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R. A. SHERMAN

3,233,526

WEB SPLICING APPARATUS

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4 Sheets-Sheet 1

ATTORNEY

Feb. 8, 1966

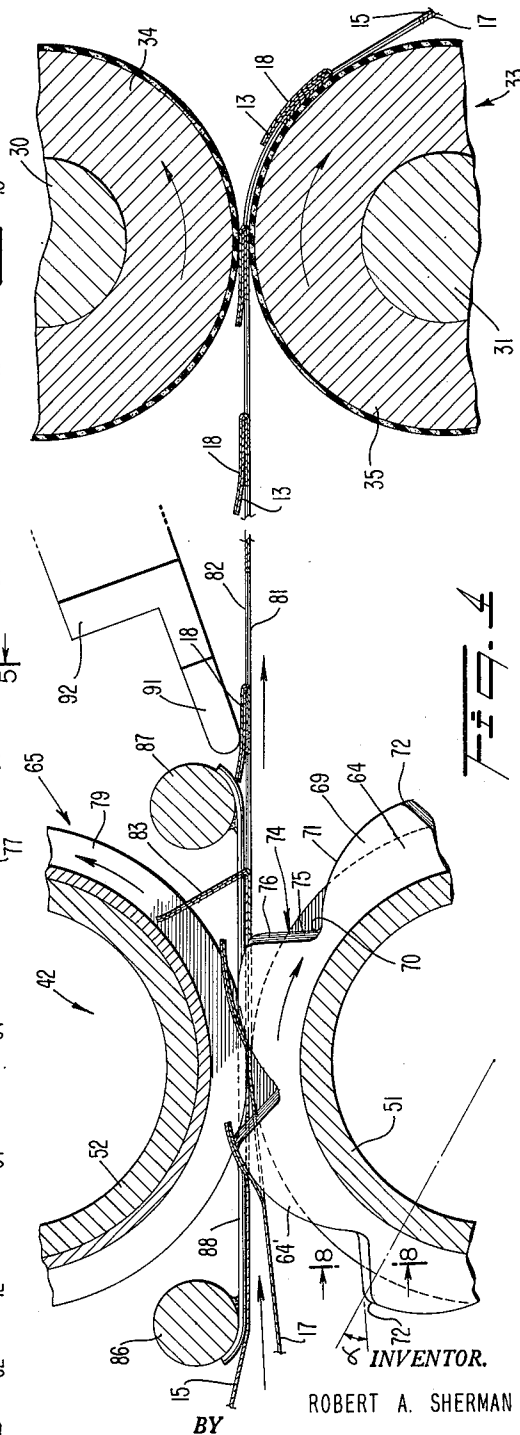
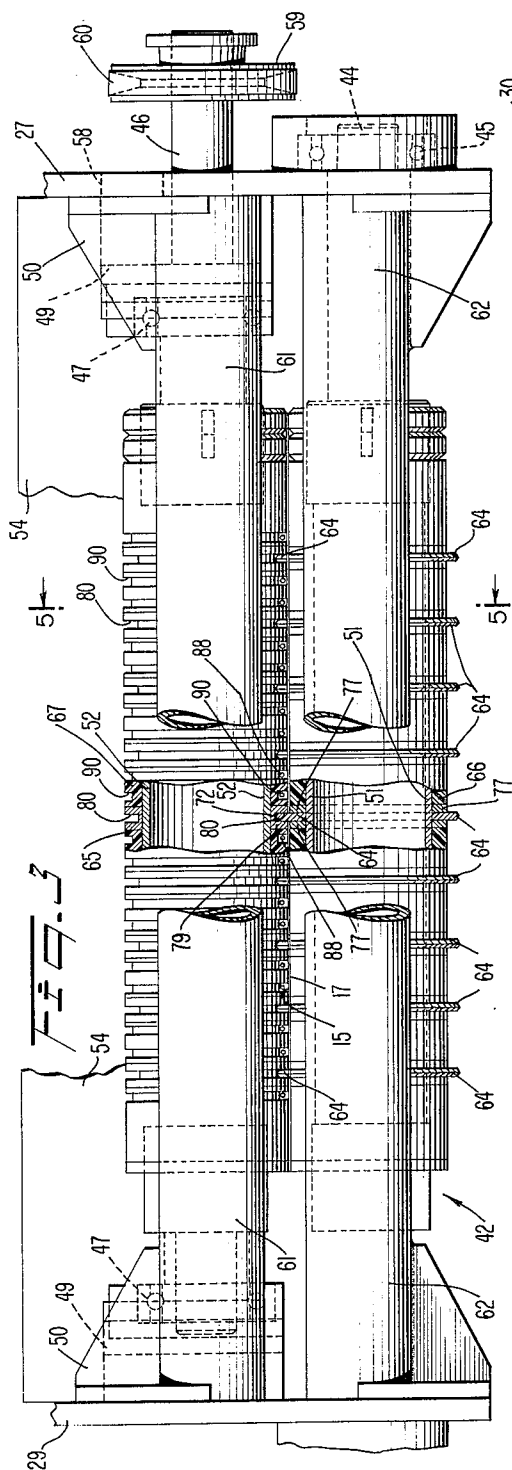
R. A. SHERMAN

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ROBERT A. SHERMAN

Alfred W. Nipper
ATTORNEY

Feb. 8, 1966

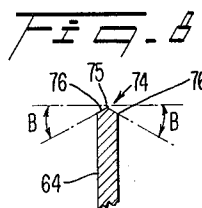
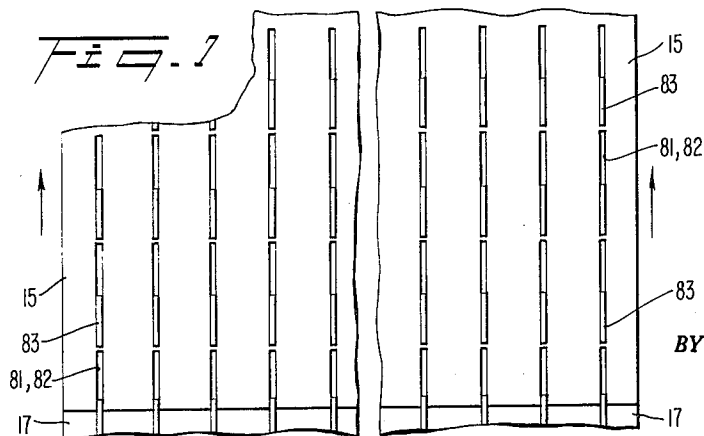
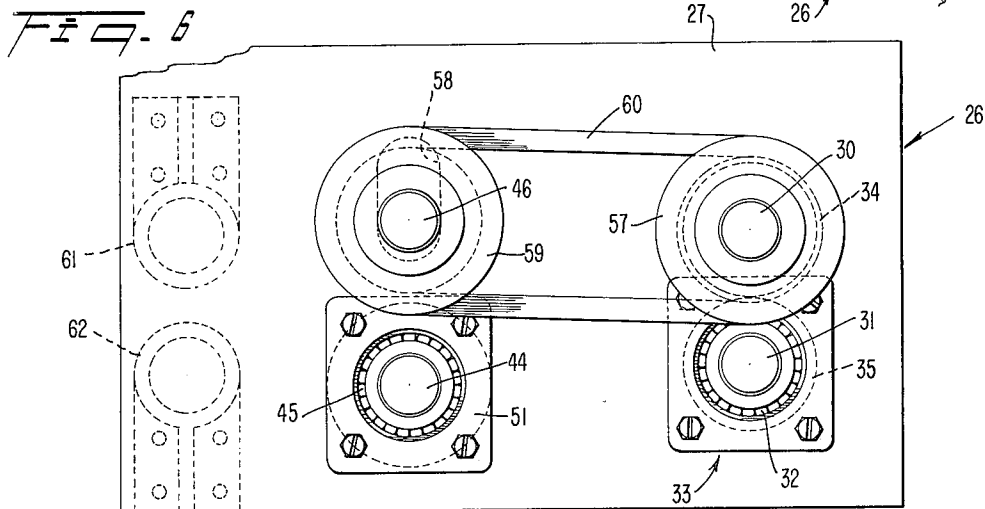
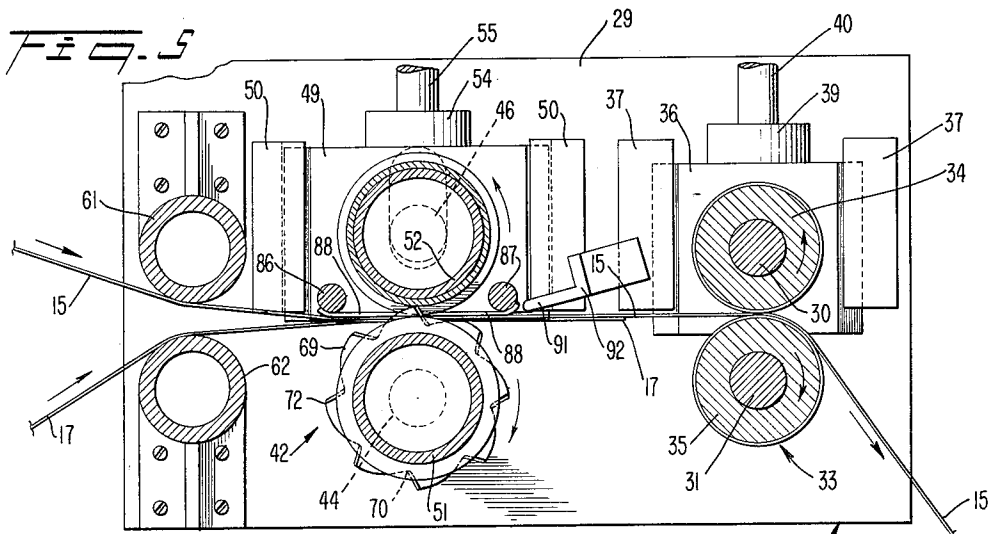
R. A. SHERMAN

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WEB SPLICING APPARATUS

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4 Sheets-Sheet 3



INVENTOR.

ROBERT A. SHERMAN

BY

Alfred W. Viller

ATTORNEY

Feb. 8, 1966

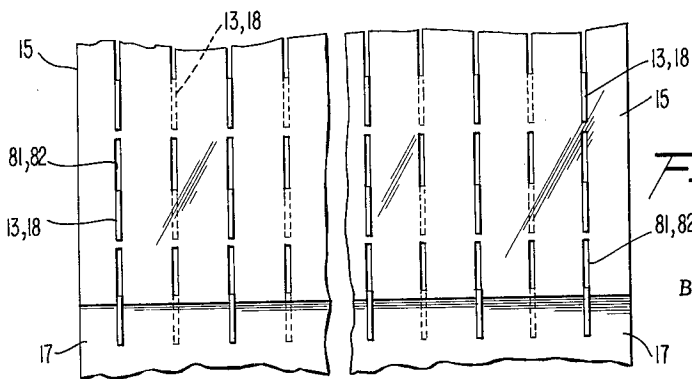
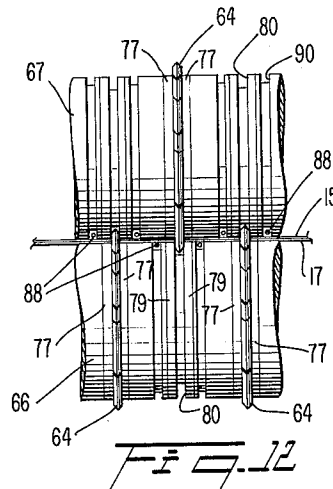
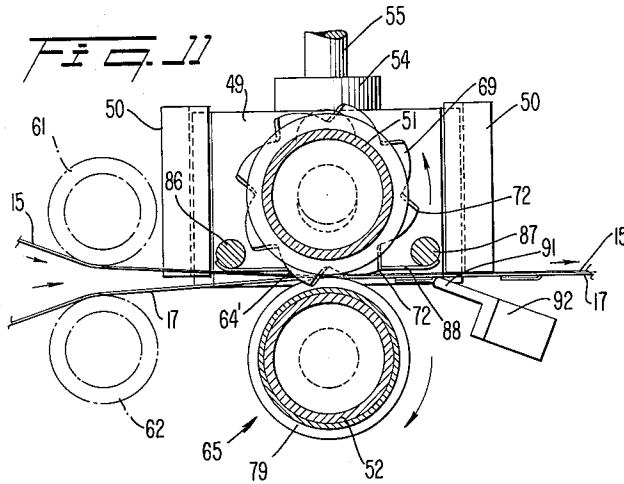
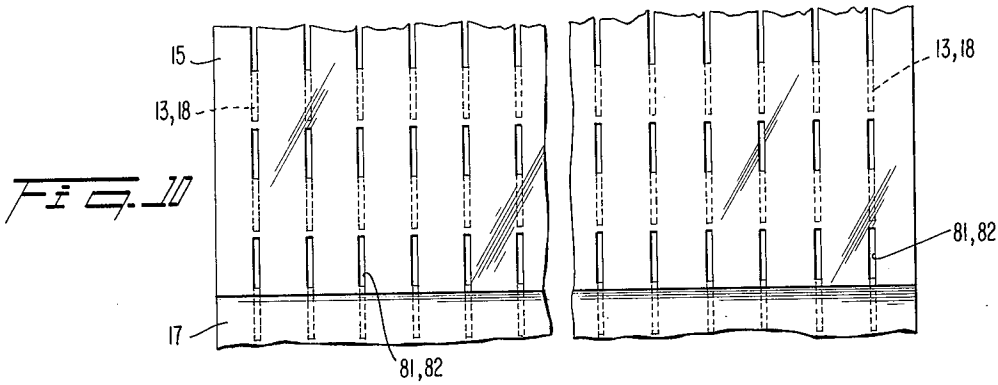
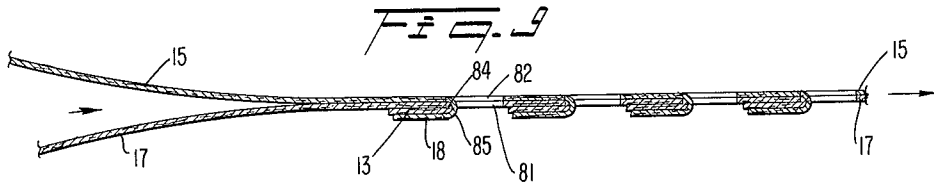
R. A. SHERMAN

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WEB SPLICING APPARATUS

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4 Sheets-Sheet 4



INVENTOR.

ROBERT A. SHERMAN

BY

Arvid W. Vetter

ATTORNEY

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WEB SPLICING APPARATUS

Robert A. Sherman, 4 N. School Road, Lancaster, Pa.
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3 Claims. (Cl. 93—1.1)

This invention relates to a method of and apparatus for splicing webs. More particularly, the invention relates to the splicing of webs of shearable, foldable material while the webs are in motion.

It is frequently necessary in the processing of web materials such as paper, paperboard, and the like to splice the leading end of a web from a new source of supply, such as a roll, to the trailing end of a web from a source of supply such as a roll which is about to become exhausted. It is obviously of advantage to splice the two webs together while they are in motion because of the saving in time thus effected. In certain operations, wherein the web material runs continuously through successive processing units, it is necessary that the material travel at substantially constant speed in order that the end product may have substantially uniform properties.

A number of methods of joining the trailing and leading edges of successive webs have been employed heretofore. In the paper-making and treating art, the ends of the webs have been pasted or adhered together while in motion. Such method is disadvantageous for a number of reasons, among them being the fact that the pasted together or adhered zone must be of quite substantial length in order for the joint between the webs to have adequate strength during the travel of the joined webs through the processing apparatus. Perhaps the most severe strain is placed upon such joint upon the start of the delivery of the new web from its source of supply; at such time the paste or adhesive in the joint will have had but little time in which to set for a cure.

In the processing of many web materials the zone of the material containing the joint between successive webs cannot be used in the final product because of the double thickness of the material. Accordingly, in the final product the joined portion of the web must be discarded. It is obviously desirable that the length of the joint between successive webs be made as small as feasible, thereby to minimize the waste attendant upon the entire process.

It is an object of the present invention to provide a novel web splicing method and apparatus which eliminates the necessity of the use of an adhesive or any added material or devices in forming the joint between the webs.

Yet another object of the invention lies in the provision of an improved web splicing method which is easily controlled, quickly performed, and which results in a strong joint in a relatively short zone of the overlapping webs.

A still further object of the invention lies in the provision of an improved web splicing method wherein the joint between webs is formed by partially punched out and interlocked portions of the two webs.

Another object of the invention lies in the provision of an improved web splicing apparatus which is economical in its space requirements and is of simple rugged construction.

A further object of the invention lies in the provision of an improved web splicing apparatus which is easily and quickly controlled so that the area of the joint between webs may be held to a minimum.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

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In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a somewhat schematic view in side elevation of the feeding or pay-off end of a web-processing apparatus, the figure showing in longitudinal vertical section a web-splicing mechanism in accordance with the present invention employed in such apparatus;

FIG. 2 is a schematic view in side elevation of two webs joined together in accordance with a first embodiment of the present invention;

FIG. 3 is a simplified fragmentary view in end elevation of a web-splicing mechanism in accordance with the invention, the view being taken generally from the line 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary view in longitudinal vertical section through a portion of the web-splicing mechanism, the view illustrating the manner in which the mechanism operates upon the webs being joined;

FIG. 5 is an enlarged view in longitudinal vertical section through the web-splicing mechanism of FIG. 1;

FIG. 6 is a view in side elevation of the web-splicing mechanism of FIGS. 1 and 5;

FIG. 7 is a view in plan of a joint between two webs made by the apparatus of FIGS. 1—6, inclusive;

FIG. 8 is a fragmentary view in section through a lower die member of the apparatus of the first embodiment, the section being taken along the line 8—8 of FIG. 4;

FIG. 9 is a somewhat schematic view in side elevation of a joint between two webs made in accordance with a second embodiment of the web-splicing apparatus of the invention;

FIG. 10 is a view in plan of the joint between webs shown in FIG. 9;

FIG. 11 is a fragmentary view in longitudinal vertical section through a second embodiment of web-splicing apparatus in accordance with the invention;

FIG. 12 is a fragmentary view in end elevation taken in the manner similar to FIG. 3 of a third embodiment of web-splicing apparatus in accordance with the invention; and

FIG. 13 is a view in plan of a joint between webs formed by the apparatus of FIG. 12.

In FIG. 1 there is shown somewhat schematically the feeding or pay-off end of a web-processing apparatus. In the embodiment shown the apparatus is for forming a corrugated web of paperboard such as that employed as the intermediate layer of a three-layer corrugated paperboard stock. Such apparatus includes a supply stand 11, a softener and conditioner 12, wherein the web is heated and humidified, and a corrugator 14 into which the conditioned web is fed upon leaving unit 12. The web splicer 10 of the present invention is interposed between the supply stand 11 and the conditioner 12. The web of paperboard being processed in the apparatus of FIG. 1 is designated 15. Web 15 is shown as being supplied from a roll 16 mounted on the stand 11.

The stand 11, which may be of conventional construction, supports a new or replacement supply roll 19 of a second web 17 in readiness to be joined to the trailing end of web 15 when the roll 16 of the latter web is exhausted. The stand 11 has two laterally spaced supports 20, each of which journals a roll-supporting structure thereon by a stub shaft 23. The roll supporting structure at each support 20 is generally in the form of a first-class lever having a first arm 21. The supply roll 16 is journaled between the outer free ends of arms 21. The other supply roll 19 is journaled between the outer free ends of the other arms 22 of the roll-carrying structure. In the embodiment shown, the floor 25 upon which the apparatus is supported is provided with a recess or well 24 below stand 11 so that the roll-supporting structure may be rotated counterclockwise with a fresh roll 19 of web mate-

rial mounted thereon. In accordance with the embodiment of method and apparatus first described herein as the supply roll 16 approaches depletion, the roll carrier of stand 11 is rotated counterclockwise to withdraw roll 16 somewhat from the web splicer 10 and to allow the leading end of the web 17 from roll 19 to be fed by the operator into the splicer along the path of the dotted line designated 17a in FIG. 1.

The web splicer 10 has a frame generally designated 26 which includes two laterally spaced side plates 27 and 29. Journalled in side plates 27 and 29 in bearings (not shown) is a lower horizontal transverse shaft 31 which carries a lower roll 35 of a first set of pinch rolls 33. An upper pinch roll 34, disposed parallel to and above roll 35 is supported on a shaft 30, the opposite ends of which are journalled in bearings which are disposed on slides 36. Slides 36 are mounted for vertical movement along the inner face of the respective one of plates 27 and 29 by vertical guideways 37 on such plates.

The slides 36 are connected by a transversely extending bridge member 39 to the center of which there is secured the lower end of a vertically disposed piston rod 40 of a double-acting fluid motor 41 secured thereabove on fixed supporting structure, not shown. The fluid motor 41, which is controlled by mechanism to be described, selectively raises slides 36 and thus roll 34 substantially away from the lower roll 35 except in those periods of operation of the apparatus in which a joint between the ends of an old and a new web is being formed.

The web splicer 10 includes a second roll set generally designated 42 which is disposed forwardly of the first roll set 33. The bottom roll of roll set 42 is mounted upon a horizontal transverse shaft 44 the ends of which are journalled in bearings on plates 27 and 29. One such bearing is shown at 45. The upper roll of roll set 42 is mounted on a horizontal transverse shaft 46, disposed vertically above shaft 44. Shaft 46 is journalled in bearings 47 which are secured to slides 49 adjacent the inner faces of plates 27 and 29. Guides 50, secured to the inner faces of the plates, confine the slides 49 to travel in a vertical direction. The lower roll of roll set 42 has a central body in the form of a tube 51 disposed coaxially of shaft 44. The upper roll of roll set 42 has a body or arbor in the form of a tube 52 which is secured to shaft 46 coaxially thereof. The slides 49 are connected by a transverse bridge member 54 centrally of which there is secured the lower end of a piston rod 55 of a second double-acting fluid motor 56. Motor 56 is controlled by mechanism to be described so that during the normal running of a web through the apparatus the slides 49 and thus the upper roll of roll set 42 is in an upper, inoperative position substantially spaced from the web. When a joint is to be formed between the trailing and leading ends of successive webs, the upper roll of roll set 42 is depressed into operative engagement with the web and, with the lower roll of such set, functions to form a plurality of tabs on the lower web and openings in the other web aligned therewith. The tabs are then folded to form a tension-sustaining connection between the webs.

In the embodiment shown, the upper roll 52 of the second roll set 42 is driven by the first roll set 33 when such latter set is in driving engagement with the web or webs passing therethrough. To provide such driving connection between the roll sets, the shaft 46 of the upper roll of the second roll set is extended at the right hand end (FIG. 3) through a vertical slot 58 in the side plate 27, as shown in FIGS. 3 and 6. A V-belt pulley 59 is fixedly secured to such extension of shaft 46. A second V-belt pulley 57 (FIG. 6) is secured to a similar extension of shaft 30 of the upper roll of the first roll set 33. A V-belt 60 is entrained over pulleys 57 and 59. It will be apparent that, when the upper rolls of both roll sets are elevated out of engagement with the web or webs, such rolls do not rotate. When, however, roll 34 is depressed into driving engagement with the web or webs, roll 52 is driven in

synchronism therewith and is thus available to provide further web-forwarding force at the tab and opening-forming station when roll 52 is lowered into operative position.

At the rear end of the splicing unit there are provided two vertically spaced transverse guide members 61 and 62. Such guide members are in the form of tubes extending between and secured to the side plates 27 and 29 by suitable brackets, as shown. Guide members 61 and 62 are disposed above and below, respectively, the pass line of the two roll sets so as to guide the webs to the splicing unit in the manner shown.

In the first described embodiment of the apparatus, which forms the splice shown in FIGS. 2 and 7 between the webs, the lower roll 51 of the second roll set 42 carries a plurality of laterally spaced male die members 64 and the upper roll 52 carries a plurality of laterally spaced female die members 65 cooperating with the respective die members 64. The portions of such upper and lower rolls between the die sets function as pinch rolls when the rolls are together in operative, web-engaging position. To give the rolls such pinch roll function, rubber or rubber-like sleeves 66 and 67 are affixed to rolls 51 and 52, respectively, as shown. Sleeves 66 and 67 are of such diameter that their surfaces are tangent to the pass line between the rolls.

The male die members 64 are of disc-like shape and are rigidly affixed to the roll 51. Each die member 64 carries a plurality of equally angularly spaced tooth-like projections 69 thereon. Each of such projections 69 rises from a valley 70 radially outwardly in a generally arcuate portion 71 to a peak 72. From peak 72 each projection or tooth slopes radially inwardly in a portion 74 thereof in a forward direction to the next valley 70. The outer surface of arcuate portion 71 is smooth and unbroken, the elements thereof lying parallel to the axis of roll 51. The forward sloping portion 74 of each projection 64 has a configuration in section which is more clearly shown in FIG. 8. As there shown, in portion 74 the die has a forward central edge 75 from which the surfaces of the projection on both sides of the edge slope away from the direction of travel of the projection at an angle β . A typical satisfactory value for angle β between surfaces 76 and the central plane of die 64 is 30°. As shown in FIG. 3, the radially outer portions of projection 64 extend upwardly somewhat above the pass line of the web or webs. Each die 64 has a spacer collar 77 affixed to roll 51 on each side of the die. Collars 77 have an outer diameter such that their outer surfaces lie at the pass line of the webs.

Each female die 65 is of disc-like shape and has two radially inwardly projecting laterally spaced flanges 79 presenting an annular groove 80 therebetween. The space 80 is of such width as to receive the outer ends of projections 64 therewithin and to shear the webs which pass between the dies, as shown in FIG. 4. The groove 80 has a radial depth such that there is appreciable clearance between the bottom of the groove and the tips of teeth 64.

As above explained, except when a splice between webs is being formed, the upper roll 42 is elevated out of operative engagement with the web or webs. Thus during normal, non-splicing operation of the apparatus, a web passing through the splicing zone is merely supported by and lightly engages the arcuate outer surfaces 71 of projections 64 so as to rotate roll 51 freely. When, however, it is desired to splice two webs, the roll 52 is lowered into the operative position of FIG. 4. In such position of roll 52 the rolls 51 and 52 now become operative to shear the webs passing therebetween to form interfitted tabs 13 and 18 on webs 15 and 17, respectively. Each leading edge portion 74 of teeth 64 functions first to puncture the webs by entry of the peak 72 thereinto. Following this, the radially outer portion of sharpened edge 75 somewhat extends the thus formed opening in the webs, as is shown in connection with the projection design-

nated 64' in FIG. 4. When the rolls 51 and 52 have rotated sufficiently further for the full thickness of a projection 64 to enter groove 80 in the female die, the coating edges of surface 71 of projection 64 and the edges of flanges 79 of die 65 progressively shear the webs to form longitudinally extending superimposed tabs which remain attached to the webs at what were initially the trailing ends of the tabs.

The superimposed tabs, composed of the tab 13 on web 15 and the tab 18 on web 17 are generally designated as a whole by the reference character 83. Such superimposed tabs are projected upwardly by the projections 64 and by the engagement of the tabs with die 65, so that as tab structure 83 leaves the dies it is bent upwardly and somewhat rearwardly, as shown in FIG. 4. To overcome the tendency of the die 65 to pull the webs upwardly out of the pass line by reason of its engagement with tab structure 83, there is provided a hold-down structure composed of horizontal cross bars 86 and 87 connected between the opposite slides 49 and lying rearwardly and forwardly, respectively, of die 65. Cross bars 49 thus travel up and down with roll 65. To the bottoms of bars 86 and 87 there are connected, as by being welded thereto, a plurality of laterally spaced longitudinally extending hold-down wires 88 which are located between the dies and slightly above the normal pass line of the webs. Preferably, one wire 88 is disposed on each side of each die set. To provide clearance between the sleeves 67 on roll 52 and wires 88 the sleeves are provided with annular grooves 90, as shown in FIG. 3, which freely receive the wires therewithin.

The composite tab structure 83 in travelling to the right (FIG. 4) with the spliced webs is progressively bent or folded into a flattened trailing position by the hold-down supporting bar 87, a folding blade 91, and by the action of the pinch rolls 34, 35 of the first roll set 33. The folding blade 91 extends across the splicing unit throughout at least substantially the width of the webs; blade 91 is supported on the side plates 27, 28 by suitable bracket members designated generally by the character 92. The spliced joint thus formed between the webs is initially strong after the tabs have passed beneath rod 87, and becomes progressively stronger as the tabs are flattened by blade 91 and by the pinch roll set 33. The splice joint is of such character, as more clearly shown in FIG. 2, as to sustain the forward tension imposed on new or replacement web 17 by the web 15 which is approaching exhaustion.

As shown in FIG. 2, the die set 64, 65 forms aligned elongated openings 81 and 82 through the webs 17 and 15, respectively, the stock of the webs thus removed being formed into superimposed tabs 13 and 18. The tab 18 is in the form of a tension-sustaining hook having a bight 85 which passes through the opening 82 in web 15. Bight 85 overlies the bight 84 of tab 13; although tab 13 does not add to the tension-sustaining function of tab 18, it is of value in providing a rounded strengthened trailing end in the opening 82, and also in preventing bight 85 of tab 18 from being weakened by being bent too sharply during the folding of the composite tab and during the further processing of the spliced webs.

The fluid motors 41 and 56 for relatively advancing the rolls of roll sets 33 and 42 into operative position and for retracting them therefrom may be controlled by mechanism such as that shown somewhat schematically in FIG. 1. Fluid such as air under pressure is fed through a pipe 94 from a source (not shown) to a manually operated control valve 95 having a control handle 96. The valve 95 has six ports, one of which is an inlet port connected to pipe 94 and another one of which is an outlet port connected to an exhaust pipe 97. The remaining four ports are arranged in sets of two, the ports of the first set being connected by pipes 99 and 100 to the upper and lower ends, respectively, of fluid motor 41. The ports of the remaining set are connected by pipes 101 and

102, respectively, to the upper and lower ends of fluid motor 56. The valve 95 is so constructed and arranged that, with handle 96 in the first position, fluid under pressure is delivered to the lower ends of both motors 41 and 56. Valve 95 is further so constructed that, with handle 96 in a second position, fluid under pressure is directed to the upper end of motor 41 and exhausted from the lower end thereof while fluid pressure is maintained on the upper end of motor 56. Finally, when handle 96 of valve 95 is placed in a third position, fluid under pressure is directed to the upper ends of both of motors 41 and 56 and exhausted from the lower ends thereof.

The described control system is easy and fast to operate, and makes it possible for the operator to minimize the length of the spliced joint formed between webs. It will be assumed that valve 95 is in its first position and that the roll 16 of web 15 is about to run out. Thereupon the operator introduces the leading end of web 17 into the splicing unit along the path 17a. Because the two pinch roll sets are then relatively retracted, the leading edge of web 17 may be thrust into the splicing unit to a position somewhat short of roll set 33, and there may be held in readiness with web 15 passing thereover. When the trailing end of web 15 approaches the splicing unit, the operator thrusts webs 17 forwardly between the rolls of pinch roll set 33 and then turns handle 96 to bring pinch rolls 33 together and thus to feed the two webs in synchronism through the unit. Shortly thereafter, the operator will further turn handle 96 thereby to cause the rolls of set 42 to approach each other and the cooperating dies thereon to become operative upon the webs. Such operation will continue until the trailing end of web 15 has passed through the splicing unit, following which the operator will return valve handle 96 to its second position, thereby to raise roll 65. When the spliced joint has passed out of the splicing unit, the operator can then return valve 96 to its initial position, thereby again to render pinch rolls 33 inoperative.

In some instances the new or replacement web 17 may be introduced into the splicing unit above the web 15 which is about to run out. With such orientation of the old and new webs, it is necessary, in forming a tension-sustaining splice therebetween, to bend the tabs 18 sheared from web 17 downwardly through the holes formed in web 15 and thence rearwardly therealong. A spliced joint of such latter type is shown in FIGS. 9 and 10.

To form the spliced joint of FIGS. 9 and 10 there is employed an apparatus which is essentially the same as that first described but with the male dies mounted on the top roll 52 and the female dies mounted on the bottom roll 51. FIG. 11 shows such alternative apparatus in a manner similar to FIG. 5. The only other major changes in the apparatus of FIG. 11 are the positioning of the hold-down device and the folding blade below the pass line of the webs, as indicated. The parts of the apparatus of FIG. 11 which are the same as those of the apparatus first described are designated by the same reference characters. Parts of the apparatus of FIG. 11 which have the same function as those of the first apparatus but which have had their positions reversed are designated by the same reference characters with added primes.

In some instances it may be desired to provide an apparatus which is capable of splicing two webs together in tension-sustaining relationship whether the leading end of the new web is presented above or below the trailing end of the old web. In FIG. 12 there is diagrammatically shown an apparatus for accomplishing such purpose. Briefly, the apparatus employs a plurality of laterally spaced cooperating die sets, the male and female die members of successive sets being reversed as to top and bottom position. With such apparatus the relative positions of the hold-down means and the folding blade are preserved for each die set, that is, a hold-down wire is provided on each side of a die set and the wires lie be-

tween the pass lines of the webs and the female die. A folding blade is employed both above and below the pass line of the webs. Parts in FIG. 12 which are the same as those in the first two described embodiments are designated by the same reference characters.

A spliced joint made with the apparatus of FIG. 12 is shown in FIG. 13. As will be evident, with the webs travelling in the direction indicated, only the upwardly and rearwardly folded composite tabs 83 function to sustain tension between webs 15 and 17, the downwardly and rearwardly folded tabs 83' being ineffective for such purpose. A sufficient number of die sets is employed so that the tabs formed by one-half their number provide sufficient strength of tension-sustaining splice for the result in hand.

Although only a limited number of embodiments of the invention have been illustrated in the accompanying drawings and described in the foregoing specification, it is to be especially understood that various changes, such as in the relative dimensions of the parts, materials used, and the like, as well as the suggested manner of use of the apparatus of the invention, may be made therein without departing from the spirit and scope of the invention as will now be apparent to those skilled in the art.

What is claimed is:

1. Apparatus for splicing two webs of flexible material together, which comprises a splicing zone, means forwardly of the splicing zone for pulling a first, leading web through the splicing zone, means rearwardly of the splicing zone for guiding a second, trailing web in alignment with the first web and so that the two webs lie in superimposed position, a first set of rolls in the splicing zone, said first set of rolls being idle pinch rolls, means selectively to advance the pinch rolls relatively together to grip the webs so that the rolls are driven by the first web and to retract the pinch rolls relatively apart so that they are relieved from the webs, a second set of rolls in the splicing zone positioned rearwardly of the first roll set, means for driving at least one of the rolls of the second set from the first set of rolls, the second set of rolls carrying selectively cooperating elements for forming a plurality of laterally spaced holes in the first web, for forming a plurality of laterally spaced tabs on the second web aligned with the holes in the first web, and for thrusting the free ends of the tabs through the respective holes, means including the first set of rolls for folding the tabs with the free ends thereof superimposed upon and extending rearwardly of the second web, means selectively to advance the rolls of the second set of rolls relatively together to form said holes and tabs in and on the first and second webs, respectively, and to retract the rolls of the second set of rolls relatively apart so that they are relieved from active cooperation with each other, one of the cooperating elements of each set thereof being a rotatable male die having a plurality of projecting members thereon, and the other of the cooperating elements being a female die which selectively receives the projecting members of the male die, and means in the splicing zone for stripping the

webs from the female die as the projections on the male die are withdrawn from the female die.

2. Apparatus as defined by claim 1, wherein the stripping means comprises at least one elongated longitudinally extending member located close to each set of cooperating dies and fixedly supported in the splicing zone close to the path of the webs, said elongated members being positioned between said path and the axis of the male die of each die set.

3. Apparatus for splicing two webs of flexible material together, which comprises a splicing zone, means forwardly of the splicing zone for pulling a first, leading web through the splicing zone, means rearwardly of the splicing zone for guiding a second, trailing web in alignment with the first web and so that the two webs lie in superimposed position, a first set of rolls in the splicing zone, said first set of rolls being idle pinch rolls, means selectively to advance the pinch rolls relatively together to grip the webs so that the rolls are driven by the first web and to retract the pinch rolls relatively apart so that they are relieved from the webs, a second set of rolls in the splicing zone positioned rearwardly of the first roll set, means for driving at least one of the rolls of the second set from the first set of rolls, the second set of rolls carrying selectively cooperating elements for forming a plurality of laterally spaced holes in the first web, for forming a plurality of laterally spaced tabs on the second web aligned with the holes in the first web, and for thrusting the free ends of the tabs through the respective holes, means including the first set of rolls for folding the tabs with the free ends thereof superimposed upon and extending rearwardly of the second web, means selectively to advance the rolls of the second set of rolls relatively together to form said holes and tabs in and on the first and second webs, respectively, and to retract the rolls of the second set of rolls relatively apart so that they are relieved from active cooperation with each other, and a common control means for the means for selectively relatively advancing and retracting the rolls of the first roll set and for the means for selectively relatively advancing and retracting the rolls of the second roll set, said control means being so constructed and arranged that the first roll set is relatively advanced into operative engagement with the webs by a first movement of the control means and that the second roll set is relatively advanced into operative engagement with the webs by a second movement of the control means.

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EARL M. BERGERT, *Primary Examiner*.