METHOD OF AND APPARATUS FOR HANDLING MATERIAL

Inventor: William E. Hawkins, Circleville, Ohio


Filed: Aug. 16, 1971

Appl. No.: 172,308

U.S. Cl. 242/56.6, 83/98, 83/102, 83/428, 226/97, 242/67.1

Int. Cl. B65h 35/02

Field of Search 242/56 R, 56 A, 56.2, 242/56.3, 56.4, 56.5, 56.6, 56.7, 56.8, 83/98, 102, 105, 103, 302, 408, 428, 516; 162/193, 255, 286, 226/95, 97

References Cited

UNITED STATES PATENTS

2,593,388 4/1952 Littman
2,181,049 11/1939 Douglas
1,338,094 4/1920 Pope
3,144,216 8/1964 Billingsley
3,252,366 5/1966 Karr

Primary Examiner—George F. Mautz
Assistant Examiner—Edward J. McCarthy
Attorney—Hoge T. Sutherland

ABSTRACT

A material handling method including a method of threading a strip of material, such as plastic film, into a pneumatic moving means including the steps of moving a web of film from a supply source along a first path by first moving means; slitting the web as it moves in the first path to form a leader strip; moving the strip in the first path by the first moving means and into operative relationship with a pneumatic moving means threadup device; threading the leader strip into threadup position with respect to a pneumatic second moving means including at least a strip first transport tube having a strip entrance opening positioned adjacent the first path; cutting the thrust strip while it is in this threadup position; and, pulling the leading edge of the cut strip into the entrance opening of such transport tube to thread it into such pneumatic second moving means. Such web handling method further includes a method of threading such strip and the web it is formed from onto a windup roll for winding thereupon including the steps of moving the strip in a second path by the pneumatic second moving means and through a strip exit opening of a strip transport tube of the pneumatic second moving means and into operative relationship with a windup roll threadup device consisting of a curved guide chute having spaced flexible members connected thereto, such flexible members being in contact with the surface of a windup roll and air currents from the exit opening of such transport tube passing along the chute surface, through the spacers of the flexible members and adjacent the roll surface to guide, pneumatically and mechanically, the leading edge of the strip into threadup position with respect to the windup roll and into contact with the surface of such windup roll; connecting the leading edge of the strip to the windup roll; pulling the strip from the transport tube or tubes through a slot therein and into a third path defined by process rolls; expanding the strip to form the full width web; moving the full width web in the third path; and, winding such web onto the windup roll.

Apparatus is provided for performing the above described method.

16 Claims, 15 Drawing Figures
METHOD OF AND APPARATUS FOR HANDLING MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is a material handling method and apparatus and, more particularly, is directed to a novel method of and apparatus for (1) threading a strip formed in a web into a pneumatic moving means and for (2) threading the strip, then winding the web onto a windup roll, at high speeds.

2. Description of the Prior Art

Material handling devices are old. It is known, for example, to thread a continuously moving web in a predetermined path by various mechanical or pneumatic means.

An early teaching is U. S. Pat. No. 1,326,615 to Pope which shows advancing a web of paper between processing stations with the aid of a series of air nozzles or jets placed strategically along a vertical stack of calender rolls. A narrow lead strip is cut manually from the marginal edge of the web and caused to be carried from a drier unit to the top of a calender roll stack by an endless driving belt and a plurality of air nozzles and doctors. Such lead strip is formed by pressing a knife into the margin of the web after which an air nozzle adjacent the belt is turned on causing the leader strip to be blown by the blast of air outwardly from the exit of the drier into contact with the belt. A doctor then detaches the lead strip with the assistance of an air blast from a second nozzle and diverts it into the bite of the top set of calender rolls. From there, it is directed into the lower rolls by other doctor and air nozzle combinations positioned at the exit ends of the rolls. After it is running satisfactorily through the calender stack, the knife is moved manually to the opposite end thereby increasing the lead strip to full web width.

Another teaching is U. S. Pat. No. 1,338,094 to Pope wherein an air nozzle conveying system is combined a guide plate or deflector for directing currents of air along the desired path of travel. Such deflector is positioned between vertically spaced guide rolls and curved partially around the downside roll such that curved end is preferably spaced close to the circumferential surface of the upper roll. At the upstream end of the plate, a perforated air pipe directs a high velocity airstream along the plate surface on which the paper is conveyed. A second air nozzle coacts with the first nozzle and helps deflect the leader strip toward the air stream. Thus, both nozzles deflect and forward the leader strip up and around the upper guide roll. From this point, a doctor air nozzle combination removes the strip from the roll and guides it into a second deflector plate.

Minor variations in strip tension or velocity of the air blasts in these conveying or strip guiding systems can create difficult operational problems and, in fact, such air nozzle systems are primarily useable for paper handling only inasmuch as paper is comparatively heavier and stiffer than limp polymeric film and, thus, easier to control by the air blasts. More importantly, the air blasts ultimately create highly turbulent flow. This combined with other problems makes it virtually impossible to maintain the strip under control, particularly in curved or circuitous paths.

These methods, requiring manual assistance and operable mainly for paper handling, impose severe limitations of use in such devices or methods.

Another, and recent, teaching is found in pending U. S. Pat. application Ser. No. 84,984, filed Oct. 29, 1970, wherein is shown and described an apparatus for winding a web onto a windup roll including first moving means for moving the web along a first path; means for forming a leader strip in the web as it moves in the first path; means for cutting the leader strip and diverting it into a pneumatic second moving means including at least one tube having a slot therein for moving the strip in a second path; third moving means for pulling the strip from the slot in the tube and into a third path and for moving it in such third path; means for expanding the strip into a full width web whereby the third moving means moves the full width web along the third path and into operative association with a web windup means; means for cutting the full width web and threading it onto a windup roll of the web windup means; and, means for winding the full width web onto the windup roll.

Still another teaching is found in copending U. S. Pat. application Ser. No. 153,512, filed June 16, 1971, wherein is shown and described a material handling method and apparatus which includes means for moving material from a supply source along a first path to a first work station; means for forming edge portions and a web in the material as it moves; means for moving the web in a second path to a second work station by second moving means; means for expanding the edge portions and severing the web to form the full width material again; and, means for again moving the full width material in the first path to the first work station.

It is known, then, to use pneumatic means in the form of a tube to convey limp strips of film or the like from one point to another. Generally, the strip is introduced into the entrance opening of the tube, manually or by blocking the first path, for example, and the air draws it through such tube or tubes to the exit opening. The automatic startup of this type system presents difficult problems. This invention provides an effective pneumatic means threadup device for improving the operation and increasing reliability of this type system.

Such means essentially consists of a diverter-cutter means which thrusts the film into a critical operative threadup position with respect to the entrance opening of the pneumatic means and, then, at the instant it reaches that position cuts the strip which is instantly drawn or pulled into the tube entrance by the air flow. It is this movement of the strip from a first path, where it has been moving at great speeds, and the introduction or threading of it into the tube that presents operating difficulties which this invention solves. This thrust, cut, pull diverting of the strip into the pneumatic means by following the critical method steps and by using the specific apparatus parts of this invention enables it to be done effectively; otherwise, many things could go wrong because it is required that the positioning, cutting and pulling be done as described or else, oftentimes, the device or method will not work with desired effectiveness.

After the strip has been carried through the pneumatic system to a second point which may be another work station or, as specifically described in this application, is a windup roll, it is then required that the leading edge of the strip be threaded onto the windup roll. This, too, presents a difficult problem because of the high speeds at which the strip is moving and due to its limp characteristics. The instant invention solves this
problem by providing a windup roll threadup device which “borrows” the air flow from the pneumatic means that has been moving the strip to blow or guide the leading edge of the strip onto a novel guiding device which is positioned adjacent the exit opening of the pneumatic moving means. The lower portion of this guiding device is positioned below and adjacent the lower surface of the windup roll and has connected to it spaced flexible bristles through which the air flow can pass. As the air travels in the curvilinear path of the inner surface of the guiding device and blows through this set of bristles, it carries with it the leading edge of the strip and brings it into a critical operative, contacting, relationship with the lower surface of the roll which has a sticky substance or some other means thereon to provide an adhesive engagement between the strip and the roll. The roll is rotating whereby it instantly accepts (i.e., threads) the strip thereon and starts the winding operation.

As will be seen, other means are provided to expand this strip into web form and, accordingly, the invention encompasses using this windup roll threadup device as a means of effectively getting a web wound onto a windup roll. Again, it is important to recognize that all of these things are happening at considerable speeds and that the material is one that is extremely difficult to handle. By using the methods and apparatus of the instant invention, significant improvements in handling are brought about. That is the crux of this invention.

SUMMARY OF THE INVENTION

This invention relates to material handling and, more particularly, to a method of and apparatus for the automatic threading or positioning of light weight, wide, width polymeric film as it moves at high speeds.

In the manufacture of elongated webs of polymeric film, the material must undergo numerous processing steps, such as heating, drying, washing, stretching, surface treatment, etc., before the finished web arrives at the packaging station. This usually requires moving of the web through a complicated process or work path for some of the operations must be performed in progressive stages and at variable speeds. For example, in the production of thin polymeric film a narrow relatively thick ribbon is initially cast in a thermoplastastic state onto a quenching surface and rapidly cooled into a hardened condition; the web is then reheated to a temperature above the glass transition temperature and stretched, usually bidirectionally into a lightweight film many times longer, wider and thinner than the initial ribbon. The speed of the thin film beyond the stretching station is, of course, substantially higher due to the corresponding elongation. Likewise, the tension forces on the web before and after stretch elongation are considerably changed. Thus, to accommodate for these variations, the web must be conveyed or moved in predetermined paths from one work station to the next over a variety of process or transfer rolls, some of which are power driven, to provide the required tensioning and forwarding forces.

Since the polymeric material must also be surface conditioned, inspected and slit to desired width at other work stations, it is not unusual for the web to follow a complicated, tortuous process path before arriving at the windup or other work station. At the windup station, special devices and web handling techniques must be applied to effect an uninterrupted threading of the web onto a windup roll or rolls. Ordinarily, this is achieved by slitting the wide web into a plurality of narrower widths and winding the slit web sections onto a plurality of windup rolls on indexing turret type windups. Such devices include auxiliary mechanisms for automatically transferring the web from a full roll to an empty core; however, they may lack the high speed capability for automatic positioning of a strip formed from the web in operative relationship with a windup device for threading of the strip and then the web onto the core of the first windup roll.

Further, such strip must first be delivered to this predetermined position for windup threading before actual transfer onto this core takes place. A novel means for doing this is by pneumatic moving means as described, for example, in copending Pat. application Ser. No. 84,984, previously mentioned under “Description of the Prior Art.” The first problem is getting the strip threaded into the first transport tube of the pneumatic moving means; the next is getting it threaded onto the windup roll. It is during these threading startups that many continuity difficulties are encountered in the prior art, for the web must be restrung through the complex process path, usually manually, by a number of skilled operators. The procedure, as generally practiced, is inefficient, is rather hazardous and, of course, is costly due to lost production from downtime. At modern high productivity rates, means must be provided for immediate movement of the web to a given location, otherwise great quantities of film accumulate in the operating area, further adding to the hazards.

The present invention solves these problems, and other problems existent in the prior art, by providing means and steps for automatically threading a strip into a pneumatic moving means and onto a windup roll and for positioning and moving it, and then the web from which it is formed, in a predetermined process path for winding the web onto the windup roll.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a fully automatic strip threading and web winding apparatus of this invention including a slitter means for forming a narrow leader strip in the web as it moves in a first path; means for threading the strip into pneumatic moving means including means for thrusting, then cutting, then pulling the leading edge of the leader strip into such moving means for pneumatically moving the strip in a second path; means for threading the strip onto a windup roll; means (i.e., the windup roll) for pulling the strip out of the transport tubes of the pneumatic moving means through slots therein and onto process rolls defining a third path; and, means for traversing the slitter means to establish the full width web for winding onto the windup roll.

FIG. 2 is a detailed elevational view of strip first threadup means for threading the leader strip into the entrance opening of a first transport tube of the pneumatic moving means including means for thrusting and cutting the strip and for pulling the leading edge thereof to divert it and thread it into the transport tube.

FIG. 3 is a plan view of a diverter knife of a diverter-cutter means for cutting the strip after it has been diverted into the entrance opening of the first transport tube.
means for moving a web of material from a supply source along a first path to a first work station by first moving means;
means for forming a leader strip in the web as it moves in the first path;
first threadup means for thrusting and cutting the leader strip and for pulling the leading edge of the leader strip into a pneumatic strip second moving means for moving the web in a second path;
second threadup means for operatively connecting the leader strip to a windup roll which is adapted to pull it into a third path;
means for expanding the strip to full width web; and
means for moving the full width web in the third path and wind it onto the windup roll.

The strip threading and web winding parts of the apparatus of this invention generally comprise:
a strip forming means 20,
a strip first threadup means 30,
a strip pneumatic means 40,
a strip second threadup means 50, and
a web windup means 60.

Referring to the drawing and FIG. 1 in particular, a web of material 10, such as plastic film, to be handled by the apparatus of this invention is supplied from a supply source 11, and moved along a first path P-1 by appropriate mechanical first moving means 12, such as nip rolls 12', and to a first work station or means 13, such as a waste shredder or scrap recovery area. The supply source 11 may be any appropriate source, for example, it may be a web of plastic film as it emerges from the tenter frame of a polyethylene terephthalate film production line.

In the embodiment shown, from the supply source 11, at startup, the material 10 first passes around guide rolls 14 and 15 and into the bite of the driven nip rolls 12'. The material 10 is moved or advanced from tenter frame along the first path P-1 by these nip rolls 12' and, hence, to the waste shredder 13 which may feature a high speed rotary blade similar to the kind described in U. S. Pat. No. 3,545,686, issued Dec. 8, 1970.

The leader strip forming means 20 is composed of a pair of web slitter knives 21 each mounted rigidly in a carriage 22 and adapted with a pneumatic actuator 23 for upward movement into contact with the moving web 10. Each carriage 22 is operatively connected to a lead-screw which is driven by a motor 24 for traversing from the point of contact with the web 10 to just beyond the outer margin thereof. Prior to the threadup sequence, the knife blades 21 are traversed to the mid-region of the web 10 within 6 inches of each other. When the threadup sequence begins the blades are activated for cutting or forming the narrow leader strip 10' in the web 10.

The material slitting knives 21 preferably are conventional industrial type razor blades and are adapted by the pneumatic actuator 23 for upward movement into contact with the moving web 10 as it moves in the first path P-1 between the tenter frame 11 and the roll 14. After the leader strip 10' is formed, it, together with the rest of the web 10, continues for a period of time along the first path P-1, through the nip rolls 12' and into the shredder 13 prior to initiation of the leader strip first threadup means 30, as will now be explained.

**STRIP FIRST THREADUP MEANS**

As best shown in FIGS. 1–4, the strip first threadup
means for threading the leader strip 10' into the pneumatic second moving means 40 is located or positioned below the leader strip 10' as it moves in the first path P-1 and adjacent such pneumatic moving means. The threading means 30 includes means 31 for quickly thrusting the strip 10' into threading position with respect to the pneumatic second moving means; means 32 for cutting the strip 10' when it reaches such threading position, thereby forming a leading edge 10'' and the pneumatic second moving means 40 being operable for pulling the leading edge 10'' of such cut strip 10' into the second moving means 40 for moving the strip therethrough and in a second path P-2 defined thereby.

The strip thrusting means 31 preferably is in the form of a rounded head 33 adapted to be thrust by actuator means 34 into the strip 10' to move it or push it into threading position as shown by dotted lines in FIG. 2. Thus positioned, the strip 10' is located in an entrance opening 41' of a first transport tube 41 of the second moving means 40 preferably in the form of a pickup horn having rounded guide members 41'' at the sides thereof. The cutting means 32 preferably consists of a flat blade 35 welded to the end of a pneumatic actuator means 36 which is attached to the machine frame by conventional fasteners. The cutting edge 37 of the blade 35 preferably has a single point profile 38 and is adapted to pierce or rupture the leader strip 10' at the precise instant that it reaches threading position. In this position, the strip 10' is in the entrance opening 41' of the first transport tube 41 and as it is cut, the leading edge 10'' of the leader strip 10' is diverted into this entrance opening 41' where the air flow from the pneumatic moving means 40 provides a means to pull the strip 10' into the pneumatic moving means for movement therethrough. The tube 41, as will be explained in greater detail, forms a part of such pneumatic second moving means 40 which guides the strip 10' through the system as a prelude to the windup roll threading operation.

Referring to FIGS. 1 and 2, it is seen that in its first path P-1 the leader strip 10' moves around transfer rolls 14 and 15 and into the waste shredder 13. The diverter horn 41 is positioned between these rolls. In operation, as will be explained in greater detail, a vacuum is formed in the diverter horn opening 41' by means of the diverter jet and immediately after this, the strip diverter arm or thrusting means 31 rotates from the dotted line position as shown in FIG. 2 into its operative threading position to depress the leader strip 10' into the mouth or opening 41' of the divert horn 41. The rounded head 33 of the diverter arm 32 draws high tension between the two stationary rounded guides 41'' of the horn 41. At the end of the arm stroke, the diverter knife 35 fires to cut the strip 10' substantially simultaneously with its reaching its threading position. This action is rapid so the tension buildup between the two guides 41'' does not propagate toward the roll 14. If tension builds up between the horn 41 and the roll 14, the leader strip 10' will snap away from the horn 41 like a rubber band. The knife 35 cuts the leader strip 10' and the vacuum in the horn 41 picks it up and starts it through the pneumatic moving means 40.

Referring now to FIGS. 1, 5 and 7, the basic component of the strip transport or second moving means 40 comprises at least one or preferably a plurality of pneumatic strip transport tubes 41 each of which includes a rectangular-shaped, thin walled conduit made of lightweight aluminum alloy about 6 inches wide, 2 inches high and about 10 feet in length. Each tube 41, excepting the first tube, has a strip entrance opening 42 in the form of a pickup horn and an exit opening 43 in the form of a flared nozzle. Each tube 41 further is adapted with an eductor jet 44 which is connected by suitable piping that includes pressure regulation means to a remote source of pressurized air, as will be explained. In the preferred embodiment, jet 44 is located approximately 18 and 24 inches from the exit opening 43 and furnishes streams of high velocity fluid toward the exit. The placement near the exit opening is preferred for a standard length tube since more complete mixing of the high velocity fluid and the entrained air in the tube takes place. This, in turn, results in maximum aspiration at the entrance opening 42 and relatively low turbulence downstream. The diverging pickup horn 42 is employed to facilitate entry of the leader strip 10' into tube 41 while the flared nozzle 43 assures snag free exit.

Each tube 41 further is provided with a strip removal slot 45 which extends continuously the length of the tube through the mid portion of one of its surfaces. Slot 45 is a narrow opening about three-eighths inch wide with smooth rounded edges through which the leader strip 10' is extracted or pulled from the second path P-2 upon completion of a strip threading sequence.

In each instance, the transport tube 41 is positioned so that slot 45 is always facing the operating final process path of the web 10; i.e., the third path P-3. This side of the tube is hereafter referred to as the "slot slide."

A typical tube 41 can be either straight or curvilinear provided that the curved portions have a radius not less than 9 inches and the curved portions are directed in the same general direction; that is, there are no S-shaped curves. As shown in FIG. 9, a reverse curvature is obtained by placement of separate tubes 41 in successive relationship. This assures that the slot side 46 of each tube 41 is facing the final operating or process path P-3 of the web 10. More importantly, the successive critical placement of tubes 41 enables the strip (and, then, the web) to be moved in very complicated and tortuous configurations over extended distances without excessive cumulative air pressure buildup.

Under ideal conditions, the leader strip 10' can be conveyed through the transport tubes 41 at speeds up to 2,000 feet per minute. The top speed of conveyance is only limited by the feed or movement rate of the strip from upstream processing equipment. Conveyance over long distances is best accomplished, when the static pressure within the tube 41 is no greater than atmospheric and preferably at a subatmospheric level. Under such conditions, the strip pull-out slot 45 is provided with a slot seal or closure means 47 which minimizes leakage but is relatively simple mechanically to permit easy, rapid removal of the leader strip 10' from the tube 41. As shown in FIG. 5, the slot closure means 47 covers the strip pull-out slot 45 the entire length of the transporter tube 41 and preferably consists of two abutting, flexible polymeric film flaps 48 attached to the external surface of the tube 41 by pressure sensitive adhesive tapes 49 which function as hinges. The flaps 47 are made of a 0.003 inch thick polymeric material which remain sufficiently stiff against the slight pres-
sure differential between the inner and outer sides of the tube. Portions of the flaps under the tapes 49 may cut out, as shown, to improve the flexing character of the material.

A preferred version of the slot closing means is shown in FIG. 6, which version includes a single slot closing means or flap 47' for closing the slot 45 upon application of suction in the tube 41 by the jets 44 to close it. As the jets 44 are disengaged, the closing means 47' is free to hinge so that the strip 10' may be easily pulled through the slot 45, from the second path P-2 and into the work or third path P-3.

Referring again to FIG. 1, ultimately, the terminal end of the last strip transport tube 41 train is aimed directly at or onto the strip threading device 50. At or adjacent the opening of the first tube 41, the diverter rolls 14 and 15 are provided for guiding first the strip 10', then the full width web 10 after the strip 10' is pulled out of the tubes 41 through the slots 45 and onto the process rolls which define the work or process path P-3.

Referring particularly to FIG. 8, the eductor jet 44 of the pneumatic strip moving means 40 essentially is a device comprising the upper and lower venturi plates 51 and 52 which are fixedly held together in spaced relationship by side plates 53 only one of which plate is shown. The space between the venturi plates 51 and 52 defines an open passageway 54 through which the leader strip 10' moves. Passageway 54 is an accurately contoured channel composed of a converging nozzle 54', a minimum throat 54'' and an expanding nozzle 54''' each blending smoothly together and at the junctions with the tube 41.

Pressurized fluid is introduced into the jet 44 in the vicinity of the throat 54'' by way of inlets 55 that communicate downstream with distribution manifolds 56 and upstream with a source of pressurized air which is regulated to about 40 scfm and 40 psig. The manifolds 56 in turn feed into narrow slot orifices 57 by way of spaced distributor apertures 58 which are circular holes drilled into the venturi plates at regular intervals across the width of passageway 54. Orifices 57 likewise extend across the passageway 54 width and are formed by flat caps 59 which direct the high velocity fluid generally along the upper and lower surfaces of the expanding nozzle 54''', as shown by the arrows in FIG. 6. Continuity of the open slot 45 along the longitudinal axis of tube 41 is maintained through centerline of jet 44 by a split arrangement of the venturi plate 52 and the orifice cap 59. The aforementioned components are each attached to the respective side plates 53 thereby forming a narrow separation that coincides with the slot 45 of the tube 41.

In the preferred embodiment, the venturi portion of passageway 54 is designed for specific fluid flow conditions capable of producing maximum aspiration at the entrance end of the tube and high velocity, low turbulence at the exhaust end. These conditions are met by a venturi featuring a convergence angle α in the nozzle 54' of about 14°, an expansion angle β in nozzle 54''' of about 68° and a minimum area throat 54'' approximated one-half the cross section area of a tube. The above proportions enable operation of the jet 44 at relatively low static pressures without appreciable decrease in aspiration or fluid velocity.

It is essential that to impose maximum drag on the leader strip 10', the fluid flow in the nozzle 54''' be maintained at high velocity and low turbulence. In other words, it is desirable to establish fluid flow patterns generally parallel to the nozzle walls since high turbulence in this section results in an unstable condition that results in twisting and eventual shredding of the strip 10'.

In the preferred embodiment, each strip transport tube 41 is no greater than 10 feet in length; however, longer lengths can be utilized to a limited extent provided that the tube is adapted with booster jets and adjusted for operation at a higher manifold pressure. Depending on the length of the tube, two or more booster jets similar to the eductor jet 44 are incorporated at spaced distances along the tube 41 with the initial jet 44; that is, the one nearest the entrance end adjusted at a substantially lower manifold pressure than that ordinarily encountered in the preferred embodiment. Each successive jet thereafter along the transport tube is adjusted to a slightly higher manifold pressure in order to maintain stream velocity and to offset the steadily increasing mass flow and internal static pressure. There is a practical limit for a long length tube beyond which the cumulative effects of high manifold pressures and mass flow render the tube inoperable. As more booster jets are added to the transport tube, the manifold air pressure level eventually attains "choke" flow condition in the venturi. Any further increase in the pressure will not result in a corresponding increase in fluid velocity and aspiration. Without higher aspiration to compensate for the increasing internal static pressure, the pressure in the downstream portion of the tube rises above atmospheric level resulting in excessive air leakage and blow out of the strip 10'. Long before this unstable condition arises, the manifold pressure in the jet 44 reaches a level where disruptive fluid flow patterns develop in the throat 54'' region. These are relatively narrow streams along the walls of the passageway 54 composed of high velocity, highly turbulent fluid. As the leader strip 10' moves through, it is radically captured within the streams, twisted and subjected to severe flutter and shattered to pieces. Thus, tubes 41 longer than 30 feet and featuring more than three eductor jets are not considered practical for conveyance of lightweight polymeric strip material. It is noted that as the thickness of the strip material and the feed rate is increased, higher fluid flow conditions can be tolerated in spite of the destructive effects. Conversely, light gauge film and low feed rates require correspondingly lower fluid flow conditions within the eductor jet.

As shown in FIGS. 1 and 7, the above described difficulties are obviated by the use of the short length transporter tube 41 arranged in a surprisingly simple fashion. Each tube is a self-contained conveyor adapted with its own eductor jet 44, pickup horn 42 and flared nozzle 43. The tubes 41 are arranged in successive order so that the pickup horns 42 are aligned with the flared nozzles 43 of the upstream tubes and separated by an intervening air space. Depending upon the configuration of the final web process path, some tubes 41 may be straight and others are shaped to suit the path. In any case, the running length of any tube 41 preferably is limited to a maximum of 10 feet. The air space serves as a pressure release which means that it allows the fluid stream in the tube 41 to expand to atmospheric level upon emerging from the flared nozzle 43. This allows each successive tube 41 to operate at sub-
stantially identical fluid flow conditions, thereby reducing consumption of pressurized air, the deleterious noise level and generally simplifying operability.

In addition to simplifying the fluid flow problems, the air space feature greatly increases the flexibility of the pneumatic transport tube concept in web handling operations that otherwise cannot tolerate permanent obstructions. For example, as shown in FIG. 9, an air space is located at a point where the web changes direction over guide rolls thereby enabling permanent installation of the transport tubes 41. Likewise, an air space can be incorporated where the moving web must travel unobstructed, as at an inspection station. The transport tubes 41 are positioned so that the leader strip 10’ is "shot" across the station thus leaving the line of sight space clear. As is apparent, the space shoot feature permits permanent installation of stationary tubes, which when properly aligned and adjusted provide a remarkably simple and reliable strip threadup system of great, and highly sought after flexibility.

The leader strip 10’ is moved in the second path P-2 by and through the pneumatic second moving means 40 to the windup roll means 60 and threaded thereon prior to being pulled from the tubes 41 and into the third path P-3 defined by the process rolls where it is adapted to be converted to a full web as will be described. In this process path P-3, the web 10 will be in position to be wound onto a windup roll or, stated another way, such web will be in operative working relationship with the web windup means 60 or other work means. It is this critical path that this invention automatically seeks and finds in a novel manner of great usefulness in the web handling arts.

**STRIPE SECOND THREADUP MEANS**

As best seen in FIG. 10, the strip second threadup means 50 for threading the strip 10’ onto a windup roll 61 after it is moved in the second path P-2 by and through the second moving means 40 is positioned adjacent the exit opening 41” of the last transport tube 41 of the pneumatic moving means 40. Such strip threadup device 50 includes a strip guide chute 71 having a curved inner surface and spaced flexible members 72 connected thereto. Means (not shown) are provided to wind the chute 71 into its operative position. Thus positioned, members 72 are in contact with parts of the lower surface of the windup roll 61 and the spacings enable the air flow from the tube 41 of the pneumatic moving means 40 to pass through such spacings and between the chute and such lower parts of the windup roll surface. In other words, the air from the tube 41 carries the leading edge 10’ of the strip 10’ onto the strip guide chute 71 where it is deflected and guided by the curved inner surface of the chute and whereby the leading edge 10’ of the strip 10’ is transported by the air flow from the exit opening 41” between the flexible brushes 72 and into contact with the lower surface of the windup roll 61. The windup roll 61, in turn, has means to connect the leading edge of the strip 10’ in this threadup position to its surface after such contact, preferably in the form of a sticky substance applied thereto.

Briefly, the web windup means 60 per se further includes a pivotable, driven lay-on roll 62; a driven tension wrap roll 63; and a pivotable idler tension sensing roll 64.

Directly above andcoating with the empty core of the windup roll 61 is the lay-on roll 62 which is rotatably journaled on pivot arms that are affixed to the main machine frame. Pneumatic cylinders (not shown) pivot the lay-on roll 62 from the retracted position (shown in dotted outline) to a web windup operating position against the core of the windup roll. During roll formation, the lay-on roll 62 maintains a predetermined force against the surface of the web 10 to assure a stable wrinkle-free windup.

Similarly, the tension roll 64 is mounted on pivot arms which are actuated between a retract position (dotted lines) to an operating position by pneumatic cylinders (not shown). In its operating position, the tension roll 64 urges the web 10 to wrap around the tension wrap roll 63 sufficiently so that the inherent tension in the material is measured by spring mounted force transducers operatively connected to the stationary antifriction bearings in which the tension roll 64 is journaled.

The fully automatic threadup system is capable of continuous windup of a 60 inch wide web of 0.00015 to 0.0020 inch thick polyester film at line speeds of high speed production units. The threadup system is integrated with the web windup means 60 which is a commercial indexing turret type unit similar to Model 30-322 manufactured by the Black Clawson Company, Fulton, N.Y. Windup 60 is adapted with standard auxiliary mechanisms for automatic transfer of the web from a full to an empty core. The positioning of the web in operative relationship to this windup device (i.e., in path P-3) is the touchstone of this invention.

In this work or web process third path P-3, the strip 10’ (and then the web 10 which follows the strip 10’) passes from the supply source 11 under the diverter roll 14, over the upper guide roll 15 and around the tension wrap roll 63 and the idler roll 64. Rolls 14, 15, 16, 63 and 64 are the process rolls of the apparatus and define the web process path P-3. From this path P-3 the web 10, after being expanded from the strip 10’, may be wound onto a windup roll of the web windup means 60.

**OPERATION**

Prior to starting up the apparatus of this invention for diverting the leader strip from the first path P-1 and threading it into the pneumatic second moving means defining the second path P-2 for positioning such strip in operative relationship with web windup means and for threading the strip and winding the web onto a core thereof, certain process conditions must be preset and activated before the automatic sequence can be initiated.

As best shown in FIG. 1, the web 10 must first be moved along a first path P-1 by the driven nip rolls 12 from the supply source 11, around rolls 14 and 15, and into a first station, such as the waste shredder 13 which has been previously activated by an operator. At the web windup means 60, the lay-on roll 62 is moved into retracted position. The movement of this roll is accomplished by the actuators (previously mentioned).

An empty bobbin or core of a windup roll 61 is placed on the indexing turret of the web windup means 60 and is ready to receive the web 10 to be wound thereon.

The windup roll 61 is made ready to receive the leader strip 10’ by these steps. The roll 61 is rotated to its normal winding position on the windup turret and
the brush tipped deflector chute 71 is extended to engage its speed-sensing roller (not shown) with the roll 61. The brush tips 72 are positioned in light contact with the lower surface of the roll 61. The brushes 72 are separated by tufting to allow air flow from the last tube 41 of the pneumatic moving means 40 to pass therethrough and under the roll surface. Sticky tape is wrapped around roll 61 in the area of brush tips 72 to insure adhesion of threadup leader strip 10' to the roll surface 61.

The windup roll 61 is started and speed controlled at about 6 percent overspeed and at a torque level which will pull leader strip 10' from transport tubes 41 but will not break the strip 10' once it becomes tensioned in the final film path. The overspeed is used to take up slack quickly as the strip 10' is pulled from the tubes 41 but prevents the windup roll 61 from developing excessive inertia which would break the strip 10' as it becomes taut in the final film path.

The operator then activates the automatic threadup sequence. The knives 21 move upwardly into the moving web 10 and, as shown in FIG. 11, the narrow leader strip 10' is formed from and in the mid-portion thereof. This leader strip 10' and the main body of the web 10 both continue to be moved along the first path P-1 and into the waste shredder 13 by the first moving means 12. After a short time delay (3 seconds), eductor jet 44 of the tube 41 is actuated. After another short delay (3 seconds), the actuator 34 of the strip first threadup means 30 pushes or thrusts leader strip 10' into operative threadup relationship with the second moving means 40. In this position the knife 35 fires and the point 38 thereof pierces and ruptures strip 10' and deflects or diverts the leading edge 10'' of the strip 10' into the entrance opening 41' of the first transport tube 41 of the second moving means 40 where it is entrained by the air stream to start the threadup operation.

For reliable diversion of the strip 10' into the entrance opening 41' of the transport tube 41 of the pneumatic moving means 40, the manner in which the diverting (i.e., the thrusting, cutting and pulling) takes place is critical. To avoid bunching of the strip 10' as it is cut, at high speed, at least a portion of such strip should come under the influence of the pneumatic stream before the strip is totally removed from its initial first path P-1. In order to do this, the cutting knife 35, illustrated in FIG. 3, which is propelled at high velocity at the instant the divertor or thrusting means 31 thrusts the strip 10' into the entrance opening of the tube 41, is provided with the extended, sharpened point 38. This point punctures the central portion of the strip 10', as shown in FIG. 4, followed by angular cutting of the leading edge or extended tongue 10'' of the strip 10'.

The tongue 10'' is picked up by the air stream and carried into the pneumatic tube 41 while the strip 10' continues to be pulled along the initial path P-1 by tails 10'''. The length of the tongue 10''', as shown in FIG. 4, is determined primarily by the speed of the strip and the angle of the edge 37 of knife 35. The more acute the angle, the longer the tongue 10''' and more effective the pickup by the air stream. As the tails 10''' become very narrow the leader strip 10' separates from the first path P-1 and follows the second path P-2 through the pneumatic moving means 40.

The leader strip 10' is conveyed from one tube 41 to the next in the second path P-2 until it finally moves into operative relationship with the strip second threadup device 50 which threads the leader strip 10' onto the windup roll 61 by pneumatically and mechanically guiding it into engaging, wrapping, contact therewith, as has been explained.

The leader strip 10' is moved along the second path P-2 at relatively low tension until it is engaged by the windup roll 61. While the main portion of the web 10 continues along the first path P-1 to the shredder 13, the speed of the roll 61, which was preset before the automatic sequence started, applies an increased tension to the leader strip 10'. This causes the strip 10' to be pulled out of the tubes 41 by way of the slots 45 therein onto the guide rolls 15 and 16, so that it, the strip 10', now is moving along path P-3 which constitutes the final operating path. These rolls together comprise the process rolls of the apparatus and the path P-3 is the process path. After a short delay (3 seconds), the lead screws of the traversing slitter knives 21 are activated and, as shown in FIGS. 13 and 14, the slitter knives 21 begin lateral movement toward the margins of the web 10 to form or restore the full width web.

When the knives 21 have traversed to past the margins of the web, as shown in FIG. 15, full width has been established and web 10 is wound onto the core of the web windup 60 or to another work means. This completes the critical web threadup sequence of this invention with the full web 10 now moving in the process path P-3 defined by the process rolls 14, 15, 16, 63 and 64.

The final operation takes place when the idler roll 64 is pivoted into contact with the web 10 to draw it into contact with the tension sensing roll 63. From this point on the web is moving in its windup the path P-3 and the web winding operation is continuous thereafter.

**METHOD**

Briefly, the web handling method of this invention including the method of threading a strip of plastic film into a pneumatic moving means and onto a windup roll and winding a web from which the strip is formed thereon includes the steps of moving the web continuously at a first speed along a first path by first moving means; slitting the web as it moves in the first path to form a leader strip; moving the leader strip along the first path by the first moving means; thrusting, then cutting, then pulling the leader strip to divert it from the first path and thread it into a pneumatic second moving means including at least one pneumatic strip transport tube having a strip removal slot therein; moving the leader strip at the first speed by the second moving means along a second path through the tube; guiding the strip into threadup position with respect to a windup roll; connecting the strip in this position to such windup roll thereby to thread it therewith; increasing the tension on the leader strip at least momentarily by moving it at a second speed greater than the first speed to pull the leader strip from the slot in the tube or tubes and position it in a third process path; moving the strip at the first speed in the third path; restoring the strip to a full width web; and,
winding the full width web onto the windup roll.

15

I claim:

1. A material handling method including the steps of:

moving a web along a first path by first moving means;
forming a leader strip in the web as it moves in the first path;
cutting the leader strip completely and transversely thereby forming a leading edge and diverting the leader strip thereby to thread the leading edge of the strip into a pneumatic second moving means;
moving the strip in a second path by means of the second moving means;
guiding the leading edge of the strip as it leaves the second moving means into contact with the surface of a windup roll;
connecting the strip to such surface thereby to thread the strip onto such windup roll;
pulling the strip from the second moving means and into a third path by increasing the tension on the leader strip at least momentarily;
expanding the strip into web width; and
winding the web so expanded onto the windup roll.

2. The method of claim 1 wherein the material is plastic film.

3. A method of threading a strip into a pneumatic moving means and onto a windup means and of winding a web connected to the strip upon such windup means including the steps of:

moving the web continuously at a first speed along a first path by first moving means;
slitting the web as it moves to form a leader strip;
moving the leader strip along the first path by the first moving means;
cutting the leader strip completely and transversely and threading it into a pneumatic second moving means including at least one pneumatic strip transport tube having a strip removal slot therein;
moving the leader strip at the first speed by the second moving means along a second path through the tube;
guiding the strip into threadup position with respect to a windup roll;
connecting the strip in this position to such windup roll thereby to thread it thereupon;
increasing the tension on the leader strip at least momentarily by moving it at a second speed greater than the first speed to pull the leader strip from the slot in the tube and position it in a third process path;
moving the strip at the first speed in the third path; expanding the strip into web width; and
winding the web so expanded onto the windup roll.

4. The method of claim 3 wherein the material is plastic film.

5. A material handling apparatus including:

first moving means for moving a web along a first path;
means for forming a leader strip in the web as it moves in the first path;
means for cutting the leader strip completely and transversely thereby to form a leading edge and threading the leading edge of the strip into a pneumatic second moving means for moving the strip in a second path;
means for guiding the leading edge of the strip as it leaves the second moving means into contact with the surface of a windup roll;
means for connecting the strip to such surface thereby to thread the strip onto such windup roll;
such winding roll adapted to pull the strip from the second moving means and into a third path;
means for expanding the strip into web width; and
the windup roll being rotatable for winding the web onto such windup roll.

6. The method of claim 5 wherein the material is plastic film.

7. An apparatus for threading a strip into a pneumatic means and onto a windup means and for winding a web connected to the strip upon such windup means including:

first moving means for moving the web continuously at a first speed along a first path;
means for slitting the web as it moves to form a leader strip;
such first moving means adapted to move the leader strip along the first path;
means for cutting the leader strip completely and transversely, then threading the leader strip to divert it from the first path and into a pneumatic second moving means including at least one pneumatic strip transport tube having a strip removal slot therein;
the second moving means adapted to move the leader strip at the first speed along a second path through the tube;
means for guiding the strip into threadup position with respect to a windup roll;
means for connecting the strip in this position to such windup roll thereby to thread it thereupon;
means for increasing the tension on the leader strip at least momentarily by moving it at a second speed greater than the first speed to pull the leader strip from the slot in the tube and position it in a third process path;
the windup roll being rotatable for moving the strip at the first speed in the third path;
the means for slitting the web being movable outwardly for expanding the strip into web width; and
the windup roll being rotatable for winding the web so expanded onto the windup roll.

8. The method of claim 7 wherein the material is plastic film.

9. Apparatus for winding a plastic web comprising:

means for moving the web in a first path; a slider with traversing means for moving laterally a pair of vertically actuable knives for forming a leader strip from the web;
first strip threadup means for cutting completely and transversely the strip and thereby forming a leading edge diverting its leading edge into a first pneumatic strip transport tube located opposite the first strip threadup means thereby to initiate strip tube threading;
at least a second strip transport tube downstream of the first strip transport tube and the tubes defining a second path and being suitably contoured generally to follow a final process path of the web, each tube comprising a converging pickup horn at the input end of the tube defining an extreme opening for facilitating
entry of the leading edge of the strip into the tube;
a flared exhaust nozzle at the exit end of the tube
defining an exit opening therein for snag free re-
moval of the strip therethrough;
a slotted eductor jet interposed in the tube near the
exhaust nozzle for supplying a stream of high ve-
locity fluid parallel to the tube wall;
means defining a continuous slot in each tube for
removal of the strip from the tube;
a flap for closing each slot;
second strip threadup means including means for
guiding the leading edge of the strip into contact
with a windup roll and connecting it thereto;
the windup roll being movable at a preset speed for
pulling the strip through the slot of each tube and
onto process rolls defining the process path;
means for expanding the strip into web width; and the
windup roll being rotatable for winding the web so
expanded onto the windup roll.

10. An apparatus for winding a web onto a windup
roll including:
first moving means for moving the web along a first
path;
means for forming a leader strip in the web as it
moves in the first path;
means for cutting the strip thereby forming a leading
edge and means for threading the strip into a pneu-
matic second moving means including at least one
tube having a slot therein for moving the strip in a
second path;
means for threading the leading edge of the strip onto
a windup roll;
means for pulling the strip from the slot in second
moving means and into a third path and moving in a
third path; and
the means for forming the leader strip being moveable
laterally for expanding the strip into web width
whereafter the windup roll moves the web so ex-
panded along the third path and winds the web onto
the windup roll.

11. The apparatus of claim 10 wherein the material
is plastic film.

12. The apparatus of claim 11 wherein the second
moving means includes at least two strip transport
tubes spaced from each other and shaped and posi-
tioned to conform to process configuration and
wherein each tube has a strip removal slot therein,
which slots face the third path of the full width web.

13. The apparatus of claim 11 wherein the leader
strip is pulled by increasing the tension thereon at least
momentarily from the transport tubes through the slots
therein and onto process rolls defining the third path.

14. The apparatus of claim 12 wherein the second
moving means is a series of pneumatic strip transport
tubes spaced apart from each other and wherein the
exit of one tube is operatively aligned with the pickup
horn of the next-in-line tube, each of the tubes being
equipped with eductors.

15. An apparatus including:
pneumatic means for moving a leader strip including
a tube having means defining an exit opening therein;
a windup roll threadup device positioned adjacent
such exit opening and such windup roll and includ-
ing:
a strip guide chute having a curved inner surface,
spaced flexible members connected to such chute at the lower edge thereof, such members
being in contact with parts of the lower surface
of the windup roll and the spacings enabling air
flow from the tube to pass therethrough and be-
tween the chute and such lower parts of the
windup roll surface after being deflected and
guided by the curved inner surface of the chute
whereby the leading edge of the strip is trans-
ported by the air flow from the exit opening into
contact with the windup roll; and
means to connect the leading edge of the strip to
the surface of the windup roll after such contact.

16. A windup roll threadup device including:
pneumatic moving means including a tube for mov-
ing a strip therethrough, said means having an exit
opening;
a windup roll;
a strip guide means positioned adjacent the exit
opening of the pneumatic moving means, such
guide means having a curved inner surface the
upper portion of which is opposite the exit opening
of the pneumatic moving means and the bottom
portion of which is adjacent and below the lower
surface of the windup roll, such guide means hav-
ing flexible members at the lower edge thereof in
contact with parts of the lower surface of such roll
whereby air flow from the pneumatic means blows
the leading edge of the strip being moved there-
through onto the inner surface of the guide means
and such air flow continues through the flexible
members of the guide means to blow the strip onto
the lower surface of the windup roll; and
means for connecting the leading edge of the strip to
the windup roll.

* * * * *