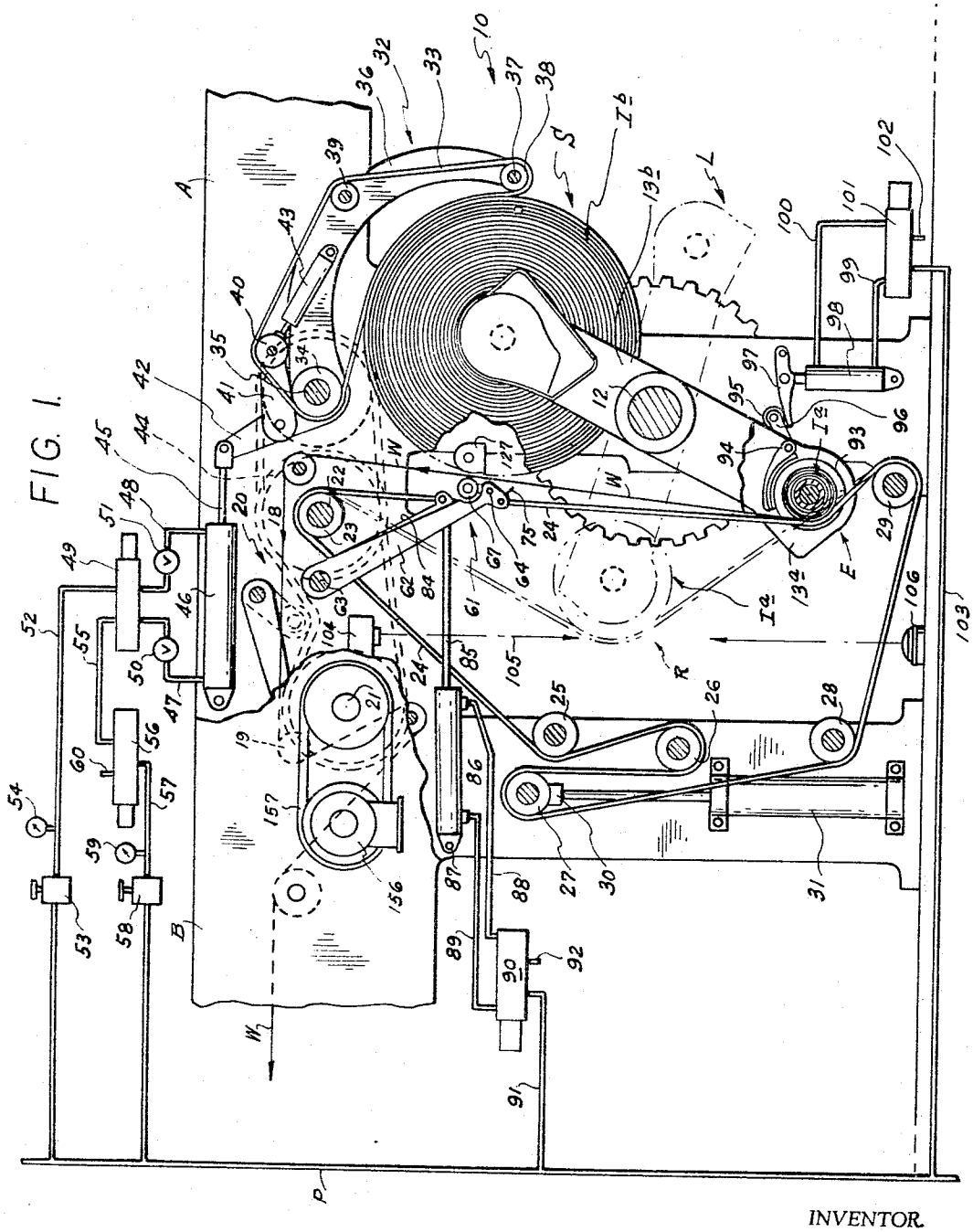
June 20, 1967 H. BLESSING 3,326,486

AUTOMATIC CONTROLS FOR SPLICING ROLLSTAND

Filed Sept. 2, 1965 4 Sheets-Sheet 1

FIG. 1.



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AUTOMATIC CONTROLS FOR SPLICING ROLLSTAND

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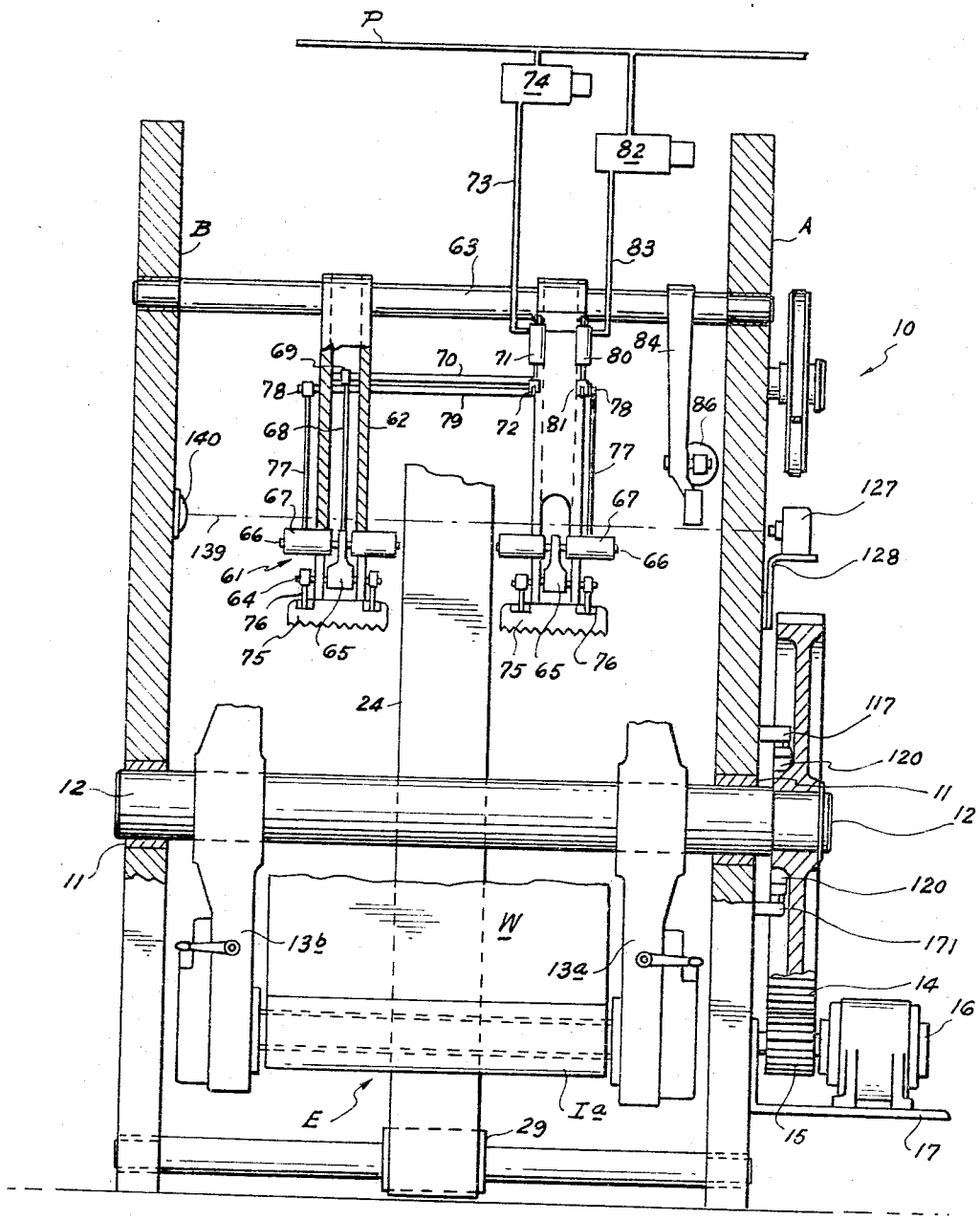


FIG. 2.

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AUTOMATIC CONTROLS FOR SPLICING ROLLSTAND

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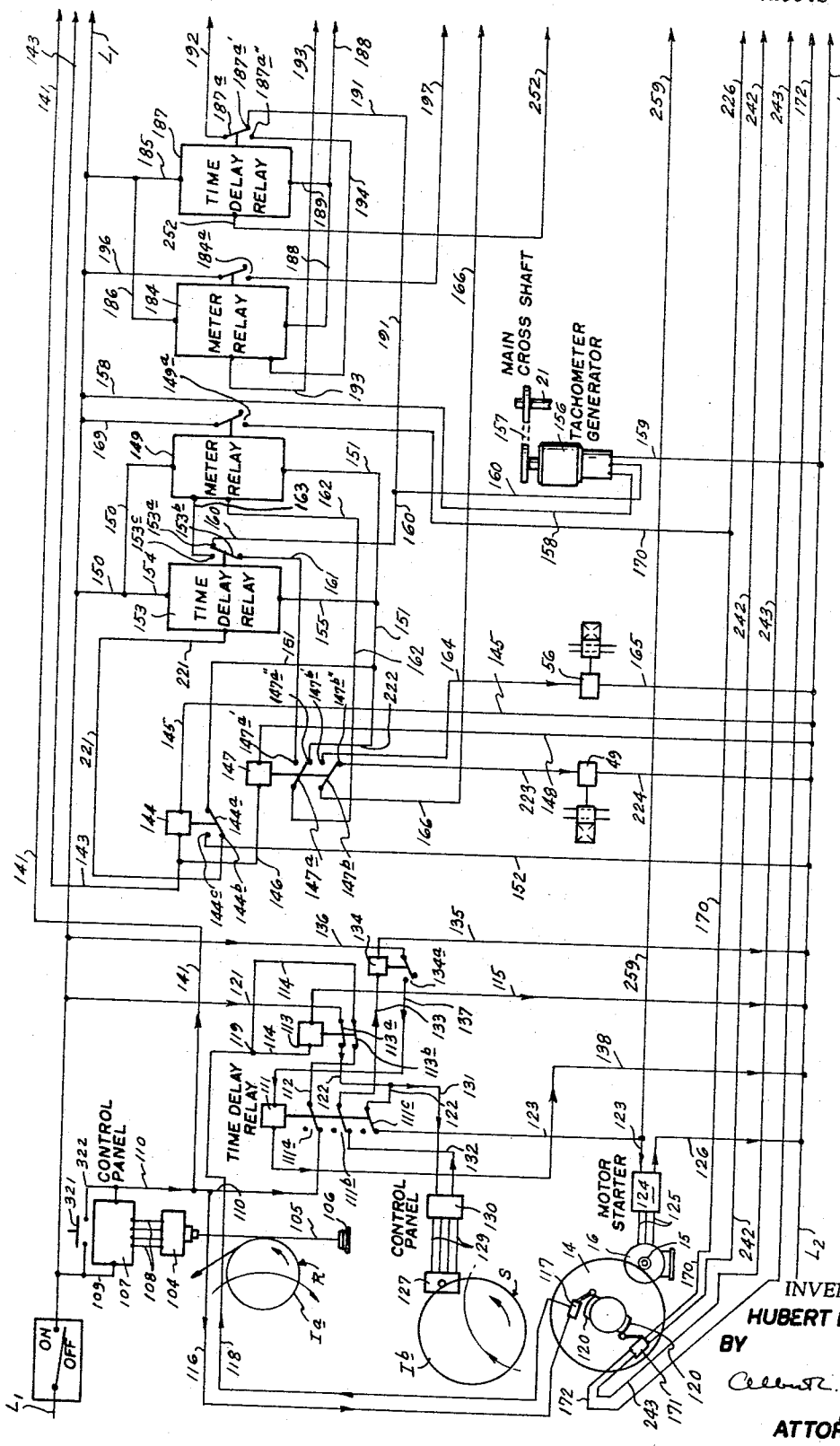


FIG. 3A.

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AUTOMATIC CONTROLS FOR SPLICING ROLLSTAND

Filed Sept. 2, 1965 4 Sheets-Sheet 4

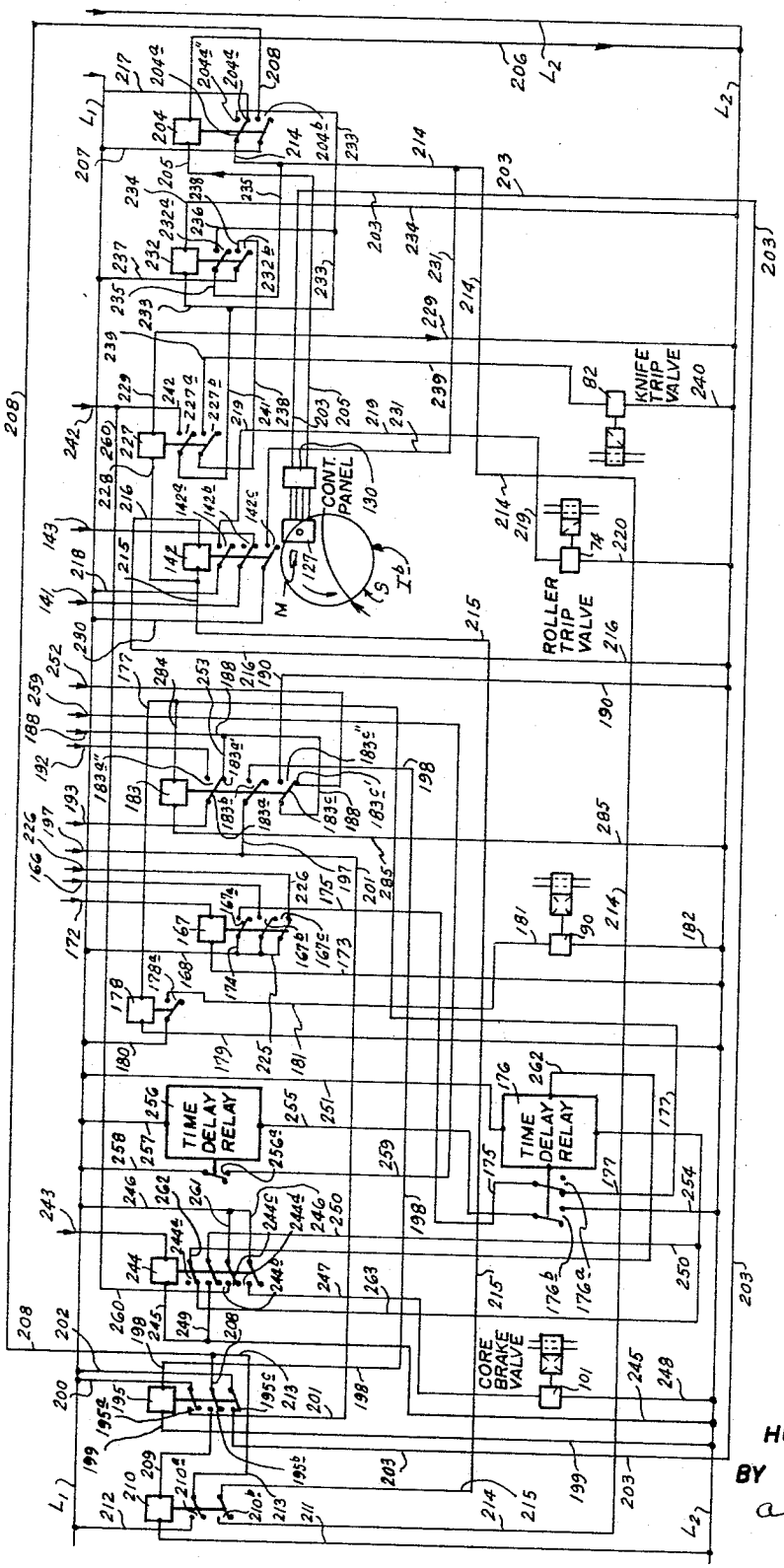


FIG. 3B.

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3,326,486

AUTOMATIC CONTROLS FOR SPLICING ROLLSTAND

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Filed Sept. 2, 1965, Ser. No. 484,551
11 Claims. (Cl. 242—58.3)

This invention relates generally to rollstands in which a web being delivered or unwound from a web supply roll about to expire is spliced to the leading end of the web forming a new web supply roll so that web material can be continuously delivered from one web supply roll after another, for example, to a printing press or other web processing machine.

Splicing rollstands of the type to which this invention relates have support means, for example, in the form of reel arms, for carrying a first web roll from which the web is being unwound and a second or new web roll which is to have its leading end, at the roll periphery, spliced to the web from the first roll. When splicing is to be effected, the reel arms are turned to move the new web roll from a loading position to a splicing position adjacent a run of the web from the first or expiring roll which is moved from a normal running position. Upon movement of the new web roll to splicing position, a splicing assembly which includes a paster pressure brush or rollers and cutting blades is moved toward the run of the web from the expiring roll so as to be operable thereon from the side of the run facing away from the new roll at splicing position. When disposed at the splicing position, the new web roll is rotated about its own axis so as to more or less match its peripheral speed to the speed of movement of the adjacent run of the web being unwound from the expiring web roll. When the thus rotated new web roll is in the angular or rotational position about its axis at which adhesive previously applied to the periphery of the roll, preferably near the leading end of its web, faces toward the adjacent run of the web from the expiring roll, the splicing assembly is actuated or triggered to cause the paster brush or rollers to press the expiring web run against the adhesive and thereby join or splice the web of the new roll to the web from the expiring roll, and then to cause the cutting blades of the splicing assembly to sever the web from the expiring roll at a location between the latter and the splice. Upon the completion of the foregoing splicing and cutting operations, the reel arms are further turned to move the new web roll from the splicing position to the normal running position, and to simultaneously move the expired web roll to the loading position at which it can be removed from the reel arms and replaced by the next new web supply roll.

In existing splicing rollstands, difficulties have been experienced in automatically controlling and coordinating the several above described operations so as to ensure that each expired web roll, when removed from the rollstand, has a uniform minimum amount of web material remaining on its core. In the past, the several operations of the splicing rollstand have been automatically controlled in accordance with a predetermined timed sequence, that is, with a fixed elapsed time between the initiation and completion of the splicing operations, irrespective of the speed at which the web material is continuously delivered from one web supply roll after another to the associated printing press or other web processing machine, so that the amount of web material running off or unwound from the expiring roll during the splicing operations will vary with variations in web speed. Further, the existing splicing rollstands initiate the splicing operations thereof when a predetermined supply of web material remains on the expiring roll which supply is at least as much as the amount of web material that would be unwound therefrom at the maximum web speed during the fixed elapsed time required for the splicing operations.

Since splicing rollstands of the described character are required to continuously deliver the web material to an associated printing press or other web processing machine at widely varying speeds, for example, speeds ranging from 150 to 2000 feet per minute, the predetermined initiation and fixed timing of the splicing operations that result in a desirably small amount of web material remaining on the expired roll when the web material is being delivered at the maximum speed in such range will result in an excess amount of web material remaining on the expired roll when the web is being delivered at slower speeds. Such excess web material remaining on the expired roll core constitutes expensive wastage.

Accordingly, it is an object of this invention to automatically initiate and control the splicing operations of a rollstand of the described character so that a uniformly small amount of web material remains on each expired roll core at the completion of the splicing operations irrespective of the speed at which web material is continuously delivered from the splicing rollstand to the associated printing press or other web processing machine.

Another object is to provide a splicing rollstand in which the sequence of operations for splicing a new web supply roll to the web being unwound from an expiring web roll is initiated automatically when the diameter of the expiring roll has been reduced to a predetermined dimension, and the sequence of splicing operations is controlled so as to be completed during the unwinding of a predetermined length of the web from the expiring roll, whereby, upon the completion of the splicing operations, a uniformly small amount of web material remains on the expired roll core irrespective of the speed at which the web has been delivered from the expiring roll.

In accordance with an aspect of this invention, the splicing operations of the rollstand are controlled by timing means operated upon initiation of the sequence of splicing operations and which vary the intervals between successive operations of the rollstand in inverse relation to variations of the web speed so that a predetermined length of web is unwound from the expiring web roll during the splicing operations, thereby to leave the desired uniformly small amount of web material on the expired roll core, irrespective of the web speed.

In a preferred embodiment of the invention, the timing means which control the splicing operations of the rollstand include time delay relay means actuated after variable periods of energization thereof to determine the intervals between successive operations, and generator means driven at a speed proportional to the web speed to generate a control voltage that varies with variations of web speed, such control voltage being impressed on the time delay relay means for varying the periods that they are energized prior to actuation.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of an illustrative embodiment thereof which is to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic elevational view of a splicing rollstand shown partly broken away and in section and having controls in accordance with this invention, with only those elements of the rollstand being shown which are essential to an understanding of the invention;

FIG. 2 is a schematic end elevational view of the rollstand also shown partly broken away and in section; and

FIGS. 3A and 3B together represent a schematic wiring diagram of the electrical components of the controls for the rollstand.

Referring to FIGS. 1 and 2 in detail, it will be seen that a splicing rollstand **10** of the type to which this invention may be applied includes vertical side frame members A and B carrying bearings **11** (FIG. 2) in which the opposite end portions of a rotatable horizontal shaft **12** are journaled. The successive web supply rolls from which web material is to be continuously delivered are rotatably supported between ends of a pair of reel or spider arms **13***a* and **13***b* which are mounted, at their centers, on shaft **12**. Shaft **12** is rotatable by a gear **14** secured on an end of the shaft extending beyond side frame member A and meshing with a pinion **15** mounted on the shaft extension of a motor **16** carried by a bracket **17** secured to side frame member A (FIG. 2).

During normal running of rollstand **10**, reel arms **13***a* and **13***b* are disposed in the position shown in broken lines on FIG. 1 and the web W is unwound from a web supply roll I*a* positioned at a normal running position R by the related ends of the reel arms. The web W unwound from web supply roll I*a* passes upwardly around a roller **18** journaled in side frame members A and B and then travels toward the left, as viewed on FIG. 1, so as to pass over a floating roller **19** forming part of a variable speed drive mechanism **20** shown in broken lines on FIG. 1 and which acts as a web tension control device. The mechanism **20** may be of the type disclosed in detail in U.S. Patent No. 3,103,320, issued Sept. 10, 1963, to William F. Huck, and provides a variable drive ratio between cross shafts **21** and **22** which are journaled in side frame members A and B. Shaft **21** is suitably driven from the printing press or other web processing machine (not shown) to which the rollstand continuously delivers web material. Shaft **22** has at least one drive pulley **23** secured thereon, and each drive pulley **23** is in driving engagement with a main unwinding or drive belt **24**. The main unwinding or drive belt **24** travels downwardly toward the left, as viewed on FIG. 1, from its drive pulley **23** and passes successively around idler pulleys **25** and **26**, a take-up pulley **27**, and idler pulleys **28** and **29**. The last mentioned idler pulley **29** is disposed below drive pulley **23** so that a run of drive belt **24** moving upwardly from idler pulley **29** to drive pulley **23**, and being shown in full and broken lines in two different positions on FIG. 1, is frictionally engageable with a web roll I*a* when that roll is in the normal running position R, and also when reel arms **13***a* and **13***b* are turned so as to dispose roll I*a* in the expiring position E indicated in full lines on FIG. 1. The several idler pulleys **25**, **26**, **28** and **29** are freely rotatable on shafts journaled at fixed locations in frame members A and B. Take-up pulley **27** is rotatable on a shaft having its ends journaled in bearing blocks **30** which are urged upwardly by fluid pressure operated cylinders **31** so that pulley **27** is effective to maintain a desired tension in drive belt **24** as the length of the drive belt included in the run engaging roll I*a* is varied by reduction of the diameter of that roll and by movement of the reel arms.

As described in detail in U.S. Patent No. 3,103,320, which is identified more fully above, variable speed drive mechanism **20** functions, in response to variations in the tension of the web W acting on floating roller **19**, to suitably vary the rotational speed of shaft **22** carrying drive pulley **23**, and hence to vary the speed of belt **24** and the speed at which that belt unwinds the web W from roll I*a*, in the sense for restoring a desired tension in the web.

When a web roll I*a* held between ends of reel arms **13***a* and **13***b* is disposed at the normal running position R and the web is being unwound therefrom, as described above, the opposite ends of the reel arms are disposed at a loading position L so as to receive a new web roll. After a substantial proportion of the web on roll I*a* at the normal running position R has been unwound therefrom and the splicing operations of the rollstand are to be initiated, motor **16** is energized, as hereinafter described, to effect rotation of reel arms **13***a* and **13***b* in the counterclockwise direction, as viewed on FIG. 1, for moving the new web supply roll I*b* to splicing position S and simultaneously moving the expiring web roll I*a* to expiring position E. It will be apparent that the run of web W being unwound from roll I*a*, and which is guided by idler roller **18**, extends across the path of travel of new web roll I*b* toward splicing position S.

The rollstand **10** is further shown to include an accelerating device **32** comprising at least one accelerating belt **33** which engages and is driven by a drive pulley **34** on a shaft **35** journaled in side frame members A and B. Arms **36** constituting a frame of accelerating device **32** are suitably supported for rocking about the axis of shaft **35** to permit movement of the accelerating device between its operative position shown on FIG. 1 and a raised inoperative position. A shaft **37** rotatably supported by the outer or free ends of arms **36** carries an idler roller **38** around which accelerating belt **33** passes so that a substantial length of the lower run of belt **33** between drive pulley **34** and idler pulley **38** can be moved against and frictionally contact the periphery of new web roll I*b* at splicing position S when the accelerating device is in its operative position. The return run of belt **33** passes over an idler pulley **39** journaled in arms **36** and then over a tensioning pulley **40** which is journaled between arms **41** pivotally carried by extensions **42** of arms **36**. Tensioning pulley **40** is urged against belt **33** by means of fluid pressure operated cylinders **43** pivotally carried by arms **36**.

Shaft **35**, and hence drive pulley **34**, are driven from shaft **22** by means of a belt and pulley transmission **44** shown in broken lines on FIG. 1. When accelerating device **32** is moved to its illustrated operative position so as to have its belt **33** frictionally contacted with the periphery of new web roll I*b* at splicing position S, transmission **44** causes belt **33** to accelerate the new web roll up to a peripheral speed equal to the linear speed of movement of the web W being unwound from expiring web roll I*a* by main drive belt **24**.

In order to effect the movement of accelerating device **32** between its raised inoperative position and the illustrated operative position, extension **42** of arms **36** are pivotally connected to forked ends of piston rods **45** extending from cylinders **46** which are pivotally supported by adjacent side frame members A and B. Conduits **47** and **48** extend from the opposite ends of each cylinder **46** to one side of a solenoid controlled valve **49**, and flow control or metering valves **50** and **51** are interposed in conduits **47** and **48**, respectively, for controlling the rate of fluid flow therethrough into the related ends of cylinder **46**. Connected to valve **49** is a conduit **52** extending from a fluid pressure supply line P and having interposed therein a pressure regulator **53** adjusted to establish a relatively high pressure, for example, 50 p.s.i., in conduit **52**, and which is capable of bleeding excess pressure fluid from conduit **52**. Also interposed in conduit **52** is a pressure gauge **54** for indicating the pressure for which regulator **53** has been adjusted. A conduit **55** extending from a second solenoid controlled valve **56** is also connected to valve **49**. Valve **56** is connected to fluid pressure supply line P through a conduit **57** having a pressure regulator **58** and pressure gauge **59** interposed therein. Pressure regulator **58** is adjusted to establish a relatively low pressure, for example 30 p.s.i., in conduit **57**. Valve **56** further has a vent or discharge port **60**.

When valve **49** is deenergized, it connects conduit **48** with conduit **52** and conduit **47** with conduit **55**. When valve **56** is deenergized, it connects conduits **55** with the vent or discharge port **60**. Thus, when solenoid valves **49** and **56** are both deenergized, fluid under relatively high pressure is supplied from conduit **52** to the right-

hand end of each cylinder **46**, as viewed on FIG. 1, and the left-hand end of each cylinder **46** is vented. The high fluid pressure acting in the right-hand end of each cylinder **46** produces a force sufficient to overcome the weight of accelerating device **32** and to raise the latter to its inoperative position.

When only solenoid valve **56** is energized, it permits fluid under pressure from supply line P to enter the left-hand end of each cylinder **46** by way of conduit **57**, energized valve **56**, conduit **55**, deenergized valve **49** and conduit **47**. Although the pressure regulator **58** in conduit **57** is set for a pressure lower than that established in conduit **52** by regulator **53**, the force resulting from the relatively low pressure acting to the left of the piston in each cylinder **46** and the weight of the components of accelerating device **32** pivotally suspended about shaft **35** more than overcome the counter-force resulting from the relatively high pressure acting to the right of the piston in each cylinder **46**, and accordingly arms **36** are moved downwardly from their raised position. Flow control valve **51** in conduit **48** is adjusted to ensure that such downward movement of arms **36** occurs at a predetermined slow rate to provide a similarly slow progressive increase in the length of belt **33** in contact with the new web roll at splicing position S, thereby determining the rate at which the new web roll is accelerated up to the speed of web W being unwound from the expiring web roll.

When solenoid valve **49** is energized and solenoid valve **56** is deenergized, for example, after the new web roll *Ib* has been accelerated up to the speed of the web being unwound from the expiring roll *Ia* and the leading edge of the new web roll is to be spliced to the expiring web, as hereinafter described, the left-hand end of each cylinder **46** receives fluid under high pressure through conduit **47** from conduit **52**, and the right-hand end of each cylinder **46** is vented to atmosphere through conduits **48** and **55** and the port **60** of valve **56**. The effect of the foregoing is to very substantially increase the contact pressure of belt **33** against the surface of web roll *Ib* at the moment when the new web is spliced to the expiring web, thereby to ensure the continued non-slip engagement of belt **33** with roll *Ib* for accurately controlling the rotational speed of the latter.

The rollstand **10** is further shown to include a splicing assembly **61** movable toward and away from the illustrated operative position at which assembly **61** can act on web W extending from expiring roll *Ia* from the side thereof facing away from new web roll *Ib* at splicing position S. When the new web roll at splicing position S has been accelerated by device **32** so as to have its peripheral speed substantially match the speed of movement of web W being unwound from the expiring web roll and the new web roll is in a predetermined angular or rotational position about its axis, splicing assembly **61** is actuated, as hereinafter described, to press the expiring web run against adhesive on the periphery of the new web roll and thereby join or splice the web of the new roll to the web from the expiring roll. Immediately after such splicing of the new roll to the expiring web run, splicing assembly **61** is further actuated to sever the expiring web run in back of the splice, that is, at a location between the splice and the expiring roll *Ia*.

The splicing assembly **61** for performing the foregoing operations may include a pair of support arms **62** depending from a shaft **63** which is journaled in side frame members A and B. As shown on FIG. 2, arms **62** are laterally located at opposite sides of main drive belt **24** so that the lower end portions of the arms can swing toward and away from the expiring web run in response to turning of shaft **63**. The lower end portion of each arm **62** carries a lateral shaft **64** having a bell crank **65** pivoted on its middle portion. A shaft **66** is journaled in the bell cranks **65** of both arms **62** and carries pressure

or pasting rollers **67**. Both bell cranks **65** may be urged, as by springs (not shown), to rock in the direction moving rollers **67** against the expiring web run for pressing the latter against the periphery of the new web roll. Bell cranks **65** are held against such rocking movement by latches (not shown) adapted to be released in response to the upward movement of cables **68** depending from arms **69** secured on a shaft **70** which is journaled in the upper portions of arms **62**. Turning of shaft **70** for effecting the latch releasing movement of cables **68** may be effected by a fluid pressure operated cylinder **71** carried by one of the arms **62** and having its piston rod connected pivotally to an arm **72** extending from shaft **70**. Fluid under pressure may be supplied to cylinder **71** by way of a conduit **73** extending from fluid pressure supply line P and having a solenoid valve **74** interposed therein. Thus, after splicing assembly **61** has been moved to its illustrated operative position, solenoid valve **74** is energized, as hereinafter described, to permit fluid pressure to act in cylinder **71** and thereby release the latches associated with bell cranks **65**, whereupon rollers **67** act against the expiring web run to press the latter against adhesive previously applied to the periphery of the new web roll.

The illustrated splicing assembly **61** further includes a knife or blade **75** carried by a bracket **76** which pivotally depends from the ends of shaft **64** of each support arm **62** (FIG. 2). Each bracket **76** may be urged, as by a spring (not shown), to rock in the direction for moving its knife **75** against the expiring web run when the splicing assembly is in its operative position, and each knife is held against such movement by an associated latch (not shown) which is released in response to upward movement of a cable **77**. Each cable **77** is connected, at its upper end, to an arm **78** extending from a shaft **79** which is journaled in the upper portions of arms **62**. Turning of shaft **79** for effecting the latch releasing movements of cables **77** is effected by a fluid pressure operated cylinder **80** mounted on one of support arms **62** and having its piston rod pivotally connected to an actuating arm **81** extending from shaft **79**. Fluid under pressure may be supplied to cylinder **80** for releasing the latches associated with knives **75**, and thereby permitting actuation of the latter, upon energization of a solenoid valve **82** which is interposed in a conduit **83** extending from fluid pressure supply line P to cylinder **80**. Thus, when solenoid **82** is energized after energization of solenoid **74**, as hereinafter described, knives **75** are actuated to sever the expiring web at a location along the latter between the splice of the new web roll to the expiring web and the expiring web roll.

Rollers **67** and knives **75** may be suitably returned to their latched positions, for example, by cams (not shown) acting on their respective bell cranks **65** and brackets **76**, during movement of splicing assembly **61** away from its illustrated operative position.

Movements of splicing assembly **61** toward and away from its operative position, may be effected by an actuating arm **84** depending from shaft **63** adjacent side frame member A and being pivotally connected, near its lower end, to a piston rod **85** extending from a double-acting, fluid-pressure operated cylinder **86** which is pivotally supported by frame member A, as at **87** (FIG. 1). Flexible conduits or hoses **88** and **89** extend to the opposite ends of cylinder **86** from a solenoid controlled valve **90** which is, in turn, connected through a conduit **91** with fluid pressure supply line P. Valve **90** has a vent or exhaust port **92** and, when deenergized, connects such port with conduit **89** while conduit **88** is connected with conduit **91** so as to supply fluid under pressure to the right-hand end of cylinder **86**, as viewed on FIG. 1, thereby to retract piston rod **85** for swinging splicing assembly **61** away from its operative position. On the other hand, when solenoid control valve **90** is energized, as hereinafter described, conduit **88** is communicated with dis-

charge port **92** and conduit **89** is communicated with conduit **91** to supply fluid under pressure to the left-hand end of cylinder **86** and thereby extend piston rod **85** for swinging splicing assembly **61** to its operative position at which rollers **67** and knives **75** are operable on the adjacent expiring web run.

The rotation of the expiring web roll I*a* is preferably braked simultaneously with the actuation or tripping of knives **75** of splicing assembly **61** so as to avoid unwinding of the web material from roll I*a* after the expiring web run has been severed. In order to effect such braking of the expired web roll, apparatus **10** is shown to have a brake assembly provided at each end of spider or reel arm **13***a*. Each brake assembly includes a drum **93** for rotation with the web roll supported by the related end of arm **13***a* and an adjacent brake shoe **94** pivotally supported on the reel arm for movement toward and away from the surface of brake drum **93**. When an end of reel arm **13***a* is disposed to position the expiring web roll I*a* supported thereby at expiring position E, a roller **95** which is connected with the related shoe **94** by an arm **96** rides onto an actuating lever **97** which is pivotally mounted on the adjacent side frame member A. The actuating lever **97** is pivotally connected to the piston rod of a fluid-pressure operated cylinder **98** having conduits **99** and **100** extending from its opposite ends to a solenoid controlled valve **101** having an exhaust port or vent **102** and a connection to fluid-pressure supply line P by way of a conduit **103**. When solenoid control valve **101** is deenergized, fluid under pressure is supplied to the upper end of cylinder **98** by way of conduit **100** so as to lower lever **97** and thereby permit release brake shoe **94** from brake drum **93**, for example, by a spring (not shown) acting on the brake shoe. When valve **101** is energized, as hereinafter described, fluid under pressure is supplied to the lower end of cylinder **98** through conduit **99**, thereby to raise actuating lever **97**, which acts on roller **95** of the brake assembly carried by the end of reel arm **13***a* then at the expiring position E, so as to engage such brake assembly for halting rotation of the expiring web roll I*a* upon severing of the web extending therefrom.

The rollstand **10**, as described above, merely represents a typical splicing rollstand that may have its operations controlled in accordance with this invention, and it will be understood that its various components, which are not parts of the invention as such, and which may be replaced by other similarly operating components, have been only briefly described and schematically illustrated to provide the necessary basis for the following description of the control system embodying the invention.

Referring now to FIGS. 3A and 3B, it will be seen that a control system in accordance with this invention, as there illustrated, automatically initiates displacement of reel arms **13***a* and **13***b* for moving a new web roll to splicing position by energizing of motor **16** when the web roll I*a*, at normal running position R, has been reduced to a predetermined diameter by the unwinding of the web therefrom. A suitable arrangement for initiating the operation of motor **16** in the manner indicated above may include a photoelectric sensing device **104** which is fixedly mounted, as shown schematically on FIG. 1, to direct a light beam **105** downwardly toward a fixed reflector **106**. The light beam **105** is initially intercepted by the web roll I*a* at normal running position R. However, when the web roll I*a* at running position R has been reduced to the predetermined diameter, as indicated on FIGS. 1 and 3A, light beam **105** passes the periphery of roll I*a* and is reflected from reflector **106** so as to impinge on a photocell in sensing device **104**.

As shown diagrammatically on FIG. 3A, the photoelectric sensing device **104** is connected to a control panel **107** by way of leads **108**, and control panel **107** is operative to close or permit current flow through a circuit therein between leads **109** and **110** when the photocell of sensing device **104** receives light reflected from reflector **106**. Lead **109** is connected to a current supply line L_1, and lead **110** is connected through a normally closed contact **111***a* of a time delay relay **111** and a lead **112** to one side of a normally open hold contact **113***b* of a relay **113**. The other side of hold contact **113***b* is connected by a lead **114** to the coil of relay **113** which is, in turn, connected to the other current supply line L_2 by way of a lead **115**. A lead **116** extending from lead **110** is connected to a normally open, cam-actuated switch **117**, and a lead **118** extends from switch **117** to a junction with lead **114** at **119**. Switch **117** is actuated to closed position by one or the other of two diametrically opposed cams **120** (FIGS. 2 and 3A) which may be mounted on the hub of gear **14** for turning with reel arms **13***a* and **13***b*. The cams **120** are disposed relative to the reel arms so as to cause closing of switch **117** only when a web roll is disposed at normal running position R. Thus, when control panel **107** closes the circuit betwen leads **109** and **110** with a web roll at running position R, or when a normally open switch **321** interposed in a line **322** by-passing control panel **107** is manually actuated, relay **113** is initially energized through line **116**, closed switch **117**, and lines **118**, **114** and **115**. Energizing of relay **113** closes its hold contact **113***b* so that, when arms **13***a* and **13***b* are turned to release switch **117**, relay **113** remains energized through normally closed contact **111***a* of relay **111**, lead **112**, contact **113***b* and leads **114** and **115**.

Energizing of relay **113** further closes a normally open contact **113***a* thereof which is interposed between a lead **121** extending from line L_1 and a lead **122** which extends to one side of a normally closed contact **111***c* of relay **111**. The other side of contact **111***c* is connected by a lead **123** to a motor starter **124** which is connected to motor **16** by conductors **125**, and the energizing circuit for motor starter **124** is completed by a lead **126** extending therefrom to supply line L_2. Accordingly, energizing of relay **113** closes the circuit for energizing motor **16** through contact **113***a* of relay **113** and contact **111***c* of relay **111**, and motor **16** is thereby operated to cause displacement of arms **13***a* and **13***b* for moving a new web roll toward splicing position.

The control system for rollstand **10** further includes a sensing device **127** for detecting the approach of the periphery of the new web and roll I*b* to splicing position. The sensing device **127** is also of the photoelectric type and is mounted, for example, on a suitably supported bracket **128** (FIG. 2) at one side of the path traveled by each new web roll upon displacement of arms **13***a* and **13***b* for moving the new web roll to splicing position. As shown schematically on FIG. 3A, sensing device **127** is connected by leads **129** with a control panel **130** from which a lead **131** extends to a junction with lead **122**. Another lead **132** extends from control panel **130** to one side of a normally closed contact **111***b* of relay **111**, and the other side of contact **111***b* is connected through a lead **133**, the coil of a relay **134** and a lead **135** to supply line L_2. Relay **134** has a normally open contact **134***a* interposed between a lead **136** extending from supply line L_1 and a lead **137** which is connected through time delay relay **111** and a lead **138** with supply line L_2.

The sensing device **127** includes a light source directing a light beam **139** (FIG. 2) laterally therefrom toward a reflector **140** positioned at the opposite side of the path traveled by a new web roll in moving toward splicing position, and a photocell for receiving light reflected from reflector **140**. So long as light beam **139** is not intercepted by a new web roll moving toward splicing position, control panel **130** responds to the reception of light by the photocell of sensing device **127** to open or block an internal circuit between leads **131** and **132**. However, when light beam **139** is intercepted by the periphery of a new web roll approaching splicing position, the internal circuit of panel **130** is closed between leads **131** and **132**, thereby to complete the circuit for energizing relay **134** through lead **121**, closed contact **113***a* of energized relay

113, leads 122 and 131, panel 130, lead 132, closed contact 111*b* of relay 111 and lead 133 to relay 134, and through lead 135 extending from relay 134. Energizing of relay 134 closes its contact 134*a* to energize time delay relay 111 by way of lead 136, closed contact 134*a*, lead 137 and lead 138. After expiration of a predetermined time delay, which may be adjusted, energized relay 111 is actuated or tripped to open its normally closed contacts 111*a*, 111*b* and 111*c* with the following results:

The opening of contact 111*a* interrupts the hold circuit for energizing relay 113 so that its contact 113*a* is opened and interrupts the energization of control panel 130 for rendering sensing device 127 inoperative. Deenergizing of relay 113 also opens its contact 113*b*, so that the continuing signalling by sensing device 104 of the absence of a web roll at the running position R cannot effect reenergization of relay 113. In fact, sensing device 104 becomes operative to again effect energizing of relay 113 only when arms 13*a* and 13*b* are subsequently turned again, as hereinafter described, to move the new web roll from splicing position S to running position R, at which time switch 117 is again closed by one of cams 120.

The opening of contact 111*b* causes deenergization of relay 134 to open its contact 134*a* and thereby interrupt the circuit for energization of relay 111.

The opening of contact 111*c* interrupts the circuit to motor starter 124 so that motor 16 is thereby deenergized to halt spider or reel arms 13*a* and 13*b* with the new web roll at splicing position at the moment when relay 111 is tripped or actuated.

Branching from lead 110 is a lead 141 extending to one side of a normally closed contact 142*b* of a relay 142 (FIG. 3B), and the other side of contact 142*b* is connected by a lead 143 to a relay 144, which is, in turn, connected by a lead 145 to supply line L_2 (FIG. 3A). A lead 146 branches from lead 143 and connects to a relay 147 which is, in turn, connected by a lead 148 to supply line L_2. Thus, when sensing device 104 detects that the expiring web roll I*a* at normal running position R has been reduced to a predetermined diameter and causes control panel 107 to complete the internal circuit between leads 109 and 110 which initiates operation of motor 16 for moving a new web roll to splicing position, a circuit is simultaneously completed from lead 110 through lead 141, relay contact 142*b*, lead 143 and lead 145 for energizing relay 144, and further through leads 146 and 148 for energizing relay 147.

A variable time delay or metering relay 149 having an R–C impedance network, for example, of the type available commercially from Struthers-Dunn Inc., Pitman, N.J., under the designation type 235 AAXP, is connected by a lead 150 to line L_1 and by a lead 151 to a movable contact 144*a* of relay 144. Relay 144 further has a fixed contact 144*b* that is normally engaged by contact 144*a*, and a fixed contact 144*c* that is engaged by contact 144*a* when relay 144 is energized. A lead 152 extends from contact 144*c* to line L_2 so that the energization of relay 144 in response to the reduction of the expiring roll to a predetermined diameter results in energizing of variable time delay relay 149.

A time delay relay 153, which may be of the same type as relay 149, but which has an adjustably predetermined tripping or actuating time, is energized simultaneously with relay 149 by way of leads 154 and 155 extending from relay 153 to junctions with leads 150 and 151, respectively. The function of time delay relay 153 is to establish a maximum limit for the tripping or actuating time of metering relay 149.

The tripping or actuating time of metering relay 149, that is, the length of the period of energization thereof required to trip or actuate the relay, is varied in inverse relation to variations of the speed at which the web is being unwound from expiring web roll I*a* so that, irrespective of the web speed, a predetermined length of the web, for example, 800 feet of web, is unwound from expiring roll I*a* between the initiation of energization of relay 149 and the moment when the latter is tripped or actuated to close its normally open contact 149*a*. In order to thus vary the tripping time of relay 149, the illustrated rollstand control system includes a tachometer generator 156 of a type that is commercially available, for example, from the General Electric Company, East Orange, N.J., as Item No. 5BC–46 AB 1528. The generator 156 may be mounted on side frame member B, as shown on FIG. 1, and driven from cross-shaft 21 by way of a belt and pulley transmission 157 so as to generate a control voltage which is proportional to the web speed. Generator 156 is energized by way of leads 158 and 159 extending to lines L_1 and L_2, respectively.

A circuit for impressing the control voltage generated by generator 156 on relay 149 to correspondingly vary the tripping time thereof includes a lead 160 extending from the output terminal of generator 156 to one fixed contact 153*a* of relay 153 which is normally engaged by movable contact 153*b*. A lead 161 extends from contact 153*b* to a fixed contact 147*a'* which is normally disengaged from a movable contact 147*a* of relay 147, and a lead 162 extends from contact 147*a* to relay 149. Thus, when relay 147 is energized, as described above, the variable output or control voltage from generator 156 is impressed on metering relay 149 by way of lead 160, engaged contacts 153*a* and 153*b* of relay 153, lead 161, engaged contacts 147*a* and 147*a'* of energized relay 147, and lead 162.

In the event that the web speed is below a predetermined low value, in which case a correspondingly small control voltage is generated by generator 156 to achieve a long tripping or actuating time of relay 149, the response of relay 149 to such a small control voltage tends to be inaccurate. Time delay relay 153 has a contact 153*c* engaged by contact 153*b* upon actuation of relay 153, and connected to relay 149 by a lead 163. Thus, upon the actuation of relay 153, relay 149 is tripped or actuated through the circuit including lead 162, contacts 147*a* and 147*a'*, lead 161, contacts 153*b* and 153*c*, and lead 163, so that the actuating time of relay 153 constitutes a maximum limit for the actuating time of relay 149. The actuating time of relay 153 is preferably preset to correspond to the actuating time of relay 149 resulting from the smallest control voltage of generator 156 to which relay 149 is accurately responsive.

Although the actuating time of relay 149 is varied in inverse relation to variations of web speed, which may range betwen speeds of 25 to 2000 feet per minute, relay 149 is preset so that its shortest actuating time, which results from the maximum web speed in the foregoing range, is longer than the time required for the movement of new web roll I*b* from loading position L to splicing position S. Thus, in all cases, the new web roll arrives at splicing position before actuation of relay 149, and variation of the actuating time of relay 149 causes a varying period to elapse between the arrival of the new web roll at splicing position and the actuation of relay 149.

Relay 147 further has a movable contact 147*b* which normally engages a fixed contact 147*b''* and is moved into engagement with a fixed contact 147*b'* upon energizing of relay 147. A lead 164 extends from contact 147*b'* to solenoid controlled valve 56, and a lead 165 extends from the latter to line L_2. A lead 166 extends from movable contact 147*b* of relay 147 (FIG. 3A) to a normally open contact 167*b* of a relay 167 (FIG. 3B), and a lead 168 extends from contact 167*b* to line L_1. The circuit for energizing relay 167 includes a lead 169 extending from line L_1 to the normally open contact 149*a* of metering relay 149, a lead 170 extending from contact 149*a* to a cam-actuated switch 171 (FIG. 3A) which is normally closed to connect lead 170 to a lead 172 extending to relay 167 (FIG. 3B), and a lead 173 extending from relay 167 to line L_2. Switch 171 is mounted (FIG. 2) so as to be actuated by one or the other of

cams **120**, thereby to interrupt the connection between leads **170** and **172**, only when arms **13***a* and **13***b* are disposed to position a web roll at the normal running position.

It will be apparent that relay **167** is energized to close its contact **167***b* and thereby complete the energizing circuit for solenoid controlled valve **56** only when metering relay **149** is actuated to close its contact **149***a*. Thus, movement of accelerating device **32** to its operative position is initiated after new web roll I*b* has arrived at splicing position S, and a predetermined length of web material, for example, 800 feet, is unwound from expiring roll I*a* between the initiation of movement of the new web roll to splicing position and the initiation of movement of accelerating device **32** to its operating position for effecting rotation of the new web roll about its axis. As previously described, the energization of solenoid controlled valve **56** causes device **32** to be urged against the new web roll with a moderate force which is adequate to ensure non-slip contact of belt **33** with the periphery of the new roll.

Relay **167** further has a normally open contact **167***a* interposed between a lead **174** connected to line L_1 by way of lead **168**, and a lead **175** which is connected through a normally closed contact **176***a* of a time delay relay **176** to a lead **177**. Lead **177** extends to a relay **178** which is, in turn, connected to line L_2 by a lead **179** so that energizing of relay **167** causes energizing of relay **178** for closing the normally open contact **178***a* of the latter. Contact **178***a* is interposed between a lead **180** extending from line L_1 and a lead **181** extending to solenoid controlled valve **90** which is connected to line L_2 by a lead **182** (FIG. 3B).

Thus, the actuation or tripping of relay **149** also results in energization of valve **90** for moving splicing assembly **61** to its operative position adjacent the expiring web run, as described above.

A relay **183** (FIG. 3B) is energized simultaneously with relay **178** by way of a lead **284** having a junction with lead **177** and a lead **285** extending to line L_2. Relay **183** has a movable contact **183***a* normally engaging a fixed contact **183***a'* and being moved into engagement with a fixed contact **183***a''* upon energization of relay **183**.

A metering or variable time delay relay **184** and a time delay relay **187** (FIG. 3A), which are respectively similar to time delay relays **149** and **154**, are connected to line L_1 by leads **186** and **185**. A lead **188** extending from relay **184** has a junction with a lead **189** extending from relay **187** and is connected to a movable contact **183***c* of relay **183** (FIG. 3B). Contact **183***c* normally engages a fixed contact **183***c'* and is moved to engage a fixed contact **183***c''* upon energization of relay **183**. A lead **190** extends from contact **183***c''* to line L_2 so that relays **184** and **187** are energized in response to actuation of metering relay **149**.

Metering relay **184** also has a varitable actuating or tripping time which is varied in inverse relation to variations of the web speed so that, during such actuating time, a predetermined further length of the web, for example, 800 feet, is unwound from expiring web roll I*a* irrespective of the web speed. Such variation of the actuating time of metering relay **184** is also achieved by impressing the output voltage of tachometer generator **156** on its R-C impedance network by way of a circuit that includes a lead **191** extending from a junction with lead **160** to a fixed contact **187***a'* of time delay relay **187** that is normally engaged by the movable contact **187***a* thereof, a lead **192** extending from movable contact **187***a* (FIG. 3A) to contact **183***a''* of relay **183** (FIG. 3A), and a lead **193** extending from contact **183***a*, which engages contact **183***a''* when relay **183** is energized, to relay **184**.

Time delay relay **187** acts to limit the maximum actuating time of relay **184** and has a preset time delay or actuating time equal to the actuating time of relay **184** corresponding to the minimum web speed, and hence minimum control voltage from generator **156**, to which relay **184** can accurately respond. In order to limit the maximum actuating time of relay **184**, relay **187** has a contact **187***a''* engaged by contact **187***a* upon actuation of relay **187** and connected by a lead **194** to relay **184**. Thus, upon actuation of relay **187**, relay **184** is immediately actuated through the circuit made up of lead **194**, contacts **187***a* and **187***a''*, lead **192**, contacts **183***a* and **183***a''* and lead **193**.

In all cases, that is, even when the actuating time of relay **184** is a minimum in response to a high web speed, such actuating time is of sufficient duration to permit accelerating device **32** to bring new web roll I*b* at splicing position S to a peripheral speed equal to the speed of movement of the adjacent expiring web run.

When relay **184** is actuated to close its normally open contact **184***a* (FIG. 3A), a circuit is closed for energizing a relay **195** (FIG. 3B). The circuit for energizing relay **195** includes a lead **196** extending from line L_1, contact **184***a*, a lead **197** extending to a normally open contact **183***b* of relay **183** which is closed by energizing of the latter, a lead **198** extending from contact **183***b* to relay **195**, and a lead **199** extending to line L_2. Relay **195** has a normally open hold contact **195***a* which is closed upon energization of relay **195**, as described above, and which is interposed between a lead **200** extending from line L_1 and a lead **201** extending to a junction with lead **197** so as to maintain energization of relay **195** so long as relay **183** remains energized to close its contact **183***b*.

Relay **195** has a normally open contact **195***c* interposed between a lead **202** extending from line L_1 and a lead **203** extending to the anode circuit of control panel **130** for sensing device **127** (FIG. 3B). Although control panel **130**, sensing device **127** and the new web roll I*b* are shown separately on each of FIGS. 3A and 3B for ease and clarity of illustration, it is to be understood that only one sensing device **127** and only one control panel **130** are provided. Upon energization of relay **195** in response to actuation of metering relay **184**, the closing of contact **195***c* causes reenergization of panel **130** and of the associated sensing device **127**.

Since time delay relay **111** (FIG. 3A) is tripped or actuated to stop motor **16** at a predetermined or adjustably fixed time after sensing device **127** detects the approach of the new web roll to splicing position, it is apparent that the new web roll will move a predetermined distance beyond the position at which its periphery is detected by sensing device **111** before coming to rest at splicing position S. Thus, when the new web roll I*b* is at splicing position S and sensing device **127** is reenergized in response to energizing of relay **195**, sensing device **127** directs its light beam against an end surface of the new web roll at a location spaced radially inward from the periphery of the roll, as indicated on FIG. 3B. Each new web roll has a reflective mark M applied to the end surface thereof facing toward sensing device **127**. Mark M is spaced radially inward from the periphery of roll I*b*, as shown, so that, when the new web roll is rotated at splicing position by device **32**, the circular path traveled by mark M is at the same distance from the periphery of the roll as the light beam directed from reenergized sensing device **127**. Mark M is further applied to the new web roll at a predetermined angular position relative to the leading edge of the web of the new roll.

After actuation of metering relay **184** to cause reenergizing of sensing device **127**, the subsequent passage of the leading edge of reflective mark M through the area scanned by the photoelectric cell of device **127** causes panel **130** to close a circuit therein for energizing a slave relay **204** by way of a lead **205** extending from panel **130** to relay **204** and a lead **206** extending from relay **204** to line L_2. Relay **204** has a movable contact **204***a* normally

engaging a fixed contact 204*a'* and being moved, upon energizing of relay 204, to engage a fixed contact 204*a''*. Relay 204 further has a normally open contact 204*b* which is closed upon energizing of the relay. Contact 204*b* is interposed between a lead 207 extending from line L_1 and a lead 208 extending to one side of a normally open contact 195*b* of relay 195. Contact 195*b* is closed upon energization of relay 195 to connect lead 208 with a lead 209 extending to a relay 210 and the latter is connected to line L_2 by way of a lead 211. Thus, relay 210 is energized in response to energizing of slave relay 204.

Relay 210 has a hold contact 210*a* which is closed upon energizing of the relay to connect a lead 212 extending from line L_1 with a lead 213 extending to a junction with lead 208, whereby to maintain energization of relay 210 so long as relay 195 is energized to close its contact 195*b*. Relay 210 further has a normally open contact 210*b* which is closed upon energization of the relay. Contact 210*b* is interposed between a lead 214 extending to contact 204*a* of relay 204 and a lead 215 extending to relay 142 which is, in turn, connected to line L_2 by a lead 216. Contact 204*a'*, which is engaged by contact 204*a* when relay 204 is deenergized, is connected to line L_1 by a lead 217.

Approximately 40 to 60 milliseconds after reflective mark M has passed the area scanned by the photocell of sensing device 127 during the first revolution of the new web roll following reenergization of panel 130 and device 127, control panel 130 interrupts the circuit for energizing relay 204 so that contact 204*a* engages contact 204*a'* and thereby closes the described circuit for energizing relay 142. Relay 142 has a normally open contact 142*a* interposed between a lead 218 extending from line L_1 and a lead 219 extending to solenoid controlled valve 74 which is connected to line L_2 by a lead 220. Thus, energizing of relay 142 following the detection of mark M by sensing device 127 during the first revolution of the new web roll after reenergizing of device 127, closes contact 142*a* and thereby causes energizing of solenoid control valve 74 for tripping or actuating the splicing rollers 67 so that the latter then act to press the expiring web run against adhesive on the periphery of the new web roll, as described above.

Energizing of relay 142 also opens its normally closed contact 142*b*, and thereby interrupts the connection between leads 141 and 143 for deenergizing relays 144 and 147 (FIG. 3A). Deenergizing of relay 144 moves its contact 144*a* away from contact 144*c*, thereby to deenergize metering relay 149 and time delay relay 153, and into engagement with contact 144*b* which is connected by a lead 221 to relay 153 for discharging the R–C network of that relay. Similarly, deenergizing of relay 147 moves its contact 147*a* away from contact 147*a'*, thereby to disconnect relay 149 from the output of tachometer generator 156, and into engagement with contact 147*a''* which is connected by a lead 222 to a junction with lead 151 for discharging the R–C network of metering relay 149.

Deenergizing of relay 147 further moves its contact 147*b* away from contact 147*b'*, thereby to deenergize solenoid controlled valve 56, and into engagement with contact 147*b''* which is connected by a lead 223 with solenoid controlled valve 49 having a lead 224 extending therefrom to line L_2, thereby to energize valve 49. As previously described, the energizing of solenoid controlled valve 49 and the deenergizing of valve 56 causes belt 33 of accelerating device 32 to be pressed into contact with the periphery of new web roll I*b* by an increased force so as to ensure non-slip engagement of belt 33 with the periphery of the new web roll during subsequent operations. As shown particularly on FIG. 3B, relay 167 has a hold contact 167*c* interposed between a lead 225 extending from lead 168 and a lead 226 extending to a junction with lead 170 (FIG. 3A) at a location between cam-actuated switch 171 and contact 149*a* of metering relay 149. Thus, after metering relay 149 is deenergized to open its contact 149*a*, as described above, hold contact 167*c* maintains energization of relay 167 to prevent opening of its contact 167*b* included in the energizing circuit for solenoid controlled valve 49 until reel arms 13*a* and 13*b* are again turned, as hereinafter described, to move the new web roll to running position R and to open switch 171 by the action of one of the cams 120 thereon.

A relay 227 (FIG. 3B) is energized simultaneously with relay 142 by way of a lead 228 having a junction with lead 215 and a lead 229 extending to line L_2. It will be seen that relay 142 has a normally open hold contact 142*c* interposed between a lead 230 extending from line L_1 and a lead 231 extending to a junction with lead 214. Thus, after relays 142 and 227 are energized in response to deenergizing of relay 204 following its first energization, relays 142 and 227 are respectively held in energized condition by way of lead 230, closed contact 142*c*, leads 231 and 214, closed contact 210*b*, and leads 215 and 216, and by way of leads 228 and 229, so long as relay 210 remains energized.

During the second revolution of the new web roll at splicing position after actuation of metering relay 184, the passage of reflective mark M through the area scanned by the photoelectric cell of sensing device 127 again causes energizing of slave relay 204 to engage its contact 204*a* with contact 204*a''*. Since relay 142 is now energized to close its contact 142*c*, the engagement of contacts 204*a* and 204*a''* completes a circuit for energizing a relay 232. Such circuit for energizing relay 232 includes lead 230, contact 142*c*, leads 231 and 214, contacts 204*a* and 204*a''*, a lead 233 extending from contact 204*a''* to relay 232 and a lead 234 extending from relay 232 to line L_2. Relay 232 has a hold contact 232*a* which is closed upon energization of the relay and which is interposed between a lead 235 extending from a junction with lead 214 and a lead 236 extending to a junction with lead 233. Thus, after relay 232 is energized in response to the second energization of relay 204, relay 232 remains energized through its hold contact 232*a*.

Relay 232 further has a normally open contact 232*b* interposed between a lead 237 extending from line L_1 and a lead 238 extending to one side of a normally open contact 227*b* of relay 227. The other side of contact 227*b* is connected by a lead 239 with solenoid controlled valve 82 which is connected by a lead 240 to line L_2. Thus, when relay 232 is energized, solenoid controlled valve 82 is energized by way of closed contacts 232*b* and 227*b* to trip or actuate knives 75, as described above, and thereby sever the expiring web between the splice thereof to the new web roll and the expiring web roll.

Extending from a junction with lead 233 is a lead 241 connected to one side of a normally open contact 227*a* of relay 227. A lead 242 extends from the other side of contact 227*a* through a normally closed contact of cam-actuated switch 171 to a lead 243 (FIG. 3A) which is connected to a relay 244 (FIG. 3B). Relay 244 is further connected to line L_2 by a lead 245. Relay 244, which is energized simultaneously with relay 232 through the above circuit, has a normally open contact 244*d* interposed between a lead 246 extending from line L_1 and a lead 247 extending to solenoid controlled valve 101 which is connected, in turn, to line L_2 by a lead 248. Thus, at the same time that valve 82 is energized to actuate the knives 75 for severing the expiring web run, valve 101 is energized to cause brake shoe 94 to engage the drum 93 associated with the expired roll I*a* and thereby apply a heavy braking force for stopping rotation of the expired roll, as described above.

Because of the described holding circuits for relays 142, 227, and 232, solenoid controlled valve 82 remains energized to maintain knives 75 in their web-severing positions for deflecting the free end of the expired web away from the periphery of the new web roll from which the web is then being unwound.

The energization of relay 244 further closes a normally open contact 244*b* thereof which is interposed between a

lead 249 extending to a junction with lead 245 and a lead 250 extending to time delay relay 176 which is connected to line L_1 by way of a lead 251. Thus, relay 176 is energized and, after an adjustably predetermined actuating time, relay 176 times out or is actuated to open its normally closed contact 176*a*. The time delay provided by relay 176 is sufficient to assure successful completion of the splice and deflection of the severed web away from the new roll. When contact 176*a* of relay 176 is opened, relays 178 and 183 are deenergized.

Deenergizing of relay 178 opens its contact 178*a* to deenergize solenoid controlled valve 90 so that the splicing assembly 61 is moved by cylinder 86 in the direction away from roll I*b* to its inoperative position. Deenergizing of relay 183 opens its contact 183*b* and thereby deenergizes relay 195 to open contact 195*b* of the latter. Opening of contact 195*b* breaks the hold circuit for relay 210 so that the latter is deenergized to open its contact 210*b*. Opening of contact 210*b* deenergizes relays 142 and 227, and the opening of contact 142*c* of relay 142 breaks the hold circuit for relay 232 to deenergize the latter.

Opening of contact 142*a* deenergizes solenoid controlled valve 74 and opening of contact 227*b* deenergizes solenoid controlled valve 82 so that, during movement of splicing assembly 61 to its inoperative position the latches associated with rollers 67 and knives 75 can again be engaged to hold the rollers and knives in the latched positions to which they are displaced during movement of assembly 61 to its inoperative position, as described above.

Deenergizing of relay 183 moves its contact 183*c* away from contact 183*c*″ into engagement with contact 183*c*′ from which a lead 252 extends to time delay relay 187. The disengagement of contact 183*c* from contact 183*c*″ breaks the circuit for energizing metering relay 184 and time delay relay 187, and the engagement of contact 183*c* with contact 183*c*′ connects leads 188 and 252 to discharge the R-C network of relay 187. Deenergizing of relay 183 also moves its contact 183*a* away from contact 183*a*″ and into engagement with contact 183*a*′ which is connected to lead 188 by way of a lead 253. Thus, lead 193 is connected to lead 188 to discharge the R-C network of metering relay 184.

Time delay relay 176 further has a normally open contact 176*b* interposed between a lead 254 extending from line L_2 and a lead 255 extending to a time delay relay 256 (FIG. 3B) which is connected to line L_1 by a lead 257. Thus, relay 256 is energized in response to actuation of time delay relay 176, and relay 256 is preset to provide a sufficient time delay between its energization and actuation to permit the splice to pass through the rollstand and associated printing press or other web processing machine and to ensure that any abnormal web tension variations resulting from the splicing operations are fully compensated for before initiating the rotation of reel arms 13*a* and 13*b* for moving the new web roll to running position R.

Time delay relay 256 has a normally open contact 256*a* which is closed upon actuation of the relay and which is interposed between a lead 258 extending from line L_1 and a lead 259 extending to a junction with lead 123 (FIG. 3A). Thus, upon closing of contact 256*a*, a circuit is again completed for energizing motor starter 124 and thereby operating motor 16 so as to move new web roll I*b* toward normal running position R.

It will be apparent that operation of motor 16 continues only so long as relay 244 remains energized to close its contact 244*b* through which relay 176 is energized to close contact 176*b* interposed in the energizing circuit for relay 256. A hold circuit is provided to maintain the energization of relay 244 after relay 227 is deenergized, as described above, and opens its contact 227*a*. Such hold circuit for relay 244 includes a lead 260 (FIG. 3B) extending from a junction with lead 242 to one side of a normally open contact 244*c* of relay 244, and a lead 261 extending from the other side of contact 244*c* to a junction with lead 246. When relay 244 is energized, the hold circuit thereof extends from line L_1 through leads 246 and 261, closed contact 244*c*, leads 260 and 242, normally closed contacts of switch 171 and lead 243 to relay 244, and from the latter to line L_2 by way of lead 245.

During movement of new web roll I*b* to normal running position R, the continued energization of relay 167 through its closed hold contact 167*c* maintains the circuit for energizing solenoid controlled valve 49 so that accelerating device 32 is moved to follow the movement of roll I*b* and to continue driving the latter until the unwinding of roll I*b* is taken over by the main drive belt 24.

When the new web roll arrives at normal running position R, one of cams 120 actuates switch 171 so as to open the normally closed contacts thereof between leads 170 and 172 and between leads 242 and 243. Opening of the contacts of switch 171 between leads 170 and 172 interrupts the holding circuit for relay 167 so that relay 167 is deenergized, and opening of the contacts of switch 171 between leads 242 and 243 interrupts the holding circuit for relay 244 which is also thereby deenergized. Deenergizing of relay 244 opens its contact 244*b* to deenergize relay 176 and thereby open contact 176*b*. Opening of contact 176*b* deenergizes relay 256 to open its contact 256*a* and thereby interrupt the circuit for operating motor 16. Thus, movement of reel arms 13*a* and 13*b* is halted with the new web roll at normal running position R. Deenergizing of relay 244 closes contact 244*a* of the latter which is interposed between a lead 262 connected to relay 176 and a lead 263 extending to a junction with lead 250 so as to discharge the R-C network of time delay relay 176. Deenergizing of relay 244 further opens its contact 244*d* to deenergize solenoid controlled valve 101 and thereby return the brake engaging lever 97 to its released position.

Deenergizing of relay 167 opens its contact 167*b* and thereby breaks the circuit for energizing solenoid controlled valve 49 so that, with both valves 49 and 56 being deenergized, cylinders 46 operate to move accelerating device 32 to its inoperative or raised position, as previously described.

When the movement of reel arms 13*a* and 13*b* is halted with the new web roll I*b* at normal running position, one of cams 120 actuates switch 117 to close the contacts thereof between leads 116 and 118 (FIG. 3A), and the new web roll then interrupts the light beam 105 from sensing device 104. The expired web roll I*a*, which is disposed at loading position L, can be removed from reel arms 13*a* and 13*b* and replaced by the next new web roll to be moved to splicing position, as described above, when the roll then at running position R is reduced to the predetermined diameter at which light beam 105 is no longer intercepted. Thus, the cycle of operations of rollstand 10 is completed and the various described components of its control system are returned to their original conditions so as to be prepared for repetition of the operating cycle.

It is to be particularly noted that, in the described system embodying this invention for controlling the splicing operations of a rollstand, the cycle of such operations is initiated by sensing device 104 when the web supply roll from which the web is being unwound is reduced to a predetermined diameter, that is, has a predetermined length of web material remaining thereon. Such initiation of the cycle of operations causes energization of metering relay 149 which has its actuating time varied in inverse relation to variations of the web speed so that, irrespective of the web speed, a predetermined length of web material is unwound from the expiring web roll between the initiation of the cycle of splicing operations and the actuation of relay 149. The actuation of relay 149 causes energiza-

tion of metering relay **184** which also has its actuating time varied in inverse relation to variations of the web speed so that, irrespective of the web speed, a predetermined further length of web material is unwound from the expiring web roll between the actuation of metering relay **149** and the actuation of metering relay **184**. Thus, at the moment of actuation of relay **184**, the amount of web material remaining on the expiring roll is fixed, irrespective of the web speed, and is equal to the difference between the predetermined amount of web material on the expiring roll at the initiation of the cycle of splicing operations, and the sum of the predetermined amounts of web material unwound from the expiring roll during the successive actuating times of relays **149** and **184**. Since the actuation of relay **184** results in the successive actuation or tripping of splicing rollers **67** or the like for splicing the expiring web to the new web roll and of knives **75** for severing the expiring web between the splice and the expired web roll, it will be apparent that a uniform amount of web material remains on the core of the expired roll upon its removal from the rollstand irrespective of the speed of delivery of web material during the splicing operations. Such uniform amount of web material remaining on the core of the expired roll may be reduced to a minimum so as to avoid waste of the web material, merely by suitably adjusting metering relays **149** and **184** so that the sum of the lengths of web material unwound from the expiring roll during their respective actuating times is only a predetermined small amount less than the length of web material on the expiring roll when the cycle of splicing operations is initiated by sensing device **104**.

Although an embodiment of this invention has been described in detailed herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to that particular embodiment, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.

What is claimed is:

1. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations in the course of which means operable to splice a web run being unwound from a first web roll to the periphery of a new web roll are brought into working position relative to said run and said new roll and then, with the new roll rotating at the speed of said run, are operated to form a splice,

wherein said control means include means for initiating said sequence of operations at a moment when the unwinding first roll has substantially a predetermined length of web remaining thereon,

means actuatable after said moment to operate said splicing means, and

means operated in accordance with the speed of travel of the web unwinding from said first roll for actuating the last-recited means at an interval after said moment varying in inverse relation to said speed, whereby a desired minimal length of web will remain on said first roll when the splice is formed, irrespective of the web speed.

2. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations in the course of which means operable to splice a web run being unwound from a first web roll to the periphery of a new web roll are brought into working position relative to said run and said new roll and then, with the new roll rotating at the speed of said run, are operated to form a splice,

wherein said control means include means for initiating said sequence of operations at a moment when the unwinding first roll has substantially a predetermined length of web remaining thereon,

means actuatable after said moment to operate said splicing means,

time delay means energized upon initiation of said sequence of operations and effective to actuate the last-recited means after a variable period of energization of the time delay means, and

means operated in accordance with the speed of travel of the web unwinding from said first roll for varying said period of energization of the time delay means in inverse relation to said speed, whereby a desired minimal length of web will remain on said first roll when the splice is formed, irrespective of the web speed.

3. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations in the course of which means operable to splice a web run being unwound from a first web roll to the periphery of a new web roll are brought into working position relative to said run and said new roll and then, with the new roll rotating at the speed of said run, are operated to form a splice,

wherein said control means include means for initiating said sequence of operations at a moment when the unwinding first roll has substantially a predetermined length of web remaining thereon,

means actuatable after said moment to operate said splicing means,

time delay relay means energized upon initiation of said sequence of operations and being operable to actuate the last-recited means after a variable period of energization of the time delay relay means,

generator means driven in synchronism with the unwinding of the web from said first roll to generate a control voltage that varies with the speed of travel of said web, and

means impressing said control voltage on said time delay relay means for varying said period of energization thereof in inverse relation to said control voltage, whereby a desired minimal length of web will remain on said first roll when the splice is formed, irrespective of the web speed.

4. A web splicing rollstand according to claim **3**; wherein said control means further includes means to operate said time delay relay means irrespective of the control voltage impressed thereon after a predetermined period of energization of said time delay means which corresponds to the minimum control voltage from said generator means to which said time delay relay means is accurately responsive.

5. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations initially causing movement of a roll support for disposing a new web roll at splicing position adjacent a web run being unwound from an expiring web roll, and, in the course of which operations, means for rotationally accelerating the new roll to the speed of said run are engaged with the new roll at splicing position, and means operable to splice said web run to the periphery of the new roll being rotated at splicing position are brought into working position relative to said run and said new roll and then are operated to form a splice,

wherein said control means includes means for initiating said sequence of operations, and thereby commencing said movement of the roll support, at a moment when the expiring roll has substantially a predetermined length of web remaining thereon, actuating means operable after said movement of the roll support to engage said accelerating means with the new roll and to bring said splicing means to said working position,

second actuating means operable after operation of the first-mentioned actuating means to operate said splicing means, and

means operated in accordance with the speed of travel of the web unwinding from said expiring roll for operating said first-mentioned actuating means and said second actuating means in succession at a first interval after said moment varying in inverse relation to said speed and at a second interval after said first interval also varying in inverse relation to said speed, respectively, whereby a desired minimal length will remain on the expiring roll when the splice is formed, irrespective of the web speed.

6. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations initially causing movement of a roll support for disposing a new web roll at splicing position adjacent a web run being unwound from an expiring web roll, and, in the course of which operations, means for rotationally accelerating the new roll to the speed of said run are engaged with the new roll at splicing position, and means operable to splice said web run to the periphery of the new roll being rotated at splicing position are brought into working position relative to said run and said new roll and then are operated to form a splice,

wherein said control means includes means for initiating said sequence of operations, and thereby commencing said movement of the roll support, at a moment when the expiring roll has substantially a predetermined length of web remaining thereon,

actuating means operable after said movement of the roll support to engage said accelerating means with the new roll and to bring said splicing means to said working position,

second actuating means operable after operation of the first-mentioned actuating means to operate said splicing means,

first time delay means energized upon initiation of said sequence of operations and effective to cause operation of the first-mentioned actuating means after a variable period of energization of the first time delay means,

second time delay means energized at the conclusion of said period of energization of the first time delay means and being effective to cause operation of said second actuating means after a variable period of energization of said second time delay means, and

means operated in accordance with the speed of travel of the web unwinding from said expiring roll for varying said periods of energization of the first and second time delay means in inverse relation to said speed, whereby a desired minimal length of web will remain on said expiring roll when the splice is formed, irrespective of the web speed.

7. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations initially causing movement of a roll support for disposing a new web roll at splicing position adjacent a web run being unwound from an expiring web roll, and, in the course of which operations, means for rotationally accelerating the new roll to the speed of said run are engaged with the new roll at splicing position, and means operable to splice said web run to the periphery of the new roll being rotated at splicing position are brought into working position relative to said run and said new roll and then are operated to form a splice,

wherein said control means includes means for initiating said sequence of operations, and thereby commencing said movement of the roll support, at a moment when the expiring roll has substantially a predetermined length of web remaining thereon,

actuating means operable after said movement of the roll support to engage said accelerating means with the new roll and to bring said splicing means to said working position,

second actuating means operable after operation of the first-mentioned actuating means to operate said splicing means,

first time delay relay means energized upon initiation of said sequence of operations and being actuatable to cause operation of the first-mentioned actuating means after a variable period of energization of the first time delay relay means,

second time delay relay means energized in response to actuation of said first time delay relay means and being, in turn, actuatable to cause operation of said second actuating means after a variable period of energization of said second time delay relay means,

generator means driven in synchronism with the unwinding of the web form from said expiring roll to generate a control voltage that varies with the speed of travel of said web, and

means for impressing said control voltage on said first and second time delay relay means during energization thereof for varying said periods of energization of the time delay relay means in inverse relation to said control voltage, whereby a desired minimal length of web will remain on said expiring roll when the splice is formed, irrespective of the web speed.

8. A web splicing rollstand according to claim 7; wherein said control means further includes means to actuate each of said first and second time delay relay means irrespective of the control voltage impressed thereon after a predetermined period of energization of each time delay relay means which corresponds to the minimum control voltage from said generator means to which the time delay relay means are accurately responsive.

9. A web splicing rollstand for delivering a web continuously from one web supply roll after another, including control means for effecting a sequence of operations in the course of which roll support means are initially displaced for moving a new web roll to splicing position adjacent a web run being unwound from an expiring web roll, means for rotationally accelerating the new roll to the speed of said run are engaged with the new roll at splicing position, and means operable to splice said web run to the periphery of the new roll being rotated at splicing position are brought into working position relative to said run and said new roll and then operated to form a splice,

wherein said control means includes means initiating said sequence of operations, and thereby commencing said displacement of the roll support means, at a moment when the expiring roll has substantially a predetermined length of web remaining thereon,

sensing means energized at said moment to detect the approach of the periphery of said new roll to splicing position,

means operative a predetermined time interval after detection of the periphery of said new roll by said sensing means to halt said displacement of the roll support means with said new roll at splicing position and to deenergize said sensing means with the latter disposed for detecting a predetermined angular position of the new roll,

actuating means operable after movement of the new roll to splicing position to engage said accelerating means therewith and to bring said splicing means to said working position,

first time delay means energized upon initiation of said sequence of operations and being actuated to cause operation of said actuating means after a variable period of energization of said first time delay means,

second time delay means energized in response to actuation of said first time delay means and being actuated, in turn, after a variable period of energization of said second time delay means,

means to reenergize said sensing means in response to actuation of said second time delay means,

means for operating said splicing means in response to detection of said predetermined angular position of the new roll by said reenergized sensing means, and

means operated in accordance with the speed of travel of the web unwinding from said expiring roll for varying said periods of energization of the first and second time delay means in inverse relation to said speed, whereby a desired minimal length of web will remain on said expiring roll when the splice is formed, irrespective of the web speed.

10. A web splicing rollstand according to claim **9**; wherein said means for varying the periods of energization of the first and second time delay means includes generator means driven in synchronism with the unwinding of the web from the expiring roll to generate a control voltage that varies with the web speed, and means for impressing said control voltage on said first and second time delay means during energization thereof for varying said periods of energization in inverse relation to said control voltage.

11. A web splicing rollstand according to claim **10**; wherein said control means further includes means to actuate each of said first and second time delay means irrespective of the control voltage impressed thereon after a predetermined period of energization of the respective time delay means corresponding to the minimum control voltage to which the time delay means are accurately responsive.

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