slitter machine having two slitting devices which are to be positioned on the rails to as to trim the edges of the web coming from the web roll. The operator dials the desired setting or program of the slitters on the thumb wheel switches and presses the pre-set button 191. This can be done whilst the winder or slitter is in operation and slitting at a previously dialled setting. The logic circuit then performs the following functions. The program fed into the machine by the thumb wheel switches is verified by comparing the instructions inserted by the thumb wheel switches with pre-programmed relative

positions of the slitters and their ranges and limits so as to ensure that the program is not non-valid as above defined. If the operator has dialled an incorrect setting such that the slitter device 32 is required to be on the right hand side of the slitter device 23, as viewed in FIG. 1, this would require interchanging of the slitter positions. This is therefore incorrect and is an example of a non-valid program and thus the "non-valid" indicator light 198 is actuated. When a valid program is fed into the unit it is held in the memory of the logic circuit until required and the "valid" indicator light 197 is actuated.

After completion of a previous program and a change in the setting of the slitters is required, the set button is pushed after the valid signal is attained and the slitters move to new positions following a sequence as below. A signal from the set button to the relay R-3 is transmitted to the relay R-4 which actuates the drive control means and causes the feed screws to rotate in a reverse direction. A signal from the logic to the relay R-2 engages the clutch and disengages the brake and the slitters traverse back to their respective datum positions, that is the slitters travel leftwards as seen in FIG. 1. Both complementary slitter pairs travel simultaneously leftwards until each slitter base reaches its respective datum, at which time a signal from the datum switch means 74 and the relays R-1 and R-2, and signals from similar datum switch means and relays for the other slitter bases are generated. Each signal independently disengages the clutch and engages the brake of each respective slitter base, causing each base to stop adjacent its datum. The feed screws continue rotating in a reverse direction until each slitter base has returned to its respective datum. When the last datum switch means is actuated, another signal from the logic circuit through the relays R-3 and R-4 causes the drive means to rotate in a forward direction, that is to rotate the feed screws simultaneously with disengagement of the brakes and engagement of the switches. Thus each slitter base starts to move to the right from its datum at the same instant. Simultaneously with movement of the slitters, the counter 63 counts pulses of the wheel 64, which pulses are fed to the logic circuit and compared with instructions relating to desired new slitter positions, which instructions were previously stored by the input means through the thumb wheel switches. When the count from the feed screw rotation corresponds to a position equal to the first new setting of a slitter base from its datum, its clutch is disengaged and brake applied through the relay R-2, which stops the slitter base at the desired position. The feed screws continue rotating and feeding the remaining slitter bases to their desired location, the count also continuing from the original datum. When the bases of the second slitter reach their new location, as determined also by the counter, the logic circuit through the relay panel similarly actuates the brakes and clutches of that slitter bases which disengage the slitter bases from the feed screws and locks the slitter bases relative to the rails. When the last slitter reaches its new location, the feed screws stop rotating. The slitters are now positioned for slitting the web to the required width.

It is seen that repositioning of the slitters occurs simultaneously and total time required for a repositioning is dependent on the maximum distance a slitter travels from its datum and not on the number of slitters to be repositioned.

Note that in a complementary slitter pair of a shear slitter the knife portion 71 is forced against the band portion 73 by a spring (not shown) and thus small difference in relative position between the portions can be accommodated by the spring. If a slitter pair has been repositioned in a new position and an accumulation of tolerances results in an incorrect spring force between the portions, the manual unit 187 can be used to move one slitter base a small distance relative to the other slitter base to attain a desired spring force between the portions.

The collision switch 83 is actuated only in a collision and, through the relays R-5 and R-4, cuts power to the drive means thus stopping immediately the feed screws. Thus the logic circuit is by-passed in such an emergency, reducing chances of mal-function.

If some slitting devices are not required in a particular program i.e. are inactive, and the inactive slitters are positioned between active slitters, the knife portion 71 of each inactive device is manually swung away from the band portions 73 so as to render the inactive slitters inoperative. The positions of the inactive slitters are immaterial provided they do not interfere with adjacent slitters. Alternatively automatic means of rendering inoperative the inactive slitters can be devised.

ALTERNATIVES AND EQUIVALENTS

In the device shown, the feed nut is a re-circulating ball nut and the screw is a complementary ball screw. This is preferred for accurate positioning to obtain an accuracy of the order of 0.01 inches. A precision feed screw, with backlash compensation means in a complementary feed nut can be substituted. In the slitter devices shown, motor driven shear slitters are used, however other types of slitters such as the score slitters and web driven slitters can be substituted. The clutch means uses a field coil wound on an annular core secured to the transmission housing, and thus attracts an annular armature free to move axially relative to the housing. Clearly the shape of the core and armature can be changed and likewise the armature can be fixed and the field coil moving relative to the housing. The brake means shown are pneumatic, however the electromagnetic or other means can be substituted. Note that the brake is not required to apply an excessive braking force, but merely a force sufficient to prevent movement of the slitter due to bearing and seal drag when the clutch is disengaged and the feed screw is rotating.

We claim:

1. A positioning apparatus to effect remote automatic positioning of a slitting device for use in a slitting machine for slitting longitudinally to a required width a web of sheet material passing through the machine, the slitting machine having at least one slitting device having upper and lower complementary slitter portions, each portion mounted on a respective slitter base, the web passing between the portions; the machine further having two parallel rails extending transversely across the web, one rail being mounted on each side of the web, the positioning apparatus having transmission means co-operating with each slitter portion for moving the slitter portions along the rails, the transmission means including:

- i. two rotatable feed screws extending transversely across the web and disposed parallel to the rails, each feed screw being adjacent a respective rail,

- ii. a feed nut engaging one feed screw and cooperating with a respective slitter base so as to be free to rotate with the feed screw and relative to the slitter portion in a free wheeling mode, and to be locked relative to the slitter base in a feed mode,
 - iii. clutch means cooperating with the respective slitter base and the feed nut and adapted to be operated remotely, the clutch means permitting relative rotation between the nut and the slitter base in the free wheeling mode, and to prevent relative rotation between the nut and the slitter base in the feed mode,
 - iv. brake means cooperating with the respective slitter base and a respective rail and adapted to be operated remotely so as to lock the slitter base relative to the rail in the free wheeling mode;
- the positioning apparatus further including:
- v. reversible drive means to rotate the two feed screws so that in the feed mode a complementary pair of slitter bases are driven at equal speed in the same direction,
 - vi. electrical datum switch means fixed relative to and adjacent a respective rail and adjacent a datum of a particular slitting device, the switch being adapted to be actuated by a respective slitter base as the slitter base traverses the rail,
 - vii. a counter cooperating with one feed screw to count the revolutions of the feed screw from a particular instant so as to permit determination of position of a particular slitter base from a respective datum thereof,
 - viii. electronic control means cooperating with the clutch means, the brake means, the drive means, the datum switch means and the counter, the electronic control means having an input to receive instructions relating to desired slitter position relative to the datum switch means thereof,
- so that to effect remote positioning of the slitters, the feed screws are driven with the clutch engaged so as to traverse the slitter portions concurrently from an old position towards a respective datum, the clutch means being disengaged and the brake means engaged when datum switch is actuated; and when the feed screws are driven in an opposite direction with the clutch re-engaged and revolutions of the screw are counted by the counter the slitter portions are traversed along the rails and the positions thereof from the datum are determined from the number of revolutions of the feed screw, so that when the desired new location of the slitter portion is reached the clutch is disengaged, thus stopping the slitter portion, and the brake means is actuated.
2. An apparatus as claimed in claim 1 in which the clutch means has two complementary clutch portions, one clutch portion being fixed rotationally relative to the slitter base, and one clutch portion being fixed rotationally relative to the feed nut; one of the clutch portions being movable into engagement with the other clutch portion in response to an electrical signal so as to effectively restrain the clutch portions against relative movement to attain the feed mode, and in response to another electrical signal to release the clutch portions from engagement to attain the free wheeling mode.
3. An apparatus as claimed in claim 1 in which the clutch means has complementary electromagnet clutch portions including:

- i. an electrical field coil secured to the slitter base and connected electrically to the control means to produce a magnetic field when energized,
 - ii. an armature cooperating with the nut and positioned adjacent the field coil so as to be within the magnetic field thereof when the coil is energized, the armature being adapted for movement so as to be locked relative to the field coil when the coil is energized,
- so that when the feed screw rotates and the field coil is energized and the clutch engaged, the slitter portion is in the feed mode and traverses the rail, and when the field coil is de-energized and the clutch disengaged, the slitter portion is in the free wheeling mode and remains stationary relative to the rail.
4. An apparatus as claimed in claim 3 in which:
- i. the electrical field coil is an annular coil enclosing the feed screw, the coil being wound on a core having a central opening providing clearance for the feed screw, the core having an engaging face disposed in a plane normal to the screw,
 - ii. the armature is an annular member enclosing the feed screw, the armature having a central opening providing clearance for the feed screw and an annular engaging face generally complementary to and spaced closely from the engaging face of the core, the armature cooperating with the feed nut so as to rotate therewith and simultaneously being free for limited axial movement into and out of engagement with the core.
5. An apparatus as claimed in claim 3 further including:
- i. a resilient means cooperating with the feed nut and armature so that when the field coil is energized and the armature is engaged with the core, the resilient means is strained tending to disengage the armature from the core; and when the field coil is de-energized the resilient means forces the clutch portions out of engagement permitting relative rotation between the armature and field coil with negligible rubbing between the clutch portions.
6. An apparatus as claimed in claim 1 in which:
- i. the feed nut is a recirculating ball nut,
 - ii. the feed screw is a ball screw complementary to the feed nut.
7. An apparatus as claimed in claim 1 in which the brake means includes:
- i. a brake member having a braking surface complementary to a braking surface on the rail, the braking member cooperating with the slitter base and being movable relative to the slitter base,
 - ii. a pneumatic means cooperating with the base and the brake member, the means having an input port and being extensible and retractable so as to engage and disengage the brake,
 - iii. a pneumatic valve provided between the pneumatic means and a pressurized gas supply, the valve being connected pneumatically to the input port and the gas supply, and electrically to the control means for actuation thereby.
8. An apparatus as claimed in claim 7 in which:
- i. the slitter base has an elongated cavity defined in part by side walls in the base, the cavity having an open end adjacent the rail,
 - ii. an insert is provided in the open end of the cavity and is adjustable laterally therein, the insert having an opening extending therethrough and an outer

- face complementary to the braking surface of the rail,
- iii. the brake member is effectively a piston having the brake surface on one side thereof and positioned within and is a sliding fit in the opening of the insert, an opposite side of the brake member closing generally the opening of the cavity in the slitler body,
- iv. the pneumatic means is an extensible and retractable flexible bladder extending in the cavity between the brake member and the slitler base, so that inflation of the bladder forces the brake member against the rail to lock the base relative to the rail, and deflation of the bladder releases the brake.
9. An apparatus as claimed in claim 8 in which:
- i. the insert is a sliding fit within the open end of the cavity,
- ii. set screws cooperate with the insert and the slitler base to provide adjustment of the insert relative to the base for attaining a snug sliding fit of the base along the rails.
10. An apparatus as claimed in claim 1 in which the slitler portion has a striker and the electrical datum switch means includes:
- i. a mounting arm having inner and outer ends, the inner end being hinged to the machine and fixed relative to the rail,
- ii. a cam is mounted on the arm, the cam adapted to be contacted by the striker of the respective slitler base as the base traverses the rail,
- iii. a resilient member cooperating with the arm so as to force the arm into path of the striker so as to cause the striker to contact the cam as the slitler base approaches the datum thereof,
- iv. a two-way electrical switch to be actuated by swinging of the arm in response to contact of the striker portion.
11. An apparatus as claimed in claim 1 in which:
- i. each feed screw has a sprocket secured thereto,
- ii. the drive means includes a reversible electric motor having an output shaft having an output sprocket mounted thereon,
- iii. a loop of chain extends between the output sprocket and the feed screw sprockets so that the feed screws rotated at equal speeds.
12. An apparatus as claimed in claim 1 in which:
- i. the input of the electronic control means has a set and pre-set button,
- ii. the drive means is connected to a drive control means,
- and in which the electronic control means includes:
- iii. a logic circuit to verify and transmit instructions from the input, the logic circuit being connected to the datum switch means of each slitler device and the counter means so as to be supplied with data

- relating to position of each slitler device,
- iv. a datum switch relay connected to the logic circuit and the datum switch so as to be actuated when the datum switch is actuated,
- v. a clutch and brake relay connected to the logic circuit and to actuating means of the clutch means and brake means so as to actuate the clutch and brake simultaneously in response to a signal from the logic circuit,
- vi. a set relay connected to the set button of the input,
- vii. a drive control relay connected to the set relay and the datum switch relay and the drive control means so as to be responsive to drive direction signals,
- so that, in response to an instruction fed into the input means, the feed screw is rotated in a reverse direction until each slitler has attained its respective datum, at which time the feed screw is rotated forward to feed the slitters to attain desired settings according to signals from the counter means received in the logic circuit.
13. An apparatus as claimed in claim 12 in which there is a plurality of slitters mounted on the rails, each slitler having complementary slitler portions cooperating with a respective feed screw, and in which:
- i. each slitler has a range on the rail, position on the rail being determined relative to a respective datum of the slitler, each datum being provided with a datum switch means which is connected to the logic circuit so that position of each slitler is known relative to its datum, the logic circuit being adapted to prevent operation of the machine should the input means be supplied with a non-valid program having at least one of the following conditions:
- interchanging of slitters on the rail; slitler positioned too close to an adjacent slitler so as to result in a collision between the slitters; a slitler positioned beyond limits of range.
14. An apparatus as claimed in claim 13 in which:
- i. each slitler base has a collision switch on one side thereof, and a collision switch striker on the opposite side thereof, the collision switch being positioned so as to be contacted by a complementary collision switch striker of an adjacent slitler base in the event of a collision between the slitters,
- and the control means further includes:
- ii. a collision switch relay connected to the collision switch of each slitler base and the drive control relay,
- so that when one collision switch means is actuated the drive control means is actuated to stop the drive means to prevent essentially further damage to the apparatus.
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