ABSTRACT
A web splicing device for forming a continuous web of material from individual shorter strips which includes a rotatable reel-type strip carrier with multiple loading stations for receiving short strips to be spliced. The short strips are mounted or positioned in a flat condition axially along the reel at a loading station and the reel or carrier is then indexed to a second position where the strip is joint spliced for subsequent move-
Fig. 10
This invention relates to a device for splicing relatively short strips of material together to form a longer web of material which is to be wound on a take-up reel. While the present invention has broad utility in terms of the type of web being formed, it has particular applicability in the film processing industry where individual exposed film strips from several customers are spliced together to form a large roll which is then commercially processed. The problem of web splicing in this industry is compounded by the fact that irreparable damage can result in the exposed film strips if handled improperly, thus making it desirable to eliminate as much physical handling as possible. In addition, the exposed film strips must usually be processed in a dark room since they are spliced before developing. In commercial operations these factors add greatly to the expense of developing film because hand processing has been slow, tedious and inaccurate. Although devices have been developed in the prior art for automating or semi-automating this operation, a great deal of physical handling by the operator is still necessary. The operation has been slow and subject to a great deal of human error. Typical of such devices is that shown in U.S. Pat. No. 3,553,056.

The present invention seeks to greatly reduce the amount of physical handling of the exposed film strip or other sensitive web material, thus eliminating the risk of damage while speeding up the operation and attaining uniform splicing, cutting and punching. With the present invention, succeeding film strips are being positioned while a preceding strip is being automatically spliced. The present device achieves a degree of reliability heretofore unattained in so-called automatic splicers and, because of its simplicity, lends itself to operation under dark room conditions by relatively untrained personnel. The saving of time and expense and avoidance of damage is always sought and particularly so in commercial developing processes. Therefore, this invention, although broadly adaptable to many splicing requirements, is particularly suited for the rapid and non-destructive large scale processing of customers' film strips.

SUMMARY OF THE INVENTION

The creation of a larger web of material by more rapidly undertaking the splicing of smaller web portions is conveniently accomplished by the use of multiple loading stations on a rotatable reel-type carrier whereby one station may be loaded while a preceeding strip is being spliced. The arrangement and handling, although suitable for increasing the web length of many materials, is particularly adaptable to splicing customers' film strips into a larger scale commercial processing roll.

The operation is commenced by the convenient finger gripping of the film strip as it is placed with its image-bearing surface clear of subsequently positioned elements of the strip holding apparatus. The gripping mechanism is first hand retracted and then spring returned to overlie the edges of the film strip. The secured film is moved toward the splicing position and, while being moved, is automatically end trimmed and, as necessary, punched with an index hole. Upon arrival at the splicing position, the former loading station becomes the splicing station, and a for-
stallation in the dark room of a commercial film processing plant is shown in its entirety in FIG. 1. Customer film strips are spliced into a larger roll for subsequent processing. The components and their functions are indicated as follows:

BED TO RECEIVE OPERATING COMPONENTS AND ITS SUPPORTS

Referring particularly to FIGS. 1 and 9, a flat channel shaped bed 22, drilled, tapped and cut out where required to retain all other equipment, is mounted on two vertical legs 24 adjustable for various heights. Adjustable nylon, or equivalent glides 26, are placed at the four bottom corners of each leg 24 for set-up and leveling adjustment. To facilitate servicing and improve operator comfort, together with the resultant increase in efficiency, the bed 22 is tiltable about trunnion 28 through an arc of approximately thirty degrees. The bed 22 can be held in any intermediate angular position by tightening the clamp screw 30 which travels in an arcuate slot 32 cut in the vertical leg 24.

MULTIPLE STRIP LOADING STATION COMPONENTS OF ROTATABLE CARRIER

Mounted to the left side of bed 22 is the rotatable reel-type carrier structure, indicated generally at 40, which provides multiple loading stations presently to be described. The carrier is mounted on a rotatable shaft 42 mounted in appropriate bearings in receiving holes 44 drilled into side support plates 46 and 48. The carrier 40 includes two receiving stations 50 spaced one hundred and eighty degrees apart and affixed to the shaft 42 by side beams 52. As shown most clearly in FIGS. 3 and 6, each loading station has a fixed lip straight edge 54 mounted at the trailing edge 56 of the loading station 50 and a spring loaded gate 58 at the leading edge 60 thereof. Mounted underneath the spring loaded gate 58 at the correct distance in from the edge 62 of the loading station 50 adjacent to the support plate 48, as shown in FIG. 6, is a flat leaf spring 64. This spring has a dimple or detent 65 which fits into one of the pre punched sprocket holes 66 located adjacent to one edge of the film strip 68. The spring loaded gate structure is shown most clearly in FIGS. 3 and 6.

Adjacent to the right hand edge 62 of the loading station 50, as viewed in FIG. 6, is an index punch 70 biased away from the film strip 68 by suitable spring means (not shown) and restrained in a receiving hole 72 machined in the end face 74 of side beam 52.

CUTTING AND PUNCHING OPERATION

As seen most clearly in FIGS. 2, 4, and 6, rotation of the carrier 40 moves the receiving station 50 away from the loading level, bringing the forward angular section of edges 62 and 76 thereof into contact with the spring loaded cutting wheels 78 mounted one on each side of support plates 46 and 48. These wheels are set at an angle of approximately 2 1/2° off the horizontal and vertical centerlines to make line contact with angled edges 62 and 76 and to insure that the film cutting will be very effectively and accurately done. Machined into side support plates 46 and 48 are grooves 80 to channel the cut-off pieces of film strip 68 to a waiting receptacle (not shown). Although only blade 78 and groove 80 associated with the end of station 50 adjacent to support plate 48 are shown in detail in FIG. 6, it will be understood that the cutter blade and groove in support plate 46 are identical in every detail and are not illustrated for the sake of brevity and simplicity. Further rotation of the carrier 40 places head 84 of the index punch 70 into contact with the face of the punch cam 86 attached to side plate 48, placing an index hole 87 in the film strip 68. The position of the cam plate 86 will, of course, be such that, as the carrier continues to rotate, the spring pressure on the punch is overcome and the punch depressed to form the index hole. Once the cam is passed, the punch is released and spring returned.

POSITION SENSING AND HOLDING

At one hundred and eighty° of rotation, the loading station 50 containing the trimmed and punched film strip has moved from the loading level to the splicing level and is fractionally held in that position by position sensing spring loaded detents 88, located in the adjacent side wall plates 46 and 48. The detents 88 protrude into appropriate recesses in buttons 90 located in the side faces 92 of the side beams 52. Only one set of detents 88 and recessed buttons 90 is shown in FIG. 6, associated with side plate 48, and it will be understood that the opposite end of the carrier is identically equipped. To prevent rotation of the carrier 40 during the splicing and take-up cycle, a solenoid 94, mounted on side wall plate 48, when deenergized through the control circuits shown in FIG. 10 by actuating selector switch operator 114, allows a plunger 96 to be placed into a receiving hole 98 located on side beam 52. The switch operator 114 operates the switch 115 through the connecting rod 116 and lever 117. This insures that no movement will occur should the frictional grip of the sensing detents 88 be overcome.

SPlicing TAPE FEED MECHANISM

The splicing tape mechanism 110, shown in detail in FIG. 6, is mounted to the underside of bed 22 and is driven by an electric motor 112 which is energized by the control circuit shown in FIG. 10 when selector switch 115 is moved to the “on” position. The electric motor 112 drives through a shaft 116, drive sprockets 118 and chain 120 for turning the shaft 122. Shaft 122 drives the tape feed wheel 124 and a spring loaded driven pressure roller 126 for feeding the correct length of splicing tape 128 off spool 130 into position for splicing. The splicing tape 128 is held in position by a guide fixture 132 affixed to the side of bed 22. At this point a limit switch 134, contacted by suitable cam means on wheel 124 (not shown), stops further motion of the system and causes energization of the splice forming mechanism 140.

SPlicing FORMING MECHANISM

The splice forming mechanism 140, located below and to the right of the carrier 40 and side wall plate 48, contains all components to automatically cut, heat and affix the splicing tape 128 to the film strip 68 after the system has been set in motion by the limit switch 134 controlled by the splicing tape mechanism 110. An electric motor 142 drives a cam wheel 144 and imparts, via a cam follower 146, a vertical up and down motion of the punch and press 148, shown in detail in FIG. 7. As the punch and press 148 moves past the spring loaded, stationary cutting face 152, the section of splicing tape 128 protruding through the slotted hole 154 in the cutting face 152 is sheared off. The splicing
tape is held in position on the upper surface 156 of the punch and press 148 by the bent over lips 158 of the two ball-sprung position clips 160.

Further upward travel of the punch and press 148 releases the position clips 160 from the restraining guides 162, allowing the position clips 160 to spring away from the punch and press 148 and being held from further movements, thereby completely exposing the section of splicing tape 128.

During travel of the punch and press 148, the section of splicing tape 128 has been heated by two heating elements 164 set into the punch and press 148 in close proximity to the upper surface 156. Both heating elements 164 are interconnected with a mercury thermostat 166, placed adjacent to the heating elements 164 and forming a triangle, to control the heat available for splicing within a high and low temperature range of 325°F to 350°F. Temperatures above and below these limits will seriously effect the adequacy of the splice and could damage the film strip 68.

At the highest point of travel, the punch and press 148 is firmly pressing the section of splicing tape 128 against the two abutterd ends of film strip 68. The punch press is held there due to the flat section of cam 144 for a prescribed length of time before being returned to the starting point ready for another cycle. At this point a limit switch 168, shown in FIG. 10, is contacted by a contact member on the wheel 144 and conditions the control circuit so as to stop further rotation of the electric motor 142.

To insure zero clearance between the cutting edge 150 of the punch and press 148 and the stationary cutting face 152, the side 170 of the punch and press 148 is preloaded by tension rollers 172, consisting of a ball bearing 174, back-up spring 176 and set screw 178.

SPliced film advance mechanism

As the splicing mechanism 140 stops, the strip advance mechanism 190, shown in detail in FIG. 5, is started by stepping of the stepper control switch shown in FIG. 10, causing the now spliced film strip 68 to advance.

Energization of the electric motor 194, directly coupled to a large diameter driving wheel 196, drives the wheel to advance the film. One edge of the circumferential surface 198 is knurled as at 200 to afford a gripping action on the edge of the film strip 68. The portion of the driving wheel 196 over which the image-bearing surface of the film strip 68 runs is undercut and perfectly smooth to prevent damage to that surface.

The drive wheel 202 has a small section 204 at each peripheral edge which actually abuts the edges of film strip 68 being driven by the driving wheel 196. The section 206 between the two ends 204 of wheel 202 is of a smaller diameter thereby precluding placing pressure on the image-bearing surface of the film strip 68. To correctly position the trailing unspliced end of film strip 68, a solenoid 208 locates a spring applied plunger 210 in adjustable slot 212 affixed to side 214 of the driving wheel 196. The solenoid may be simply placed in parallel with the motor 194 such that the solenoid is energized in parallel as to withdraw the plunger when the motor is operating and deenergized when the motor is cut off so as to lock the wheel. Control of the spliced film advance mechanism is afforded by limit switch 192 with striker lever 216 running on cam face 218 located on face 214 of wheel 196. Spring clutch 222, affixed to the hub of wheel 196, slips when an over torque condition exists so as to prevent excess tension and breaking of the film strip in case of jamming of any of the mechanism.

SPliced film take-up reel mechanism

The take-up reel mechanism is shown in detail in FIG. 8. The electric motor 230 of the spliced film take-up reel mechanism 232 is sequenced to start taking up the film strip 68 onto the take-up reel 234 after the spliced film advance mechanism 190 has generated enough slack to allow the tension arm 236 to rotate in the direction of the arrow in FIG. 8, causing the member 237 to contact the limit switch 238. The spring 239 maintains a constant bias on the mounting axis of the arm 236.

Once energized, the electric motor 230 advances the spliced film take-up reel 234 at a speed coincidental with the speed at which the spliced film advance mechanism 190 is advancing the film strip 68. At the point where the spliced film advance mechanism 190 stops, the spliced film take-up reel mechanism 232 keeps advancing, taking up the film strip slack induced by the pre start of the spliced film advance mechanism 190.

Taking up the slack of film strip 68 gradually moves the tension arm 236 out of contact with limit switch 238, thereby deenergizing electric motor 230.

HOLDING ATTACHMENT

To facilitate removal of the film strip 68 from the spool 270, a spool holder attachment 272 may be coupled to the mounting shaft 42 of the film strip carrier, as illustrated in FIG. 2, by any suitable means, such as the coupling 274. A cross arm 276 is mounted on the outer end of the extended shaft 278 and has at each end thereof a spool holder 280 positioned on a level with each receiving bed. As illustrated in FIG. 2, the film strip may be pulled from the spool with a minimum of physical handling.

OPERATING SEQUENCE

The operating sequence of the device will now be described with reference to the electrical schematic shown in FIG. 10. To start the sequence of operation, the operator places the master switch 250 in the "on" position, energizing the electrical system up to the heating elements 164 and up to the selector switch 115 through the stepper control switch once the heating elements have reached a temperature of 325°F so as to close the switch 165. The stepper control switch is at this time in the start or number one position shown in FIG. 10. The coils 164 are maintained within the selected temperature range by means of the thermostatic control shown. It will also be noted that, as shown in FIG. 10, the locking solenoid 94 is energized and withdraws the locking pin 96 from the hole 98 to permit the carrier 40 to be rotated.

The film strip 68 is removed from its spool by hand or by using the spool holder attachment 272 and then laid flat with the image-bearing surface uppermost on the loading station 50 with one edge under the lip of the straight edge 54 and the other edge held by the spring loaded gate 58. The detent 65 of the leaf spring 64 located in the pre-punched sprocket hole 66 positions the film strip ready for cutting. The carrier 40 is manually rotated so as to move the loading station 50 with the film strip 68 past spring loaded cutting wheels 78,
thereby removing excess film, and past the punch cam 86 which contacts the punch head 84 and drives the punch 70 through the film strip 68, forming an index hole 87. At the completion of the one hundred and eighty degrees rotation, the loading station 50 is now at the splicing level and held there by engagement of the spring loaded detents 88.

The operator, by moving the selector switch operator 114 to the “on” position, closes the switch 115 and completes a circuit through the step coil 251. When the operator releases switch operator 114, the switch 115 again opens and the coil 251 causes the stepper control switch to move one step to the number two position. As seen in FIG. 10, movement of the stepper switch contacts to the number two position deenergizes solenoid 94, allowing pin 96 to engage and lock the carrier, and energizes the tape advance motor 112. The electric drive motor 112, through the shaft and chain drive shown, advances an exact length of splicing tape 128 onto the punch and press 148. When the proper length of tape has been dispensed, the limit switch 134 is contacted by a suitable cam or roller 124 (not shown) and released, causing the stepper to advance to position number three. This cuts off the electric motor 112 and, in turn, energizes the electric motor 142 which drives the punch and press 148.

Electric motor 142, driving a cam wheel 144, imparts, by way of a cam follower 146, an upward motion to the punch and press 148. This motion shears off a section of splicing tape 128 and carries it upward still further, depositing the splicing tape 128 against the abutted ends of the film strip 68. Heat derived from the heating elements 164 is used to form a hot splice. The flatness of the cam 144 at this juncture in the cycle insures holding pressure against the hot splice for a set period of time after which the punch and press 148 is returned to the starting point of the cycle.

Upon reaching this point in the cycle, a limit switch 168, shown in FIG. 10, is contacted and released by a suitable operator on the cam wheel 144, causing the stepper switch to move to position number four. This cuts off further rotation of the electric motor 142 and in turn energizes the electric motor 194 on the spliced film advance mechanism 190, shown in FIG. 5.

The film strip 68 is advanced until slack is produced, allowing spring loaded tension arm 236 to move, at which point a limit switch operated by the tension arm 236 energizes an electric motor 220 driving the spliced film take-up reel 234 which winds up the film strip 68.

The spliced film advance mechanism 190 advances the film strip 68 until the unsupplied end is positioned over the center of the punch and press 148, at which point a limit switch 192 is contacted and released, causing the stepper switch to again move to the number one position, which cuts out the electric motor 194 and energizes the solenoid 94, thereby removing the plunger 96 and again allowing movement of the carrier 40.

Take-up reel 234 continues rotating, winding up the slack created by the pre start of the spliced film advance mechanism 190, and then is cut out by the limit switch 238 operated by the tension arm 236.

At this point in time the system is now in a position ready for splicing of another section of film strip 68.

During this automatic phase of the operation the machine operator has been placing another film strip 68 on to the loading station 50 at the loading level in preparation for rotation of the carrier 40 to start another cycle.

**SUMMARY OF ADVANTAGES**

Substantially continuous loading is achieved by using this semi-automatic machine for splicing together webs of material such as film strips. The components and their operations are easily identified, handled, and controlled with special emphasis on doing so within the dark rooms of commercial film processing plants. One side of the web, such as the image-bearing side of photographic film, is never contacted by the operator or by the machine.

Once the hand movement of the carrier 40 is achieved, the follow-on functions are automatic, permitting the hand loading of the next strip of material, thereby accomplishing the almost full time feeding of the machine. This increases the capacity of each operator without creating any inconvenience. Moreover, the machine is adjustable to fit the stature and the comfort desires of the operator.

Throughout all operations, the possibility of shearing, overheating and mishandling of the film is prevented by the controlled sequencing of the operations of the various components. Moreover, accessibility throughout the machine is excellent for operations, servicing, and repair.

We claim:

1. Apparatus for splicing elongated strips in end-to-end-abutting relation comprising in combination;
   a. a rotatable reel-type carrier having at least two strip holding means constituting strip holding stations located about its circumference and extending axially therealong,
   b. each of said strip holding stations being movable upon rotation of the carrier between a first position for loading and a second position for splicing and unloading,
   c. a splicing station located adjacent the carrier and including splicing tape dispensing means and splicing tape applicator means for applying a strip of splicing tape across the abutted ends of the carrier loaded strip in said second position and a preceding strip held in a predetermined position, and
   d. means for advancing the spliced strips a predetermined distance after the splicing tape has been applied, to position the last spliced strip in a position to be spliced to a succeeding strip.

2. The apparatus according to claim 1 including:
   a. cutter means mounted on support frame members adjacent the ends of said carrier and positioned to contact and trim the ends of a strip held in the holding station upon rotation of the carrier prior to the positioning of the station in said second position.

3. The apparatus according to claim 2 including:
   a. strip index punch means mounted on one end of said carrier for punching an index hole in said strip,
   b. said punch means including a cam actuated operator, and
   c. cam means mounted adjacent said punch means and positioned to operate said punch upon rotation of the carrier prior to the positioning of the station in said second position.

4. The apparatus according to claim 3 including;
a. normally engaged locking means carried by said support frame members for locking said carrier against rotation, and
b. control means for selectively energizing an electrical release mechanism for releasing said locking means and stepper switch control means for deenergizing said locking means after rotation of the carrier to move said strip to the second position.

5. The apparatus according to claim 4 wherein said splicing tape dispensing means comprises;
a. a supply of splicing tape,
b. splicing tape feed means including electrical motor drive means,
c. electrical control means for controlling said motor means to advance a predetermined length of splicing tape across the abutted ends of the strip held in the holding station of the carrier and said preceding strip, and
d. said splicing tape applicator including means for severing said splicing tape and applying said tape with heat and pressure to span the abutted ends of the strip.

6. The apparatus according to claim 1 wherein said splicing tape dispensing means comprises;
a. a supply of splicing tape,
b. splicing tape feed means including electrical motor drive means,
c. electrical control means for controlling said motor means to advance a predetermined length of splicing tape across the abutted ends of the strip held in the holding station of the carrier and said preceding strip, and
d. said splicing tape applicator including means for severing said splicing tape and applying said tape with heat and pressure to span the abutted ends of the strip.

7. The apparatus according to claim 6 wherein said means for advancing the spliced strips comprises;
a. a motor actuated driving wheel and a driven wheel for contacting said strip,
b. said wheels being undercut on the peripheral surfaces thereof so as to contact the edges of said strip and relieve pressure on the major portion of the strip surface,
c. a power driven strip take-up reel, and
d. said take-up reel including sensing and control means to drive said reel responsive to slack in the strip caused by operation of the strip advancing means.

8. The apparatus according to claim 5 wherein said splicing tape dispensing means comprises;
a. a supply of splicing tape,
b. splicing tape feed means including electrical motor drive means,
c. electrical control means for controlling said motor means to advance a predetermined length of splicing tape across the abutted ends of the strip held in the holding station of the carrier and said preceding strip, and
d. said splicing tape applicator including means for severing said splicing tape and applying said tape with heat and pressure to span the abutted ends of the strip.

9. The apparatus according to claim 8 including;
a. adjustable support means for vertically adjusting the height of said carrier and rotating the carrier

and its supporting frame member about an arc to a convenient tilt position.

10. The apparatus according to claim 1 wherein said strip holding stations comprise;
a. an elongated surface extending axially along said reel for receiving said strip,
b. a fixed lip extending substantially the length of said surface and disposed to overlie one edge of the strip, and
c. a manually releasable spring biased gate extending substantially the length of said surface and disposed to overlie the other edge of the strip.

11. In a strip splicing apparatus having a splicing tape dispenser and applicator and strip advancing means for positioning the end of a previously spliced strip adjacent said dispenser and applicator, a strip positioning mechanism comprising;
a. a rotatable carrier,
b. means mounting said carrier for rotation adjacent said splicing tape dispenser and applicator,
c. at least two strip holding means constituting strip holding stations on said carrier, and

d. said carrier being movable upon rotation for locating said strip holding stations at a first position for loading and second position for splicing and unloading.

12. The apparatus according to claim 11 including;
a. cutter means mounted on support frame members adjacent the ends of said carrier and positioned to contact and trim the ends of a strip held in the holding station upon rotation of the carrier prior to the positioning of the station in said second position.

13. The apparatus according to claim 12 including;
a. strip index punch means mounted on one end of said carrier for punching an index hole in said strip,
b. said punch means including a cam actuated operator, and
c. cam means mounted adjacent said punch means and positioned to operate said punch upon rotation of the carrier prior to the positioning of the station in said second position.

14. The apparatus according to claim 13 including;
a. normally engaged locking means carried by said support frame members for locking said carrier against rotation, and
b. control means for selectively energizing an electrical release mechanism for releasing said locking means and stepper switch control means for deenergizing said locking means after rotation of the carrier to move said strip to the second position.

15. The apparatus according to claim 14 wherein said splicing tape dispensing means comprises;
a. a supply of splicing tape,
b. splicing tape feed means including electrical motor drive means,
c. electrical control means for controlling said motor means to advance a predetermined length of splicing tape across the abutted ends of the strip held in the holding station of the carrier and said preceding strip, and
d. said splicing tape applicator including means for severing said splicing tape and applying said tape with heat and pressure to span the abutted ends of the strip.

16. The apparatus according to claim 11 wherein said splicing tape dispensing means comprises;
a. a supply of splicing tape,
b. splicing tape feed means including electrical motor drive means,
c. electrical control means for controlling said motor means to advance a predetermined length of splicing tape across the abutted ends of the strip held in the holding station of the carrier and said preceding strip, and
d. said splicing tape applicator including means for severing said splicing tape and applying said tape with heat and pressure to span the abutted ends of the strip.

17. The apparatus according to claim 16 wherein said means for advancing the spliced strips comprises;
a. a motor actuated driving wheel and a driven wheel for contacting said strip,
b. said wheels being undercut on the peripheral surfaces thereof so as to contact the edges of said strip and relieve pressure on the major portion of the strip surface,
c. a power driven strip take-up reel, and
d. said take-up reel including sensing and control means to drive said reel responsive to slack in the strip caused by operation of the strip advancing means.

18. The apparatus according to claim 15 wherein said means for advancing the spliced strips comprises;
a. a motor actuated driving wheel and a driven wheel for contacting said strip,
b. said wheels being undercut on the peripheral surfaces thereof so as to contact the edges of said strip and relieve pressure on the major portion of the strip surface,
c. a power driven strip take-up reel, and
d. said take-up reel including sensing and control means to drive said reel responsive to slack in the strip caused by operation of the strip advancing means.

19. The apparatus according to claim 18 including;
a. adjustable support means for vertically adjusting the height of said carrier and rotating the carrier and its supporting frame member about an arc to a convenient tilt position.

20. The apparatus according to claim 11 wherein said strip holding stations comprise;
a. an elongated surface extending axially along said reel for receiving said strip,
b. a fixed lip extending substantially the length of said surface and disposed to overlie one edge of the strip, and
c. a manually releasable spring biased gate extending substantially the length of said surface and disposed to overlie the other edge of the strip.

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