Jan. 8, 1963 H. W. MOSER 3,072,353

WEB SLITTING AND WINDING MACHINES

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FIG. I.

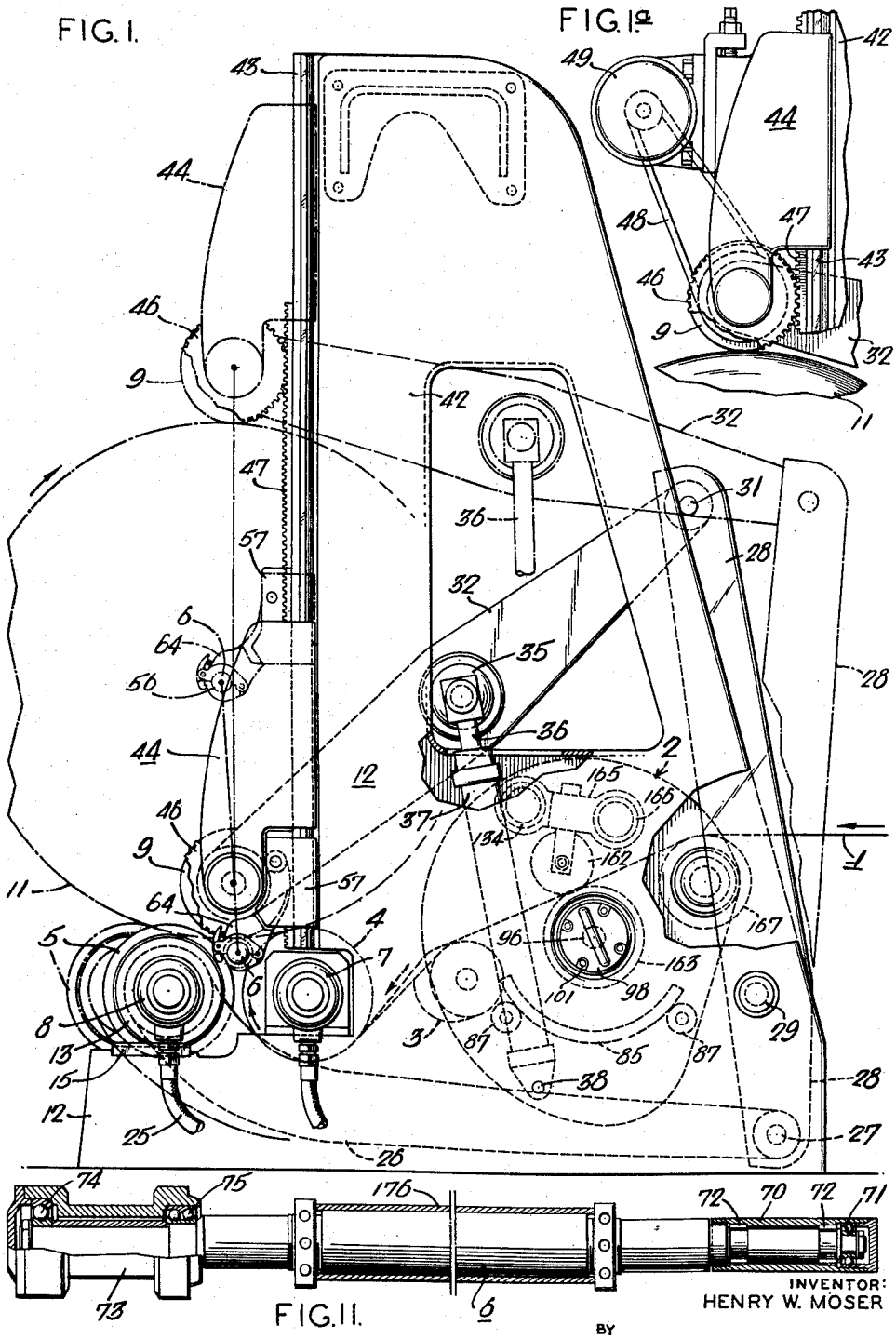

FIG. Ia

FIG. II.

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WEB SLITTING AND WINDING MACHINES

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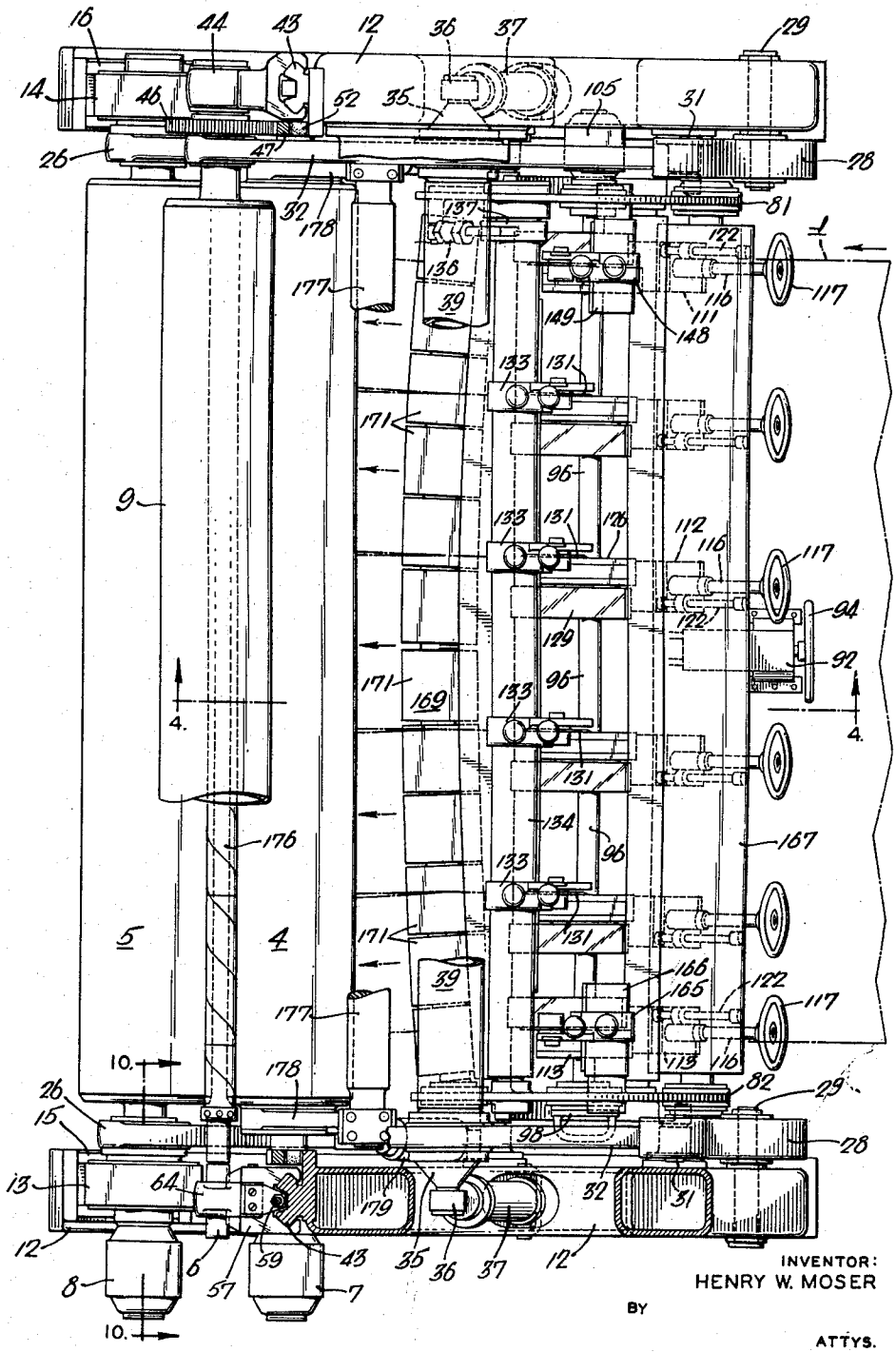
FIG. 2.



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WEB SLITTING AND WINDING MACHINES

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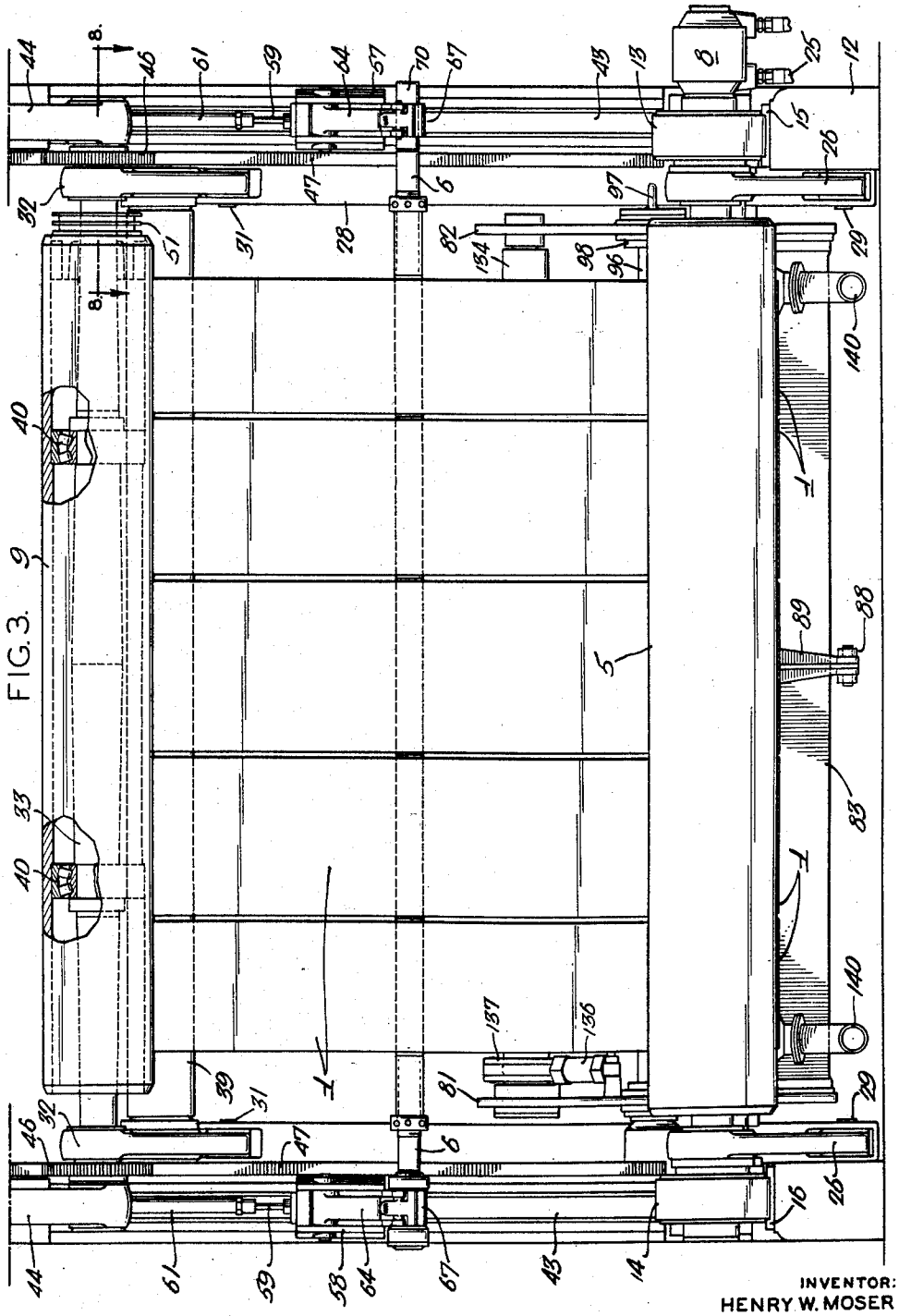

FIG. 3.

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WEB SLITTING AND WINDING MACHINES

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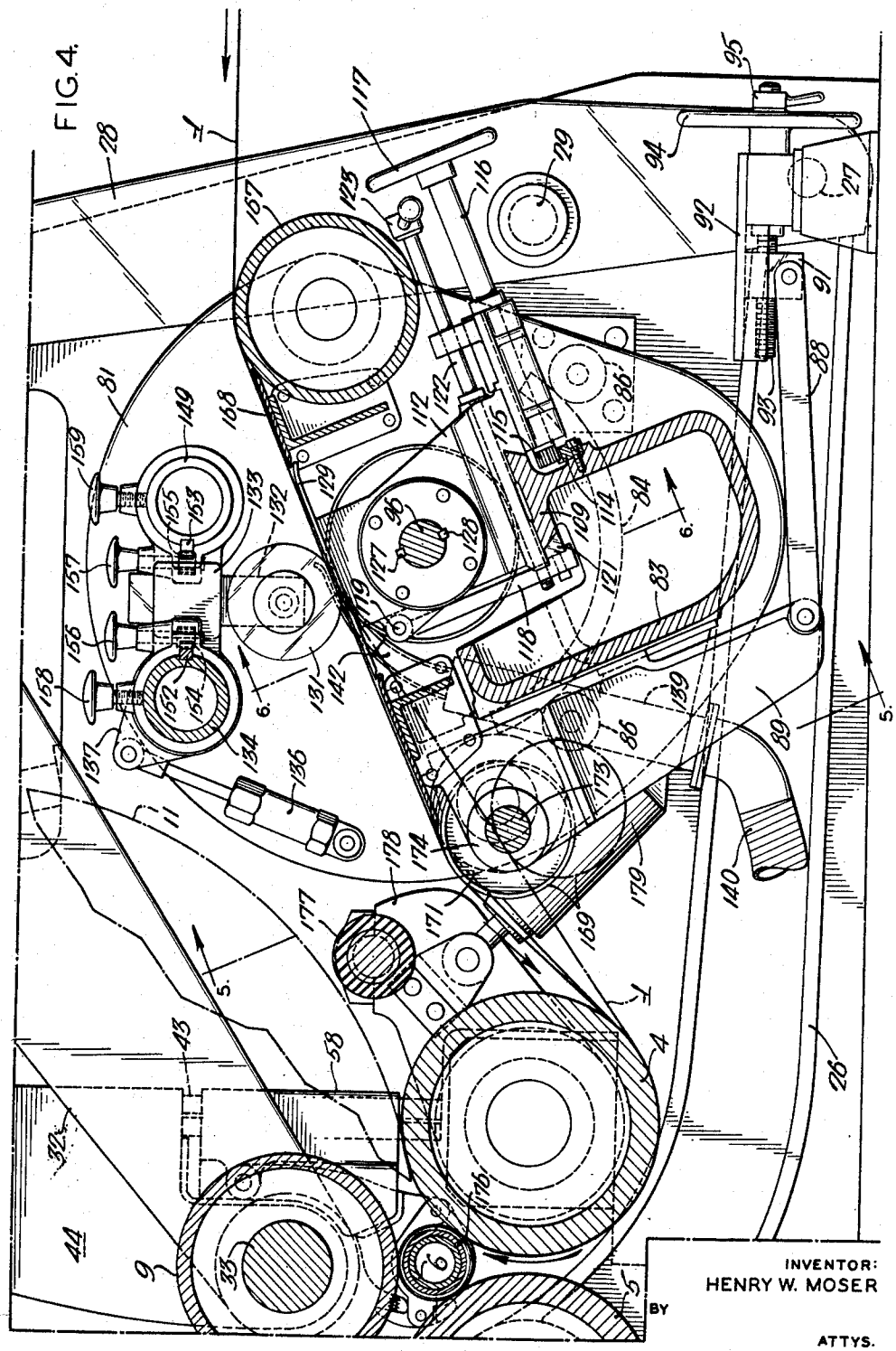
FIG. 4.



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WEB SLITTING AND WINDING MACHINES

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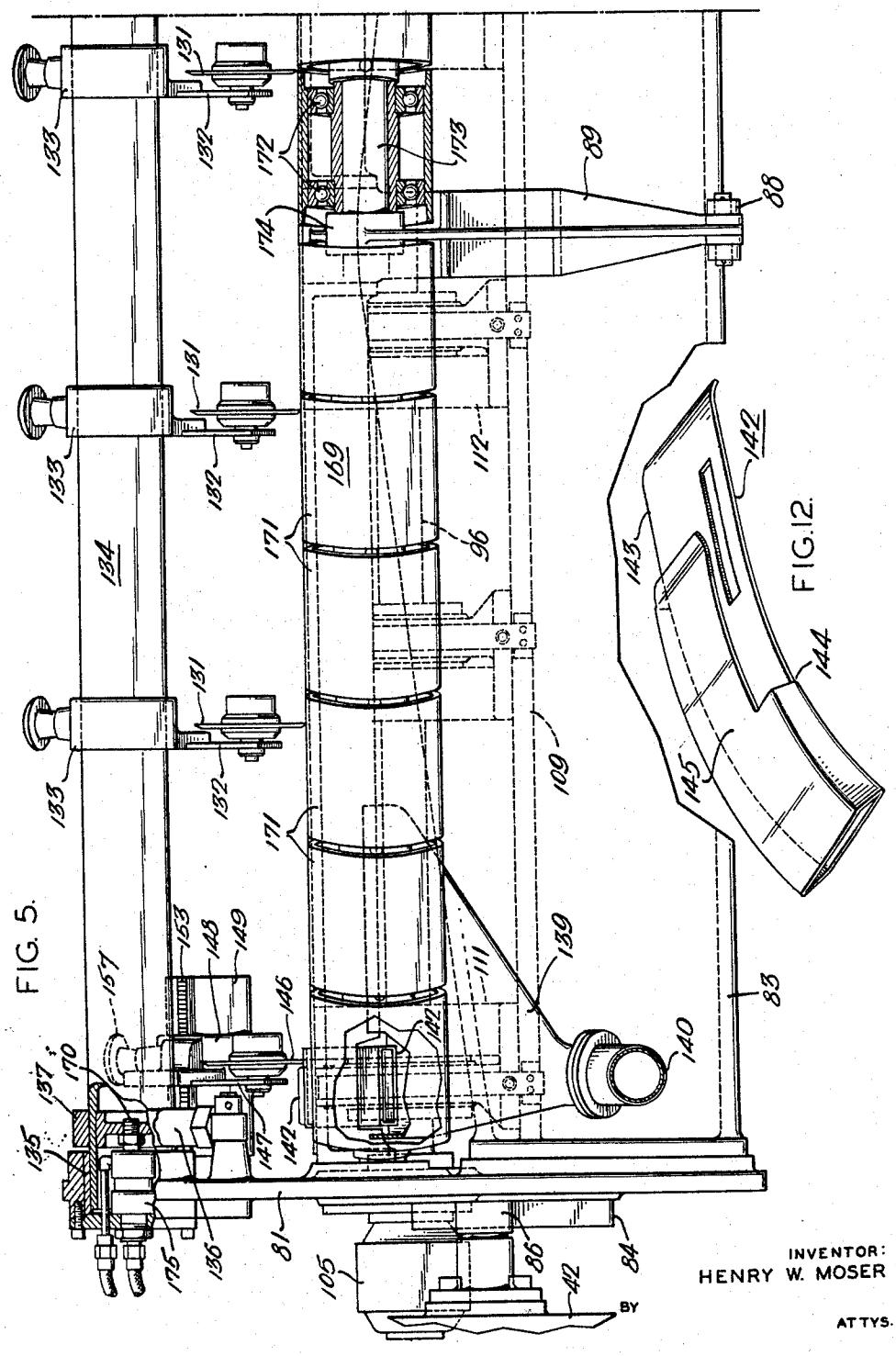

FIG. 5.

FIG. 12.

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WEB SLITTING AND WINDING MACHINES

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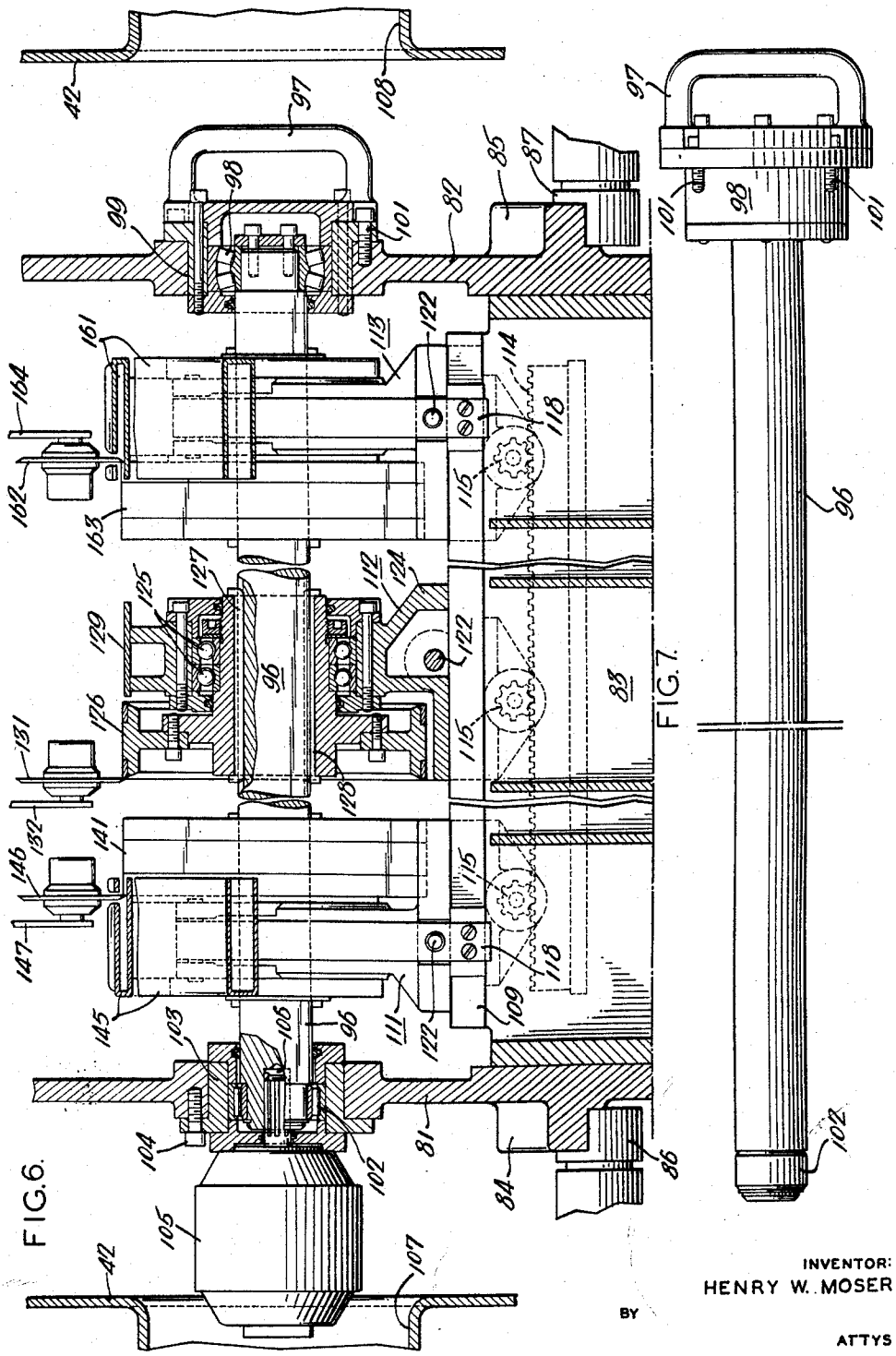

FIG. 6.

FIG. 7.

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WEB SLITTING AND WINDING MACHINES

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FIG. 8.

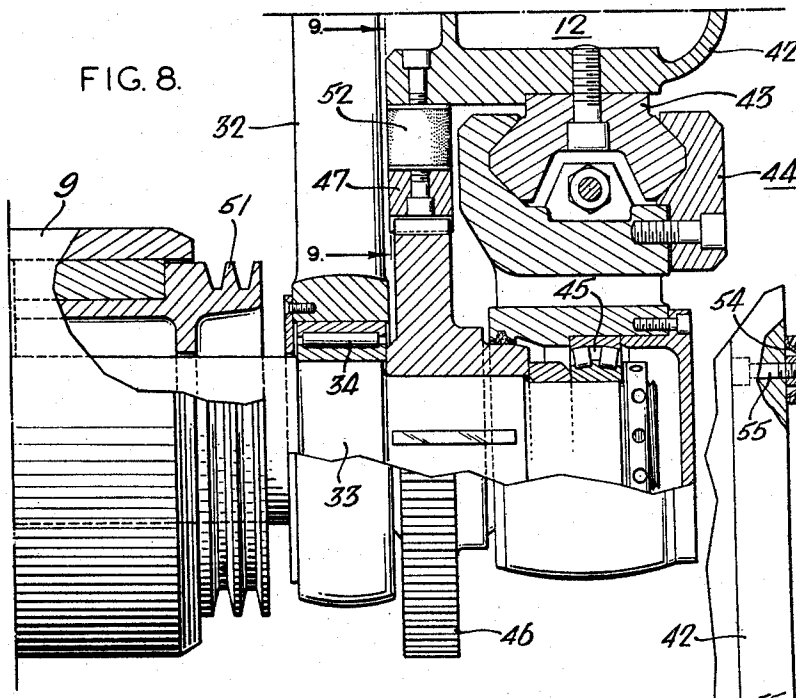


FIG. 9.

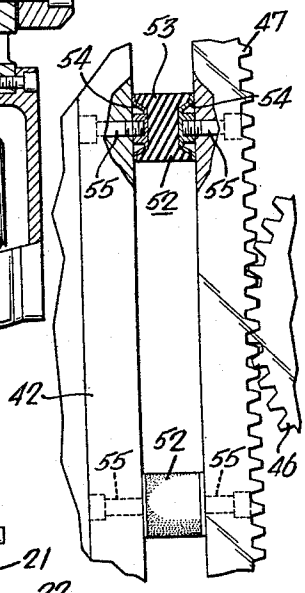
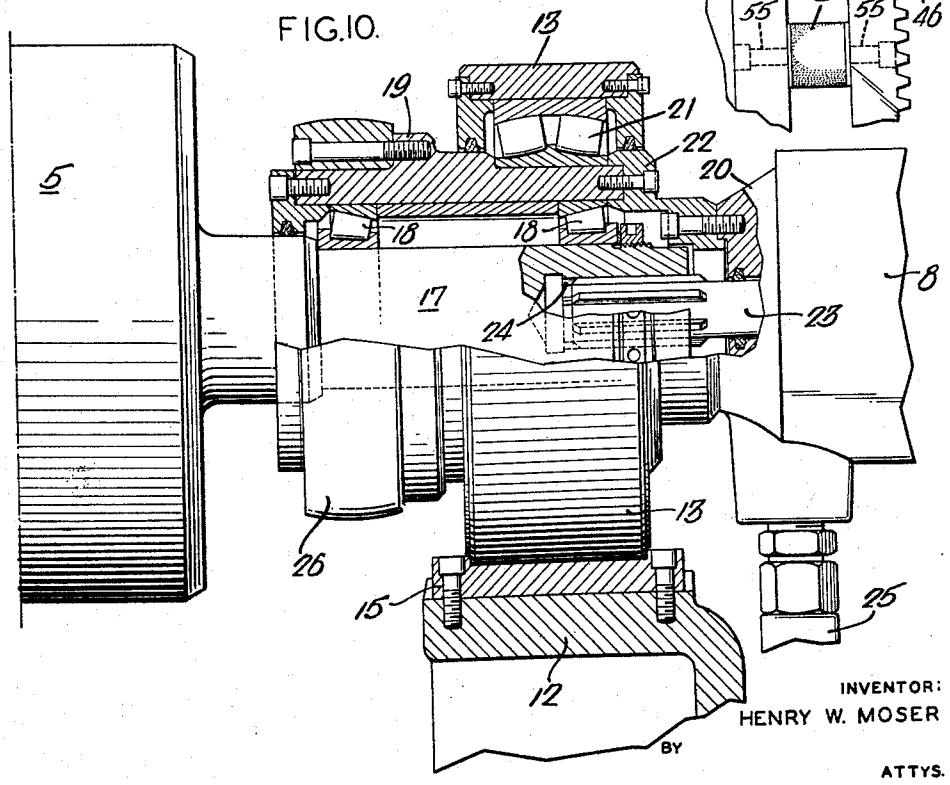


FIG. 10.



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WEB SLITTING AND WINDING MACHINES

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FIG. 13.

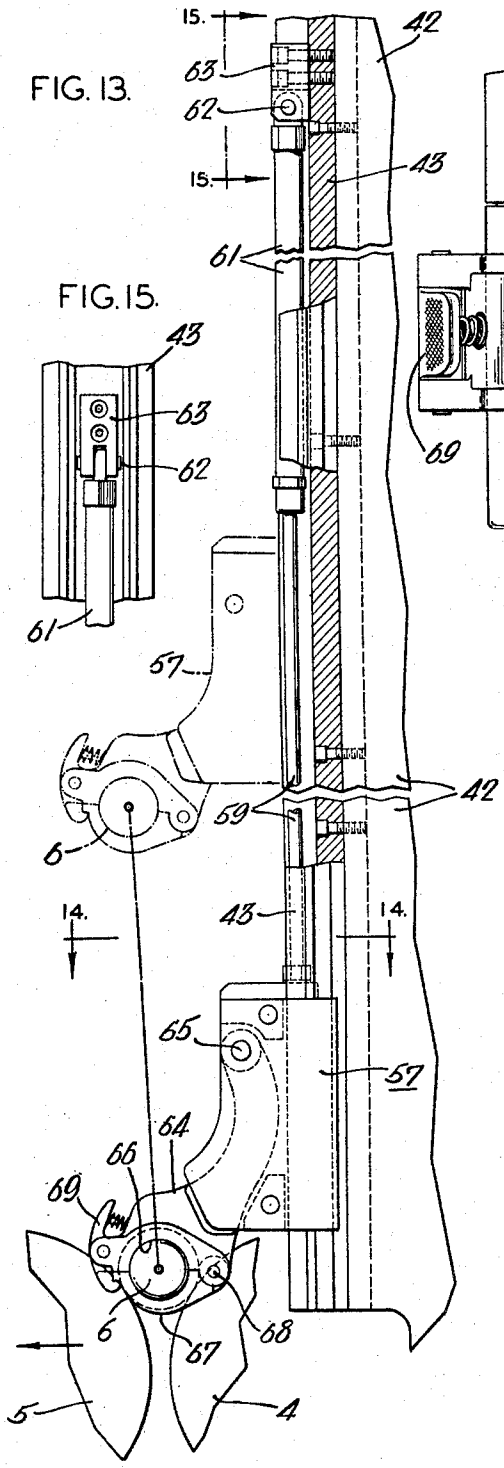

FIG. 14.

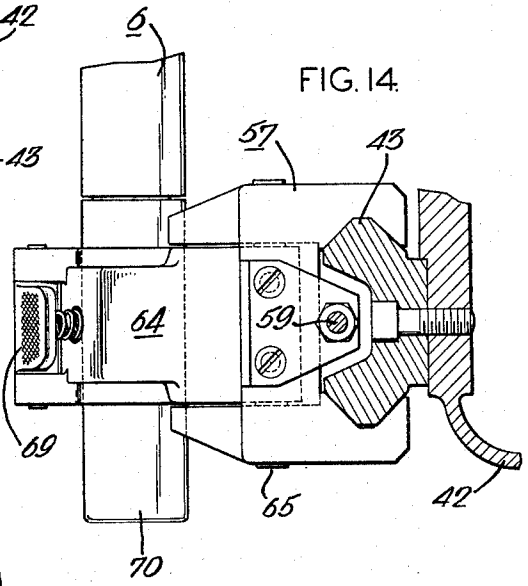

FIG. 15.

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WEB SLITTING AND WINDING MACHINES

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FIG. 17.

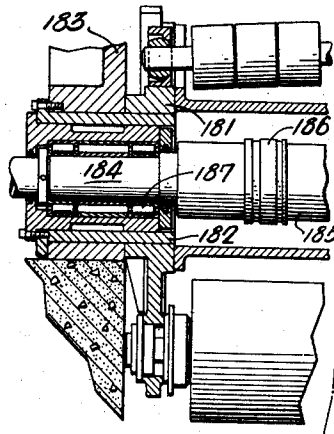
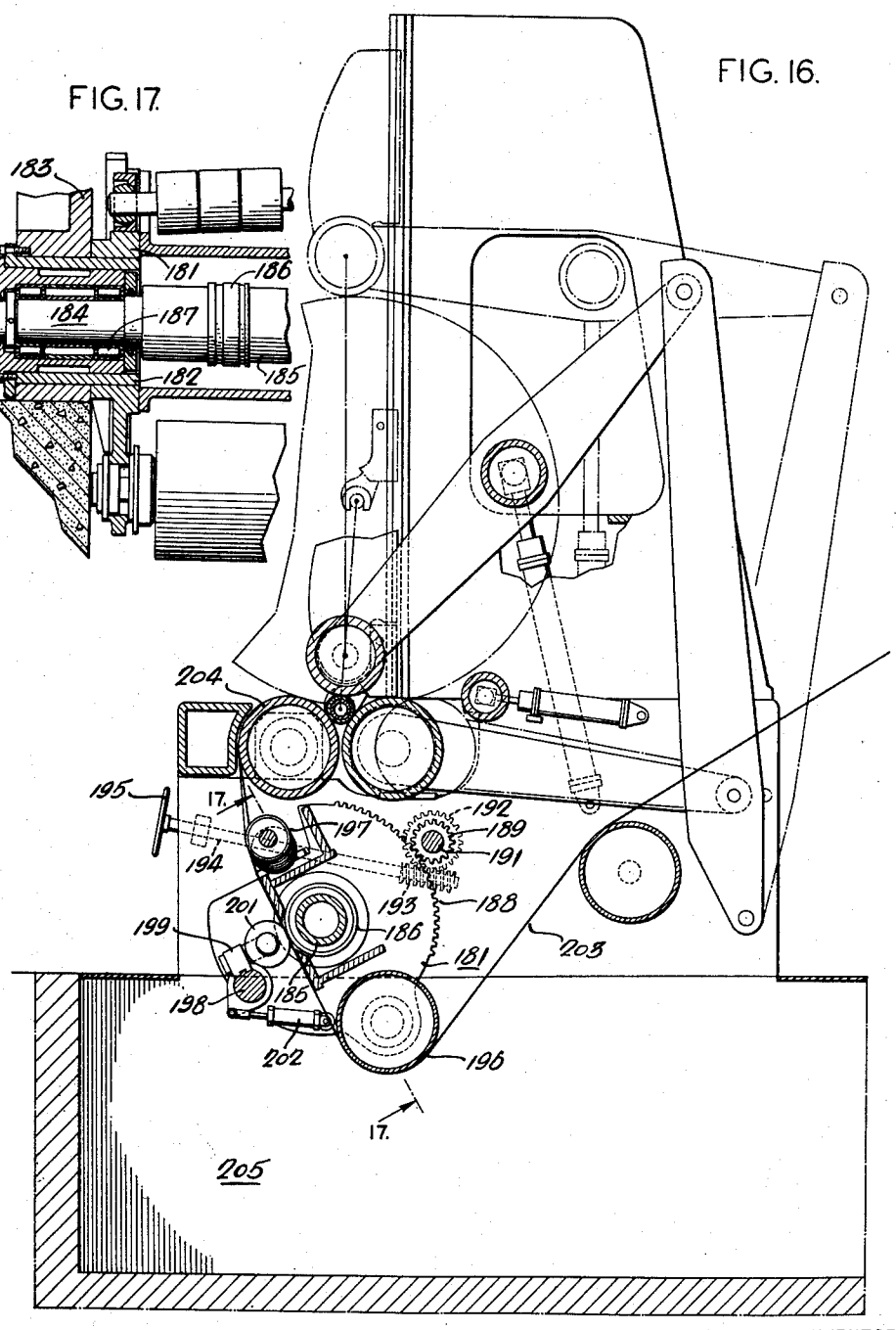


FIG. 16.



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WEB SLITTING AND WINDING MACHINES

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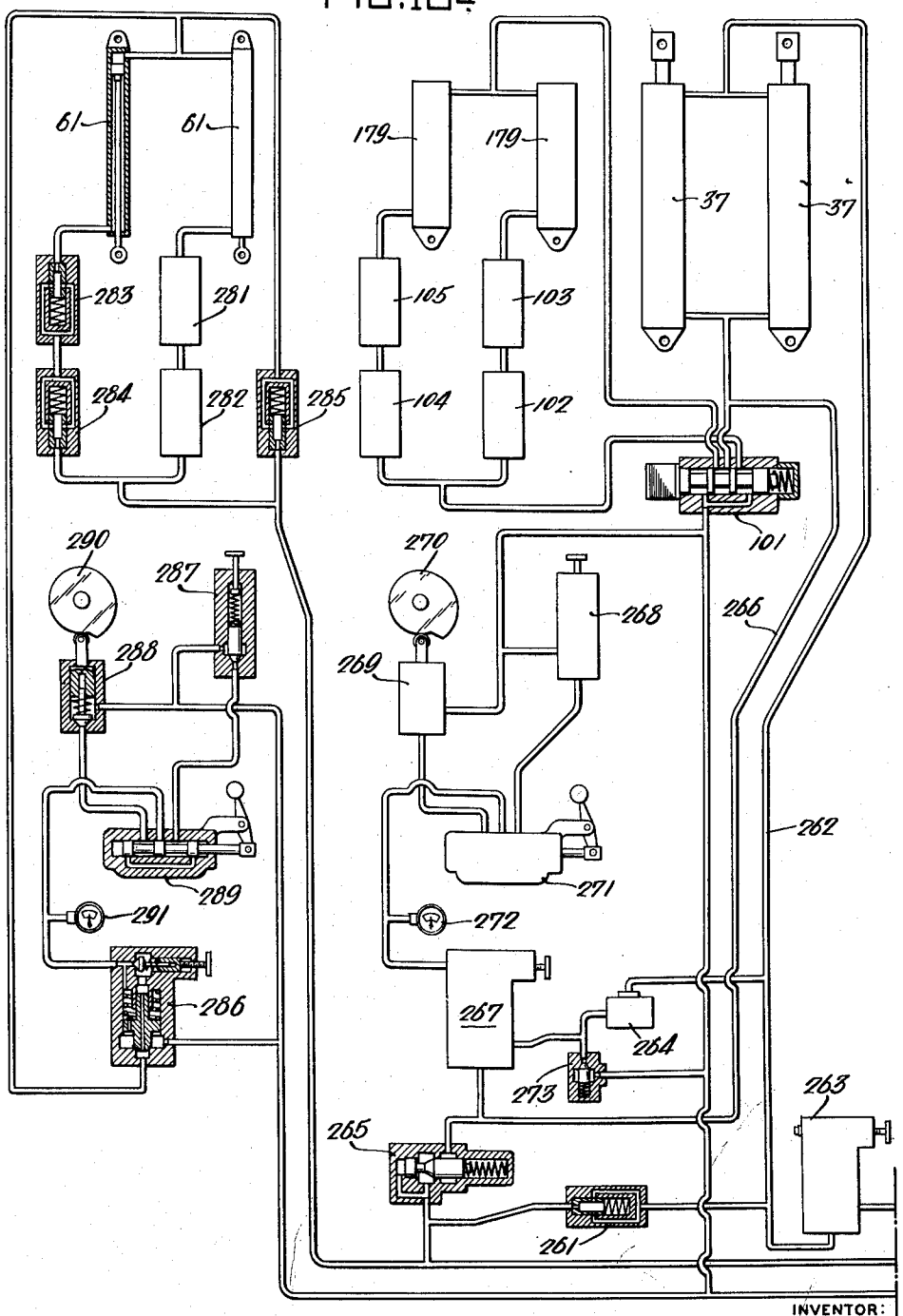
FIG. 18a



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WEB SLITTING AND WINDING MACHINES

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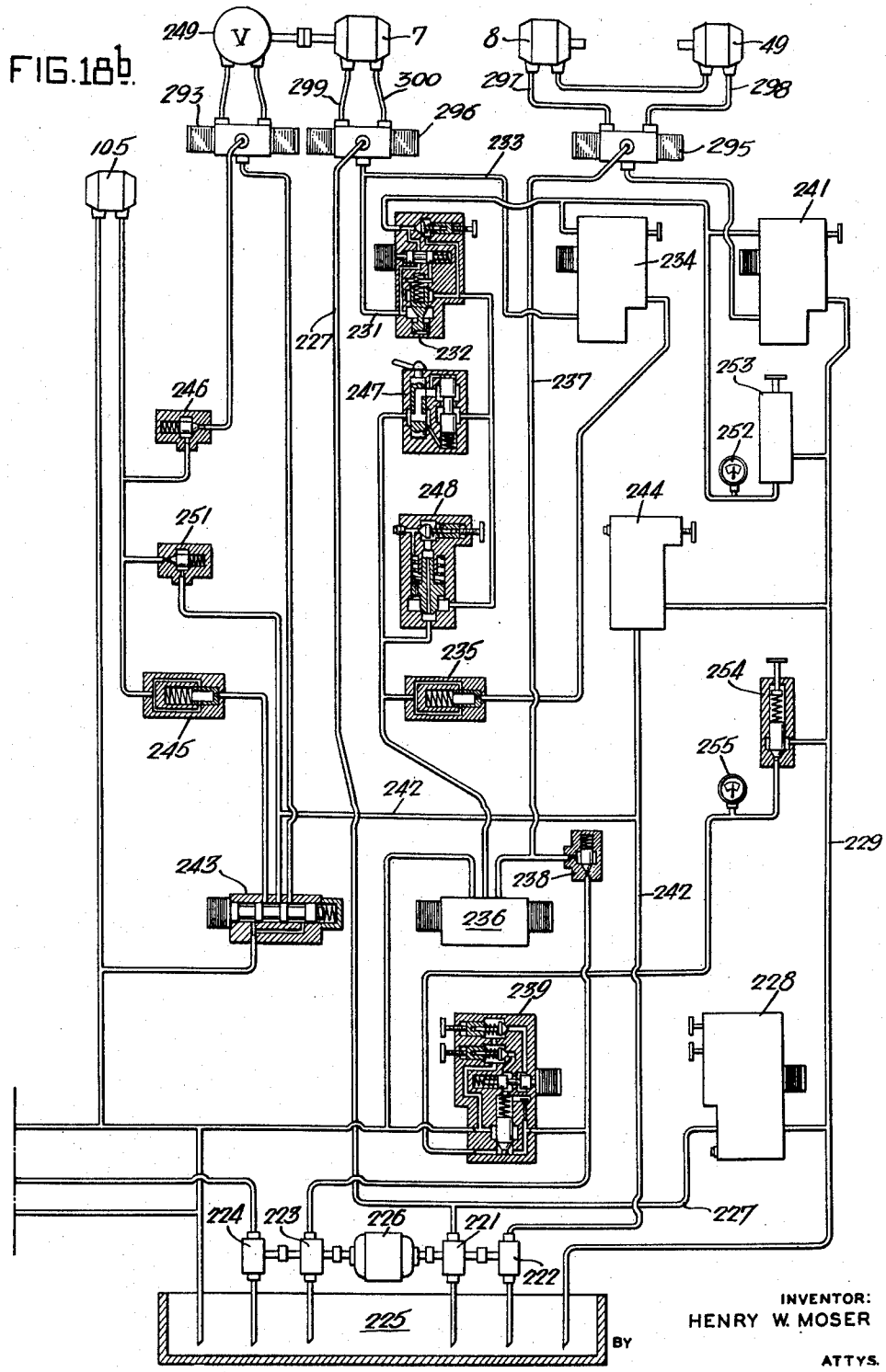
FIG. 18b.



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WEB SLITTING AND WINDING MACHINES

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FIG. 19.

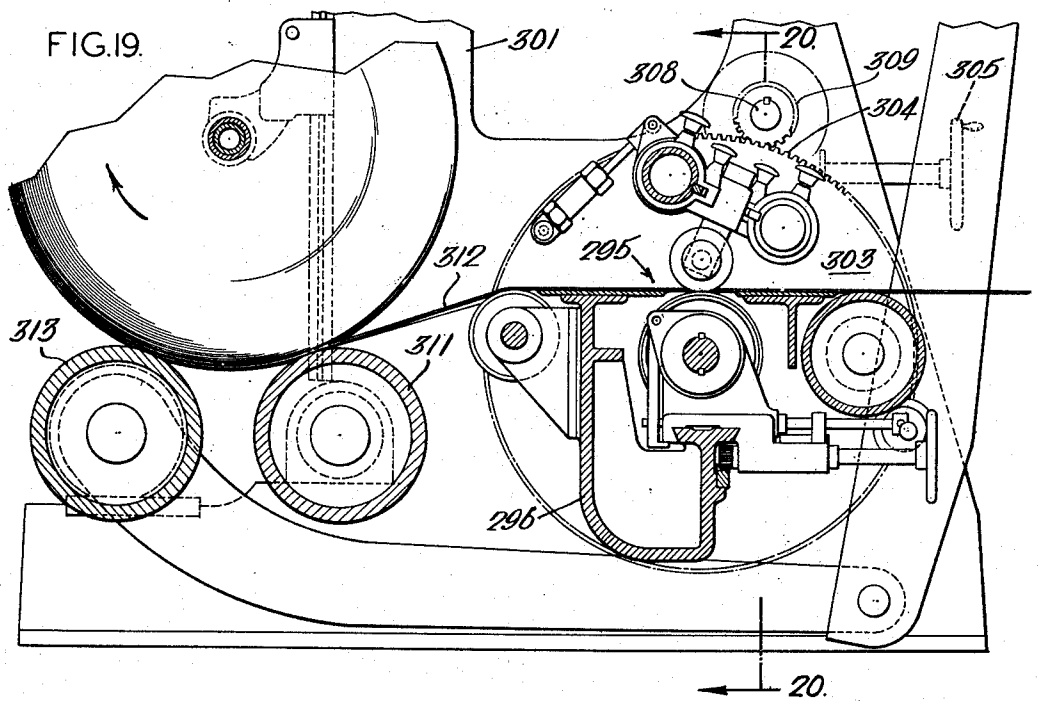
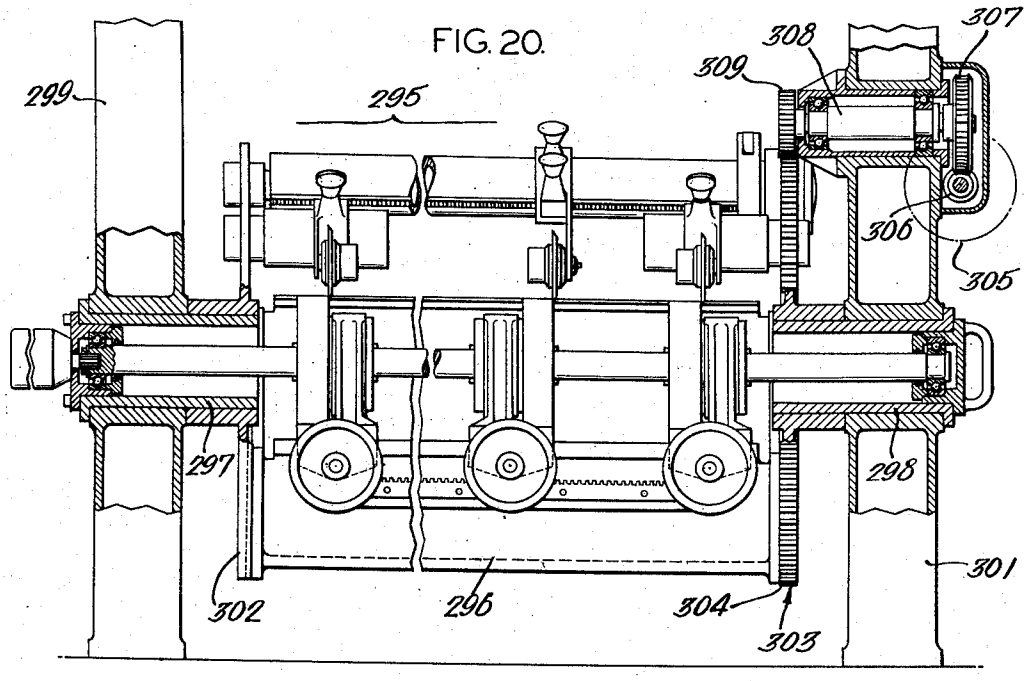


FIG. 20.



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United States Patent Office 3,072,353 Patented Jan. 8, 1963

3,072,353

WEB SLITTING AND WINDING MACHINES

Henry W. Moser, Haddonfield, N.J., assignor to Samuel M. Langston Company, Camden, N.J., a corporation of New Jersey

Filed May 16, 1958, Ser. No. 735,730
8 Claims. (Cl. 242—56.4)

A principal object of this invention is to improve the structural and functional characteristics of web slitting and winding machines of the class hereinafter described.

To this primary end, the invention contemplates the provision of an improved support for the re-wind roll comprising means for compensating certain undesirable effects arising from the increasing diameter of the roll in process of winding and higher operating speeds.

Another object of the invention is to provide improved means for maintaining a uniform winding tension throughout the winding operation and to produce rolls of more uniform average density.

Still another object of the invention is to provide an improved unitary and individually adjustable slitter knife assembly comprising improved means for relatively adjusting, removing and replacing the several individual slitter elements.

A further object is to provide a unitary slitter knife assembly including a deflector element for relatively spreading or spacing the individual slit sections or strips of the parent web, said element being adjustable with the assembly unit as a whole to regulate the extent of separation of the said strips passing to the re-wind roll.

A still further object of the invention is to provide an improved slitter blade unit including novel means for resiliently retaining the blade in operative engagement with the complementary element of the slitting knife.

The invention contemplates further an improved device for more positive elimination from the machine of the severed edge portions of the parent web to preclude accidental interference of these severed edge portions with the normal winding operation.

Still another object is to provide an improved riding roll for the re-wind roll relatively free from deflection and, capable of exerting a more uniform pressure on the re-wind roll over the entire axial length of the latter.

A further object is to provide an improved riding roll design by use of which higher operating speeds and greater machine widths may be achieved.

Still another object of the invention is to provide in association with said riding roll an improved squaring device affording a degree of resiliency for self-adjustment of the riding roll to compensate for irregularties in the web tending to affect uniformity of diametrical dimension in the re-wind roll and to thereby insure substantially uniform roll density.

Another object of the invention is to provide improved means of feeding the web material, said feeding means affording better control over the density of the rewound roll and making possible the winding of either side of the web selectively toward the outside of the roll.

It is an object also of the invention to provide a slitting and winding machine capable of operating efficiently at relative high speeds and having a correspondingly great productive capacity.

To this end the invention contemplates the provision of hydraulic drive means for the driven elements of the machine together with an associated hydraulic system affording accurate and flexible torque and relative speed control of the winding rolls, all as hereinafter described.

This is a continuation-in-part of my copending application Ser. No. 600,532, filed July 27, 1956, now Patent No. 2,960,277.

Other novel structural and mechanical features and details constituting elements of the invention will appear in the following description, and in the attached drawings, wherein:

FIG. 1 is a side elevational view of a slitter winder made in accordance with the invention;

FIG. 1*a* is an enlarged fragmentary view showing a detail of the winding mechanism;

FIG. 2 is a top plan view of the machine partly in section;

FIG. 3 is a fragmentary front end elevation of the machine as viewed from the left of FIG. 1;

FIG. 4 is an enlarged sectional view on the line **4—4**, FIG. 2;

FIG. 5 is a sectional view on the line **5—5**, FIG. 4;

FIG. 6 is a sectional view on the line **6—6**, FIG. 4;

FIG. 7 is a side view of the slitting roll support mandrel detached from the machine;

FIG. 8 is a sectional view on the line **8—8**, FIG. 3;

FIG. 9 is a fragmentary elevational view partly in section as viewed from the line **9—9**, FIG. 8;

FIG. 10 is a sectional view on the line **10—10**, FIG. 2;

FIG. 11 is a sectional view of the front cradle roll;

FIG. 12 is a fragmentary view in perspective of one of the suction nozzles for withdrawal of the severed waste end portions of the web;

FIG. 13 is a fragmentary side elevational view partly in section showing details of the rewind shaft and its mount;

FIG. 14 is a sectional view on the line **14—14**, FIG. 13;

FIG. 15 is a fragmentary elevational view from the line **15—15**, FIG. 13;

FIG. 16 is a sectional elevational view illustrating a modification within the scope of the invention;

FIG. 17 is a sectional view on the line **17—17**, FIG. 16;

FIGS. 18*a* and 18*b* are jointly a diagrammatic illustration of the electrohydraulic control system;

FIG. 19 is a sectional view similar to that of FIG. 4 but illustrating a further modification within the scope of the invention; and

FIG. 20 is a sectional view on the line **20—20**, FIG. 19.

With reference to the drawings, in the applicant's machine as in prior machines of the same class the paper or other web **1**, drawn from a mill roll or other source, passes through a slitter organization designated generally in FIG. 1 by the reference numeral **2** wherein the web is divided longitudinally into a number of strips of required widths. The split sections or strips are then separated or spread apart laterally of the web, by means in the present instance of a bow spreader **3**, and the divided web passes to and below a rear cradle roll or drum **4** and upwardly between the said roll **4** and a forward cradle roll **5** to a mandrel **6**, said mandrel at the initiation of the winding operation lying in the nip of the rolls **4** and **5** as shown in FIG. 1. The web in transit to the mandrel **6** passes between the mandrel and the roll **5** and in contact with the latter. In accordance with the present invention both of the cradle rolls **4** and **5** are driven, each said roll being provided with its individual hydraulic motor **7** and **8** respectively. The normal directions of rotation of the rolls **4** and **5** are indicated by the arrows in FIG. 1. The direction of rotation of rolls **4** and **5**, and of the roll **9** described below, can be reversed by reversal of the hydraulic fluid to facilitate threading of web material over front roll **5**.

Mounted above the mandrel **6** and resting initially on the latter is a roll **9**, and as the slit web builds up on the mandrel the roll **9** rides upon this composite re-wind roll. The re-wind roll is shown in broken lines in FIG. 1 and is designated by the reference numeral **11**, and this figure illustrates the manner in which the rider roll **9** moves

upwardly as the diameter of the roll 11 increases. With exception of the hydraulic drive motors 7 and 8, and in other respects pointed out below, the basic elements of mechanism described above are conventional in slitter-winder machines of the class to which the present invention relates, as shown for example in U.S. Patent 2,733,018.

The cradle roll 4 is journalled in the fixed frame 12 of the machine and operates about a fixed axis. The roll 5, in accordance with the invention, is supported on a pair of rollers 13 and 14 at opposite sides respectively of the machine which rollers ride on track plates 15 and 16 mounted on the frame 12 of the machine as best shown in FIGS. 1, 2 and 10. The cradle roll 5 is thereby adjustable horizontally to and from the companion roll 4. The manner in which the roll 5 is journalled in the rollers 13 and 14 is illustrated in FIG. 10. The roll is provided at each end with a trunnion 17 which is mounted in bearings 18, 18 in a relatively fixed sleeve 19. This sleeve carries bearings 21 for the roller, in this case the roller 13. A cap flange 22 is secured to the outer end of the sleeve 19 and also to the housing 20 of the hydraulic motor 8, the shaft 23 of which extends into a cylindrical recess 24 in the end of the trunnion 17 and is splined to the latter. The motor 8 is connected to a source of pressure fluid by means of a flexible connector 25.

The inner end of the sleeve 19 at each end of the roll 5 is fitted rigidly into the apertured end of an arm 26, and each of these arms extends rearwardly and substantially horizontally at the inner side of the proximate frame member and is pivotally connected at its rear end 27 to a lever 28. Each of the levers 28 is pivotally connected at 29 to the frame and is pivotally connected at its upper end, as indicated at 31, to one end of an arm 32. The outer end of each of the arms 32 is connected to the shaft 33 of the rider roll 9, and as shown in FIG. 8, the shaft 33 is journalled in needle bearings 34 in the said arm. Each of the arms 32 is connected at its midsection and by way of an outwardly projecting trunnion member 35 with the upper end of a plunger 36 which operates in a hydraulic cylinder 37 pivotally attached at 38 to the frame. The arms 32 at the opposite sides of the machine are rigidly connected one with each other by a tubular bar 39 which extends across the machine as shown in FIG. 2, and it will be noted that this connecting bar 39 is co-axial with the trunnion members 35.

It will be apparent that as the rider roll 9 moves upwardly at the top of the re-wind roll 11 as the latter builds up in the winding operation, the end of the arm 32 attached to this roll will also move upwardly as indicated in broken lines in FIG. 1. As hereinafter described, the roll 9 is constrained to move in a vertical path, so that the upward movement of the roll 9 is accompanied by a rearward movement of the upper end of the lever 28 and a consequent adjustment of the roll 5, through the arms 26, to the left as viewed in FIG. 1 and away from the roll 4. By this means, the relative spacing of the cradle rolls 4 and 5 increases with the increasing diameter of the re-wind roll 11 thereby compensating for unstabilizing effect of the increasing diameter of the latter roll and maintaining the stability of its seat on the cradle rolls. The hydraulic cylinders 37 take no functional part in this compensating adjustment of the cradle rolls. The cylinders provide, however, a means for elevating the pressure roll 9 from the top of the re-wind roll when the winding operation is complete and a means also for controlled retraction of the roll 9 to the starting position. They function also as hereinafter described to maintain a regulated pressure between the roll 9 and the rewind roll.

The manner in which the rider roll is constrained to move in a vertical path is illustrated in FIGS. 1, 1*a*, 3, 8 and 9. Secured to the upright members 42 of the frame 12 at each side of the machine is a rail 43 to which is slidably attached a carriage 44, see particularly FIG. 8. This carriage provides a support for the roll 9, the ends of the shaft 33 of this roll being journalled in bearings 45 in the lower end of the carriage, also as shown in FIG. 8. The bearing 45 is of the spherical or self-aligning type. Keyed to the respective ends of the shaft 33 is a pinion gear 46 which meshes with the teeth of a rack 47 secured as hereinafter described to the uprights 42. With this construction, the carriage 44 is constrained to move vertically on the rail 43; and the gears 46 and racks 47 at the respective ends of the shaft tend to maintain the shaft always in a normal horizontal position. In the present instance, the roll 9 is journalled for rotation on spherical bearings 40 on the shaft and is driven through a belt 48 from a hydraulic or electric motor 49 mounted on the carriage 44, see FIG. 1*a*, said belt passing around a pulley 51 at one end of the roll.

To afford a degree of flexibility in the mounting of the shaft 33 of roll 9, the racks 47 at opposite sides of the frame are attached to the uprights 42 by resilient means indicated at 52 in FIG. 9. These resilient fasteners consist of cylindrical blocks 53 of rubber or other suitable resilient material bonded to and between members 54 which members are attached by means of screws 55 to the uprights 42 and the rack respectively. The resilient connectors afford a degree of longitudinal displacement of the racks 47 with respect to the uprights 42 and thereby permit limited angular displacement of the roll 9 from the normal horizontal position. This angular displacement of the shafts 33 in the carriages 44 is provided for by the self-aligning character of the bearings 45 which support the shaft end in the carriages.

It will be noted also that the roll structure described above makes possible deflections of the roll shaft 33 from the normal straight line, due to bending of the shaft between the bearings 45, without corresponding deflections of the roll with respect to its normal straight axis of rotation, this by reason of the self-aligning bearings 40 which journal the roll on the shaft.

By reference to FIG. 1 it will be noted that adjustment of the roll 5 with respect to the roll 4, which occurs during the build up of the re-wind roll 11 as described above, will result necessarily in an adjustment of the axis of the roll or mandrel 6 away from the uprights 42 of the frame. The initial position of the mandrel is illustrated in FIG. 1 and the final position of the mandrel at the completion of the build up of the roll is illustrated at 56 in the same figure. The opposite ends of the mandrel 6 are supported in identical carriages 57 and 58 at opposite sides respectively of the machine, said carriages being guided for vertical movement on the rails 43 previously described. Each of these carriages has attached to the upper end thereof a rod 59 which is connected to a plunger in a hydraulic cylinder 61 pivotally suspended, as indicated at 62, from a bracket 63 secured to the face of the rail 43. Each of the carriages 57, 58 also has an arm 64 pivotally connected thereto by means of a pin 65, and at the lower end of each arm is a bearing 66 for the end of the mandrel, the lower half of this bearing being formed in an element 67 pivoted at 68 to the arm and being retractable from the upper bearing part by release of a retaining latch 69 to admit or release the ends of the mandrel. The mandrel 6, best shown in FIG. 11 has at one end a sleeve 70 supported on bearings 71 and 72 and, as shown in FIG. 14, this roller sleeve is seated in the arm 64 of the carriage 57 as described. At the other end, the mandrel has a circumferentially recessed spool-like roller sleeve 73 similarly mounted on bearings 74 and 75 on the end of the mandrel, and in this case, as best shown in FIG. 3, the sleeve is confined in the arm 64 of the proximate carriage 58 against axial displacement. The hydraulic cylinders 61 provide means for raising and lowering the mandrel as required and also supplies adjustable support or lift to the rewind mandrel so as to reduce the weight of the paper roll during winding on

the carrier drums. The amount of this lifting force is adjusted manually or automatically, selectively, by valves hereinafter described. It will be apparent that as the upward movement of the mandrel occurs, the mandrel-retaining arms 64 may pivot clockwise, as illustrated in FIG. 13, around the supporting pivots 65 in accordance with the lateral displacement of the roll axis previously described.

The slitter organization 2 is best shown in FIGS. 2 and 4 to 6 inclusive. As therein illustrated, the organization comprises a frame in the form of a cradle structure which consists of two end plates, 81 and 82 respectively, rigidly united by a transverse member 83 the cross-sectional shape of which is shown in FIGS. 4 and 5. The end plates 81 and 82 each comprises an outwardly projecting arcuate track member, 84 and 85 respectively, which in the assembly seats upon a pair of rollers, 86, 86 and 87, 87 attached to and projecting inwardly from the frame side members 42. The cradle is thereby adapted for angular adjustment in the frame and on the rollers 86 and 87 about an axis intersecting the common center of the arcs defined by the tracks 84 and 85. The cradle is anchored in adjusted position by means of a link 88 which is attached at one end to a depending arm 89 on the cradle and at the other end to a cross head 91, see FIG. 4, which is guided for rectilinear adjustment in a bracket 92 and which is engaged by an adjusting screw 93 which may be turned in the bracket by means of a hand wheel 94, the screw 93 and link 88 thereby afford a means for angularly adjusting the cradle and for anchoring the cradle in the adjusted position as set forth. A lock nut 95 is provided for immobilizing the screw 93 in adjusted position. Hydraulic cylinders A and A' are anchored to side members 42 by means of pivot pin C and C'. The piston rods of these cylinders are attached to clamping shoes B and B' which firmly lock the entire slitting station 2 during operation of the machine.

Journalled in the side plates 81 and 82 of the cradle coaxially with the arcuate tracks 84 and 85 is a shaft 96 shown detached in FIG. 7. This shaft has at one end a handle 97 and adjoining this handle a spherical bearing structure 98 shown in detail in FIG. 6. The cylindrical housing of this bearing structure is designed to fit nicely within an opening 99 in the end plate 82, and the housing with the handle element 97 may be secured to the end plate by means of screws 101. The opposite end of the shaft 96, also as shown in FIG. 6, carries the inner race of a bearing 102 the outer race being mounted in a housing 103 secured by screws 104 in an opening in the end plate 81. The housing 103 also provides a support for a hydraulic motor 105 the splined shaft of which extends into an axial bore 106 in the proximate end of the shaft 96, said bore having a complementary spline to operatively connect the two shafts. By releasing the screws 101 at the other end of the shaft 96, the shaft may be axially withdrawn from the cradle by means of the handle 97 through an aperture 108 in the adjoining frame member 42. In operation, the motor 105 functions to drive the shaft 96 as described below.

A dovetail track 109 is formed on the transverse member 83 of the cradle, as illustrated in FIGS. 4 and 6, and on this rail are slidably mounted a number of slitter knife heads, three of which are shown in FIG. 6 and designated respectively by the reference numeral 111, 112 and 113. These heads are individually adjustable along the track through the medium of a rack 114 on the transverse cradle member 83, below and paralleling the rail 109, and a pinion 115 rotatably mounted on each of the heads and engaging the rack as shown in FIGS. 4 and 6. In each case, the pinion may be turned to shift the head by means of a pinion shaft 116 and hand wheel 117. The individual heads may be locked to the rail in adjusted position by a clamping arm 118 which is pivotally connected at 119 in the head structure and engages one side of the track 109 as indicated at 121 in FIG. 4. A clamping screw 122 having a handle 123 has threaded engagement with the arm 118 and when turned will draw the arm into clamping engagement with the rail.

The slitting knife head 112 comprises a rigid body 124 in which is journalled for rotation upon bearings 125 a cylindrical slitter roll 126. As shown in FIG. 6, this roll is keyed to the shaft 96 as indicated at 127 and 128, the shaft 96 being longitudinally grooved for reception of the keys. At the top and at one side of the slitting roll 26, the body 124 of the head carries a flat guard plate 129; and the opposite edge of the roll 126 is adapted for functional engagement with a slitting blade 131 in the performance of the web slitting operation.

As shown in FIGS. 2, 4 and 5, the circular slitting blade 131 is rotatably supported on a resilient arm 132 which depends from a bracket 133 keyed to a tubular shaft 134. This shaft is journalled at its opposite ends in the side plates 81 and 82 of the cradle as indicated at 135 so that the shaft may be rocked to angularly displace the bracket 133 and the slitter blade 131 with respect to the companion slitter roll 126. Such angular adjustment of the shaft 134 is effected in the present instance through medium of a hydraulic cylinder 136, see FIG. 4, which is connected to an arm 137 on one end of the shaft.

Means is provided also for shifting the shaft 134 axially so as to remove the slitting blade 131 from the companion slitter roll 126 to a position, for example, indicated in broken lines in FIG. 6, the means for accomplishing this result being hereinafter described. In operation, however, the blade-supporting bracket 133 will occupy a position wherein the side of the blade in the peripheral area lies in pressure engagement with the proximate side of the slitter roll 126, this pressure contact being a resilient one by reason of the flexibility of the arm 132 which supports the blade.

The slitter knife head 111 differs from the head 112 in that the slitter roll 141 of this head is mounted at the opposite side of the head, and in that the plate 129 of the latter head is replaced by a fitting 142 of the form illustrated in FIG. 12. The upper end 143 of this fitting functions in the manner of the guard plate 129 but is extended in part into overlapping relation with the roll, as illustrated in FIG. 6. The fitting extends downwardly in conformity with the curvature of the slitter roll 141, and the outer edge is turned upwardly and back over and in spaced relation with the portion 144 so as to form with the latter an open-sided duct 145 which extends away from the slitting station in the direction of movement of the paper web 1 through the latter. The duct thus receives and embraces the severed outer edge portion of the web as it leaves the cutter knife and conducts it away from the cutter head. The lower end of the duct terminates in the extended nozzle end 139 of a suction tube 140 through which the said severed edge portion of the web is continuously withdrawn from the machine. This device precludes inadvertent interference of this severed edge strip with the operating parts of the slitter assembly. In other respects the head 111 functions in the same manner as the head of 112.

The slitter blade 146 is mounted on a resilient arm 147 corresponding to the arm 132 of the blade 131, and this arm 147 is attached to a bracket 148 which is slidably supported on a tubular stub shaft 149 which parallels the shaft 134 and is supported in the side plate 81. Both the shaft 134 and stub shaft 149 are slotted for reception of a key, 152 and 153 respectively, by means of which the brackets 133 and 148 are secured against relative angular displacements with respect to the shafts. Each of the keys 152 and 153 is in the form of a rack, as best shown in FIG. 5, and each of the brackets 133 and 148 has mounted therein a pinion, 154 and 155 respectively, which meshes with the associated rack and which may be rotated by means of knobs, 156 and 157 respectively, so as to adjust the carrier bracket longitudinally of its carrier shaft. Each of the brackets 133 and 148 also has a set screw,

158 and 159 respectively, by means of which the bracket may be releasably secured in adjusted position to its carrier shaft. By release of these set screws it is possible to adjust the brackets to bring the slitter blade into operative engagement with the proximate edge of the complementary slitter roll.

The slitter knife head 113 is identical in form with the head 111 except that its guide chute 161 faces in the opposite direction and lies at the opposite axial side of the head. The function of the chute 161 is the same as that of the chute 145 previously described in connection with the head 111. A slitter blade 162 in this case engages the right hand side of the complementary slitter roll 163, see FIG. 6, and the resilient arm 164 of the blade 162 is carried in this instance by a bracket 165 mounted on a stub shaft 166 corresponding to the stub shaft 149 of the opposite end bracket 148 and axially aligned with the latter. The construction of the bracket 166 is identical with the bracket 149, and the mode of adjustment of the bracket and the manner in which it is secured to its stub shaft is the same.

The web 1 in passing to the slitter organization passes over an idler roll 167 which is journalled in the side plates 81 and 82 of the cradle. The web then passes over a relatively fixed guard plate 168 at the inner side of the idler roll 167 to and over the rolls of the several slitter heads described above. The side edges of the web pass into the chutes 142 and 161 as described above. In the threading operation, the slitter blade brackets on the shaft 134 and their blades will be displaced both axially and radially from the respective slitter rolls by means hereinafter described so that the web may pass freely over the said rolls to the spreader roll 169 at the opposite side of the cradle. The terminal blades 146 and 162 will, however, remain in operative engagement with their complementary slitter rolls 141 and 163 so that the waste edge portions of the web will be severed and will pass to the evacuating tubes 140, leaving only that portion of the web which is to be re-wound to pass to the mandrel 6.

The spreader 169 is best illustrated in FIG. 2. It comprises a longitudinal series of cylindrical sleeves 171, 171 individually mounted in bearings 172, see FIG. 5, on the bowed shaft 173, the latter shaft being suitably fixed in said end plates 81 and 82. As indicated in FIG. 5, the central portion of the shaft 173 is supported in a collar 174 at the upper end of the arm 89 through which the cradle is adjusted angularly about the axis of the shaft 96 as previously described. The web 1 passes over this spreader roll as illustrated in FIG. 4 and downwardly under the cradle roll 4. It will be apparent that with this arrangement, as shown in FIG. 4, any angular adjustment of the cradle about the axis of the shaft 96 will affect the functional relationship between the web and the spreader, and controls the extent to which the slit sections of the parent web will diverge in passing to the roll 4. Thus, if the cradle is adjusted counterclockwise as viewed in FIG. 4 to the position wherein the roll 169 and the immediately associated portion of the web 1 assume the state of relative tangency illustrated in broken lines, the separation of the slit strips of the web will be at a minimum; whereas an adjustment of the cradle in the opposite direction progressively increases the angle of divergence and the extent to which the strips will be separated at the roll 4. This spreading action is clearly indicated in FIG. 2.

In the operation of the machine the paper web is first trained through the slitter organization 2. To facilitate this operation, the hollow shaft 134 is adjusted axially to a position in which each of the blades mounted on this shaft is displaced laterally from the cooperative edges of the respective associated slitter rolls 126. This axial movement of the shaft is effected through the medium of a hydraulic cylinder 175 mounted in one end of the shaft as illustrated in FIG. 5 the plunger 176 of which reacts with the proximate side frame 42 of the machine to displace the cylinder and the shaft as described when hydraulic pressure is applied in the cylinder. Obviously, the axial movement of the shaft required to accomplish the desired result is a relatively small one. Thereafter the cylinder 136 is actuated by admission of hydraulic medium to oscillate the shaft 134 and to thereby angularly displace the slitter blade brackets so as to withdraw the blades radially from the slitter rolls. As previously set forth, the terminal slitter blades 146 and 162 remain in operative relation to the slitter rolls 141 and 163 so that the waste edge portions may be trimmed from the web.

In passing from the slitter organization the web travels over the spreader 169 to and under the cradle roll 4, thence, as shown in FIG. 4, upwardly between the cradle rolls 4 and 5 and counterclockwise around a cylindrical core sleeve 176 on the mandrel 6. Another way of feeding the material is to pass the web under drum 4 to roll 5 and around this roll to mandrel 6. In this case, rolls 4, 5 and 9 run clockwise, and the mandrel 6 counterclockwise. The directions of rotation of 4, 5 and 6 may be reversed by hydraulic means. After the end of the web has been passed around the mandrel, the rider roll 9 is lowered into engagement with the web. Subsequently, the shaft 134 is re-adjusted to bring the slitter blades by radial and axial movements into normal operative engagement with the slitter rolls.

During this threading operation the cradle rolls 4 and 5 and rider roll 9 are preferably driven at uniform speeds. In the subsequent slitting and winding operation, however, the front cradle roll 5 will be driven by its separate hydraulic motor at a speed somewhat greater than the speed of the back roll 4 to maintain the web in constant uniformly taut condition as it passes to the rewind roll. The desired density of the slit and rewound roll can be controlled by the driving torques applied at rolls 4, 5 and 9. As hereinafter described, the torques on rolls 4, 5 and 9 can be selected and controlled to suit the special requirements of the web material. As the roll increases in diameter, the mandrel is elevated, as also is the rider roll 9, and this upward movement of the roll operates as previously described through the linkage consisting of the arm 12, lever 28 and arm 26, to continuously move the front cradle roll 5 away from the roll 4 to thereby increase the effective width of the cradle support provided by these rolls for the rewind roll 11. By reason of this adjustment of the roll 5, there will be a corresponding adjustment of the axis of the rewind roll 11 in the mandrel 6 away from the vertical plane containing the axis of the roll 4 and this displacement of the mandrel is permitted by a clockwise adjustment of the mandrel-retaining arms 64, it being noted that the carriages 57 and 58 for these arms are constrained to move in vertical paths by reason of their operative connection with the rails 43.

The rider roll 9 moves in a vertical path as illustrated in FIG. 1. This upward movement of the roll results from the increasing diameter of the rewind roll 11 on which the roll 9 rests, and during this upward movement, the roll is continuously rotated through the motor 49 so as to operate in conjunction with the cradle rolls to maintain the rewind roll in continuous rotation. The effective pressure of the roll 9 on the rewind roll 11 may be regulated hydraulically through the cylinder 37. Various means of controlling the contact pressure of the rider roll on the paper reel are disclosed in U.S. Patent 2,733,018. By reason of the fact that the cylindrical shell of the roll 9 which contacts the rewind roll 11 is journalled on bearings 40 on the roll shaft 33, a tendency for this roll to deflect or bow at the center is avoided. Any deflection occurring in the roll structure as a whole will be confined to the shaft 33 and the cylindrical roll shell will maintain its normal rectilinear form. This fact, in conjunction with the resilient mounting for the racks 47 previously described, operates to maintain a substantially

uniform rider roll pressure over the entire axial length of the re-wind roll even though inequalities in the paper web may tend to cause small differences between the opposite end diameters of the latter roll. As a result of this device, the re-wind roll will exhibit a substantially uniform density throughout.

When the re-wind roll **11** has reached the desired diameter, the winding operation is terminated, the web is severed, and the roll **9** is elevated through the medium of the hydraulic cylinders **37** so as to permit discharge of the roll from the machine. This discharge may be effected by means of a push-off device consisting in the present instance of a roll **177** journalled in arms **178, 178** pivotally mounted on opposite sides of the machine for movement around the axis of the cradle roll **4** and operatively connected with a hydraulic cylinder **179**. The arms **178** and the roll **177** may be rocked through the cylinder **179** in counterclockwise direction, as viewed in FIG. 4, into engagement with the underside of the re-wind roll **11** and to the further extent required to displace the re-wind roll from the cradle rolls **4** and **5**.

There may be modification of the machine without departure from the principles of the invention described above, and one such modification is illustrated in FIGS. 16 and 17. In this case, the cradle forming the frame for the slitter organization is mounted at the front of the machine instead of at the rear. To this end, the cradle, identified by the reference numeral **181**, is supported for pivotal adjustment upon journal structures of the character illustrated at **182** in FIG. 17 in side frames **183** of the machine. Mounted also in these journal structures coaxially are the reduced end portions **184** of the shaft **185** which carries the slitter rolls **186**, the portions **184** being supported in suitable anti-friction bearings in **187** in the journals. The cradle structure may be adjusted angularly about the axis of the shaft **185** through the medium of an arcuate rack **188** on one of the end plates of the cradle and a pinion **189** which meshes with this rack and which is carried on a jack shaft **191**. A worm wheel **192**, also secured to the shaft **191**, meshes with a worm **193** at the end of a shaft **194**, which shaft may be turned manually through the medium of a hand wheel **195**. The cradle is locked in any desired position by means of clamp cylinders as shown in FIGS. 4 and 5. The slitter cradle, FIG. 16, can also be adjusted to a position where threading of the web material can take place upwards and between the carrier drums. It is understood that the rotation of the rolls in contact with the web material must be reversed to suit the feeding conditions.

The cradle carries an idler roll **196** and a spreader roll **197** which functions in the same manner as the corresponding elements of the previously described assembly. Also supported in the cradle is a shaft **198** to which are secured the brackets **199** which carry the slitter blades **201**. The shaft **198** may be rocked by means of a hydraulic cylinder **202** to move the blades away from the slitter rolls **186** to facilitate threading of the paper web **203** into the machine in the manner previously described. The spreading effect of the spreader **197** may be adjusted by angular adjustment of the cradle in the manner also previously described. In this case, the web in passing from the spreader roll **197** moves upwardly around the forward side of the front cradle roll **204** and thence to the mandrel in the manner illustrated. This type of assembly requires a pit **205** below the floor level to accommodate the lower portion of the cradle. In all essential mechanical respects, this modified machine is the same as the embodiment previously described.

The slitting and rewind mechanism described above is actuated in the present instance by four hydraulic pumps through the hydraulic system shown in FIGS. 18*a*–18*b*. As indicated, the pumps feed from a common sump or reservoir **225** and are driven by a single electric motor **226**. The hydraulic system can best be described in terms of six basic functions, namely: (1) Web Threading, (2) Running, (3) Braking, (4) Rider Roll Control, (5) Rewind Mandrel Control, and (6) Roll Ejection.

Threading

In threading the web from the parent source through the slitter assembly and to the re-wind mandrel, as described above, pump **221** delivers oil, or other hydraulic medium, by way of pipe line **227** to the hydraulic motor **7** which drives the rear cradle roll **4**. A solenoid operated pressure relief valve **228**, which controls the connection between line **227** and reservoir return line **229**, is energized and is, therefore, in working position. The setting of valve **228** will thus determine the maximum torque of the motor **7**. From the motor **7** oil discharges to line **231** but is blocked by electrically operated sequence valve **232** which, being now de-energized, is in closed position. The oil is therefore diverted through line **233** to electrically operated sequence valve **234**, and this valve, being energized, permits the oil to flow to and through flow control valve **235** to valve **236**. Valve **235** is of the pressure-responsive uniform flow type and maintains substantially uniform volume flow to valve **236**. The setting of valve **235** therefore determines the maximum speed of the motor **7**.

Four-way electrically operated valve **236** is energized and is in position therefor to divert oil flowing from valve **235** to line **237** and therethrough to hydraulic motor **8** which drives the forward cradle roll **5**. Motor **8** is connected in series with hydraulic motor **49** which drives the rider roll **9**, so that oil discharged from the motor **8** passes to and through the motor **49**. A check valve **238** prevents loss of flow through electrically operated relief valve **239** which at this time is in open position. Discharge from motor **49** passes through an electrically operated relief valve **241**, which is energized and in open position, to return line **229** and reservoir **225**. During the threading operation, therefor, the motors **7, 8** and **49** are connected in series.

Pump **222** delivers oil by way of line **242** to valve **243**. Line **242** is protected from over-pressure by a relief valve **244** through which the line is connected to return line **229**. Valve **243** is a solenoid-operated four-way valve which is now de-energized and in position therefor to divert the oil flow through a flow control valve **245** to hydraulic motor **105** which operates the slitter shaft **96** described above. A check valve **246** prevents loss of oil to the inoperative portion of the system. In this case, therefore, the maximum torque of motor **105** is determined by the setting of valve **244**; and the setting of valve **245** determines the maximum speed of motor **105**.

As described above, in this threading phase the motors **7, 8** and **49** are connected in series, and are therefore in step, and the motors are relatively sized so as to give the same surface speed to the two cradle rolls, **4** and **5**, and to the rider roll **9**.

Running

While the machine is running in the slitting and rewinding function, pump **221** supplies oil under pressure to the motor **7**, as described, the electrically operated relief valve **228** being energized. Discharge from the motor **7** passes through electrically operated sequence valves **232**, which is now energized, and thence to manually adjustable speed control valve **247**. Relief valve **248** limits the pressure in the line **231** between the motor **7** and the valve **247**. Flow of oil continues from the valve **247** through the solenoid-operated four-way valve **236**, which is now de-energized, to the reservoir **225**.

Oil from pump **222** is diverted by solenoid-operated four-way valve **243**, now energized, to the inlet port of a metering valve **249**, thence through check valve **246** to the inlet port of hydraulic motor **105** which drives the slitting knives. Pressure control of this portion of the system is effected by relief valve **244** through check valve **251**.

Oil from pump 223 is delivered to solenoid-operated pressure relief valve 239, now energized to closed position, through check valve 233 to the inlet of hydraulic motor 8. The discharge flow of hydraulic motor 8 is directed to the inlet port of the motor 49 which as previously set forth drives the rider roll. Discharge from motor 49 returns to reservoir 225 through electrically operated sequence valve 241, now energized and in open position. In this phase of the operation valve 228 controls the maximum torque of hydraulic motor 7; and the speed of motor 7, is determined by the setting of valve 247. As previously set forth, the speed of motor 7 is such that the surface velocity of cradle roll 4 is somewhat less than that of the cradle roll 5. The calibrated dial of valve 247 gives visual indication of the speed of the motor 7. The setting of valve 239 determines the maximum torque of motors 8 and 49, and this torque is indicated by gauge 252. Manually adjustable valve 253 affords remote control for the valve 239. The setting of valve 244 determines the maximum torque of motor 105; and metering valve 249 maintains motor 105 in correct speed relation with motor 7. Motors 8 and 49 are sized to give the same surface speed to the rider roll 9 and the front cradle roll 5.

An important function of this drive is the ability to reverse the direction of rotation of motors 7, 8 and 49. This is accomplished by two solenoid-operated four-way valves 295 and 296. Valve 295 interchanges lines 297 and 298, reversing flow through motors 8 and 49 thereby reversing the direction of rotation of torque motors. Valve 296 interchanges lines 299 and 300 reversing flow through motor 7. In order to keep direction of rotation of slitter motor 105 unchanged, four-way valve 293 interchanges supply and return lines of metering valve 249.

Braking

In braking the machine to interrupt or retard the operation, oil from the pump 222 is directed by solenoid-operated four-way valve 243, which is de-energized, through the flow control valve 245 to the inlet port of hydraulic motor 105. The oil from the discharge of hydraulic motor 105 returns to reservoir.

Oil from the pump 221 goes to solenoid-operated relief valve 228 which is de-energized to the low pressure position and thence to the inlet of hydraulic motor 7. The oil discharge from the motor 7 passes through solenoid-operated sequence valve 232, now de-energized to high pressure position, through valve 247 to solenoid-operated four-way valve 236, this valve being de-energized and passing the oil to the reservoir.

Oil from the pump 223 passes to solenoid-operated relief valve 239 which is de-energized to the low pressure position. Oil from this pump also passes through check valve 238 to the inlet of the hydraulic motor 8. Discharge from the motor 8 is connected to the inlet of hydraulic motor 49. Discharge from the latter motor passes to the reservoir through electrically operated sequence valve 241, now de-energized to high pressure position.

In this operation the low pressure adjustment in valve 228 controls the low pressure supercharge to and prevents cavitation of oil in line 227 to motor 7. High pressure setting of valve 232 controls maximum reverse torque of motor 7. Valve 239 similarly controls low pressure supercharge to hydraulic motors 8 and 49; and valve 241 in its high pressure setting controls maximum reverse torque of motors 8 and 49. The pressure settings of valves 232 and 241 are controlled simultaneously by panel-mounted control valve 254; and the valve of this reverse or braking torque is indicated on gauge 255. Valve 243 reduces slitter drive to idling speed.

Rider Roll Control

For control of the rider roll 9, oil from pump 224 passes through flow control valve 261 to line 262 which conducts the oil to the rod-end of the rider roll cylinders 37, 37. Pressure in the line 262 is controlled by relief valve 263. Loss of pressure is prevented by check valve 264.

Oil from the pump 224 also passes through sequence valve 265 to the base end of the cylinders 37, 37 by way of line 266. Pressure in the line 266 is controlled by hydraulic relief valve 267.

The pressure setting of valve 267 may be accomplished manually by control valve 268, or automatically by control valve 269. Selection between automatic and manual control is accomplished by hand-operated four-way valve 271. Valve 267 controls the pressure applied to the re-wind roll by the rider roll, and the amount of this pressure is indicated at all times by gauge 272. As indicated, the pressure can be regulated manually by way of valve 268; or it can be regulated automatically in response to the changing diameter of the re-wind roll through valve 269 and associated adjusting cam 270 in accordance with the principle disclosed in United States Patent 2,733,018. Flooding of oil for the rider roll cylinders 37, 37 on the return stroke is afforded by check valves 273 and 264.

Rewind Mandrel Control

In controlling the pressure applied on the re-wind mandrel 6 by hydraulic cylinders 61, 61, pump 224 delivers oil to flow control valves at 281, 282, 283 and 284 and thence to the mandrel-elevating ends of cylinders 61. These cylinders are connected to the mandrel bearings as previously described. Valves 281, 282, 283 and 284 control the flow to and from the cylinders 61, 61 in a manner to keep their movements parallel both on raising and lowering.

Pump 224 also delivers oil through constant flow valve 285 to the upper or blind ends of cylinders 61, 61. This flow continues to pressure control valve 286. Increase in the pressure setting of valve 286 tends to lower the re-wind mandrel; decrease of this pressure setting will tend to elevate the mandrel. The pressure setting of valve 286 may be accomplished manually by control valve 287, or automatically by control valve 288. The selection between automatic and manual control is by hand-operated four-way valve 289. The value of the re-wind mandrel lift pressure both during manual and automatic control is indicated on pressure gauge 291. Under automatic control this value will increase as the weight of the re-wind roll increases, the adjustment of valve 288 through an associated cam 290, which is geared to the movement of the rider roll 9 so as to make one revolution during full travel of the said roll, being in response to the increasing diameter of the roll, as set forth in relation to the automatic actuation of valve 269.

Roll Ejection

In the roll ejector mechanism, oil passing from discharge port of valve 265 enters the solenoid-controlled four-way valve 101. This valve, de-energized, directs the oil to the rod-side of ejector cylinders 179, 179. In the energized position, valve 101 directs oil flow through flow control valves 102, 103, 104 and 105 to the base side of the cylinders 179, 179. The return oil flows from the exhaust port of valve 101 through to the reservoir. Pressure in this portion of the system is controlled by pressure relief valve 267.

In this function the valve 267 controls the maximum force of the cylinders 179, 179. Valves 102, 103, 104 and 105 keep the ejector roll 177 parallel to the cradle rolls both on ejection and on retraction. Valve 101 controls the movements of the ejector roll.

A further embodiment of the invention is shown in FIGS. 19 and 20. In this case the slitter assembly 295 occupies the same general position in the machine as the assembly 2 of the embodiment of FIG. 4, but the cradle 296 of assembly 295 is mounted on journals 297 and 298 in the side frames 299 and 301 after the manner of the cradle 181 shown in FIGS. 16 and 17. The cradle

has circular end plates 302 and 303, and the latter plate is provided at its periphery with gear teeth 304. Through the medium of a crank 305 which is connected to the gear 304 by the worm 306, wormwheel 307, shaft 308 and pinion 309, all shown in FIG. 20, the cradle may be angularly adjusted about the axis of the journals to any position relative to the cradle roll 311 that may be required by the selected feed. In the present instance the web 312 is fed over the top of the roll 311 and its companion adjustable cradle roll 313. In all other respects the slitter assembly is essentially the same as those described above and functions in like manner.

I claim:

1. In a machine for slitting web material, a main frame, a sub-frame comprising side frame mebers and a transverse member rigidly connecting said side members, arcuate track elements projecting outwardly from the respective side members, and cradle supports on the main frame for said tracks, said tracks and supports affording angular adjustment of the sub-frame in the main frame about an axis defined by the centers of curvature of the arcuate tracks, and slitter mechanism including slitting heads and web guide means mounted in the sub-frame, said web guide means including means engaging the slit web to regulate the amount of divergence between slit strips, said slitting heads being located on the said centers of curvature and forming with the sub-frame a unitary slitter assembly adjustable in and with respect to the main frame for pivoting said sub-frame and said web guide means while maintaining the slitting heads in slitting engagement with web material to change the amount of divergence between strips slit from the web and adapted to change feed angle of travel of the web from over to under drums on which the slit strip may be wound selectively.

2. In a machine for slitting web material, a main frame, a sub-frame, a shaft journalled in the sub-frame, slitting elements mounted on the sub-frame and connected to the shaft, means for mounting the sub-frame in the main frame for angular adjustment with respect to the latter about the shaft axis, means for adjusting the sub-frame and for anchoring the sub-frame in adjusted position in the main frame and web guide means mounted on the sub-frame and including means engaging the slit web for regulating the amount of divergence between slit strips, said sub-frame upon angular adjustment pivoting said web guide means while maintaining the slitting elements in slitting engagement with web material to change the amount of divergence between strips slit from the web and adapted to change feed angle of travel of the web from over to under drums on which the slit strip may be wound.

3. A machine according to claim 2 wherein said means engaging the slit web comprises a bowed roller spreader means carried by the sub-frame and having portions individually engaged with the said strips and angularly offset with respect to each other to regulate the amount of divergence between slit strips.

4. In a machine for slitting web material and winding the resulting strips into rolls, a main frame, web winding elements mounted in said frame including a pair of winding drums forming a support for said rolls during the winding operation, a sub-frame a shaft journalled in the sub-frame, slitting elements mounted on the sub-frame and connected to the shaft, means on said sub-frame for directing a slit web from the slitting elements to the said drums for subsequent feed to the said roll, selective means for rotating each of the drums in either direction, means for mounting the sub-frame in the main frame for angular adjustment with respect to the latter about the shaft axis, means for angularly adjusting the sub-frame, angular adjustment of the sub-frame serving to direct slit web material selectively under or over a first one of said web winding drums to change the direction of winding of the web in conjunction with the selected direction of rotation of the drums and additionally angular adjustment of the sub-frame serving to move said sub-frame and slitting elements mounted thereon to a position of enhanced accessibility for thread-up and observation during operation of the machine, and means for securing said sub-frame in adjusted position.

5. A machine according to claim 4, a riding roll seating on the web rolls and movable upwardly on the latter as the diameter of the rolls increases, individual hydraulic motors for each of the winding drums, the slitter shaft, and the riding roll, individual control means for each of said hydraulic motors, and means for operating the hydraulic motors for the drums and for the rider roll in synchronism at a common speed suitable for threading the web into the machine.

6. A machine according to claim 5 comprising a hydraudraulic system embracing said motors and control means and including means for operating the drum and rider roll motors in synchronism at a predetermined common speed while initially threading the web into the machine.

7. A machine according to claim 6 wherein the said system comprises devices operative during the threading operation for driving the slitter shaft motor at a pre-set constant speed.

8. A machine according to claim 5 including means for directing the slitted web upwardly to the web rolls around one of the drums, and hydraulic means for actuating the motors of the last named drum in fixed ratio with the motor of the slitter shaft.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,072,353 January 8, 1963

Henry W. Moser

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Sheet 1 of the drawing, reverse direction of arrow on roll 11 so as to be counterclockwise. Sheet 10 of the drawing, change 105 to 258, change 103 to 256, change 104 to 257, change 102 to 255, change 101 to 254. Sheet 12 of the drawing, change both occurrences of 295 to 314, change 299 to 310, change 297 to 316, change both occurrences of 296 to 315, change 298 to 317. Column 6, line 9, change 26 to 126. Column 8, line 43, change 12 to 32. Column 12, line 56, change 101 to 254; line 58, change 101 to 254; line 59, change 102 to 255, change 103 to 256, change 104 to 257, change 105 to 258; line 61, change 101 to 254; line 65, change 102 to 255, change 103 to 256, change 104 to 257; line 66, change 105 to 258; line 67, change 101 to 254; line 70, change 295 to 314. Column 12, line 73, change 296 to 315, change 295 to 314, change 297 to 316; line 74, change 298 to 317, change 299 to 310.

Signed and sealed this 29th day of December 1970.

(SEAL)
Attest:

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