Feb. 1, 1966

R. H. DRIES ET AL

3,232,808

METHOD AND APPARATUS FOR PRODUCING LOOSE-LEAF REINFORCED SHEETS

Filed Aug. 16, 1962

5 Sheets-Sheet 1

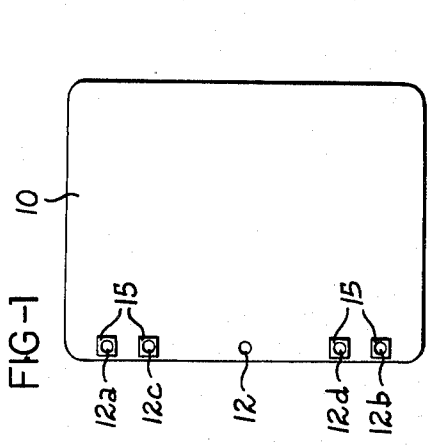

FIG-1

FIG-2

FIG-2A

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5 Sheets-Sheet 2

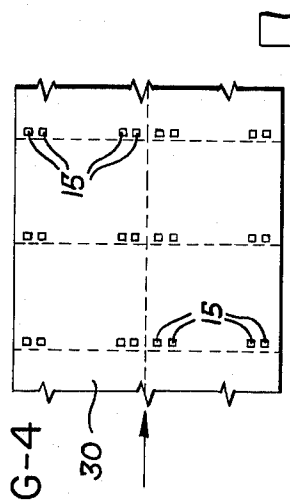

FIG-4

FIG-3

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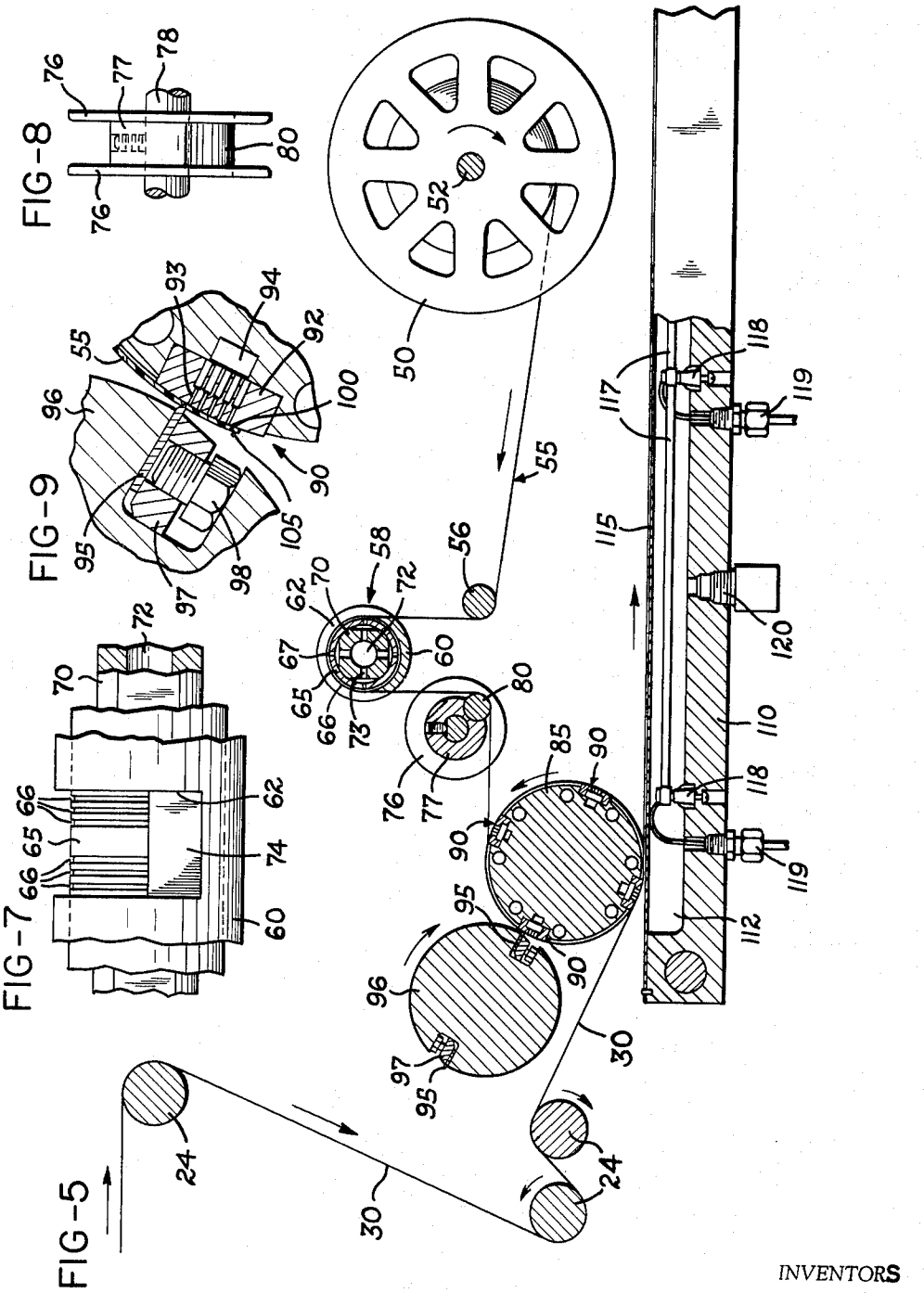
5 Sheets-Sheet 3



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5 Sheets-Sheet 4

FIG-6

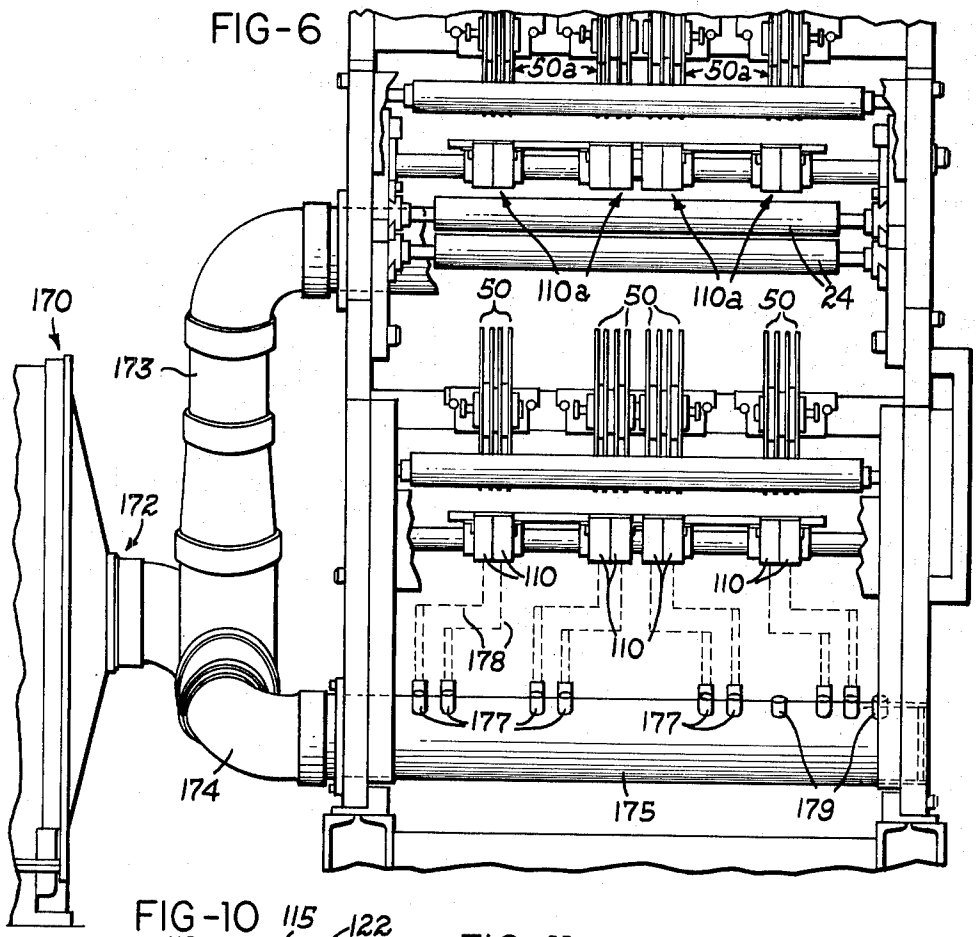


FIG-10

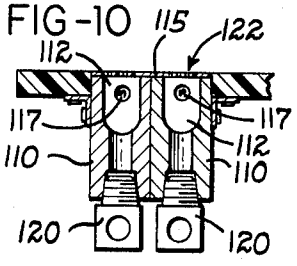
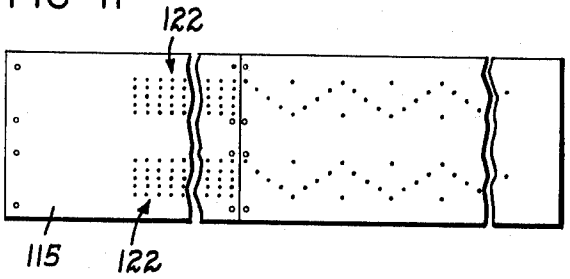


FIG-11



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5 Sheets-Sheet 5

FIG-12

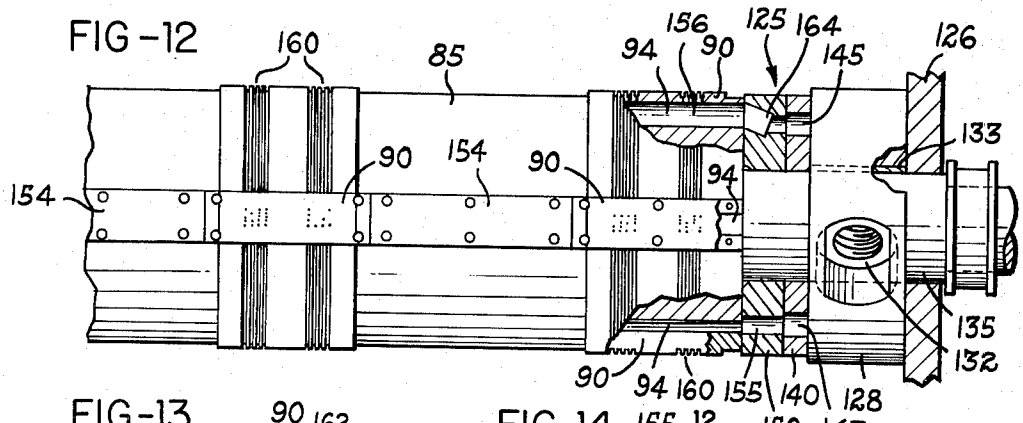


FIG-13

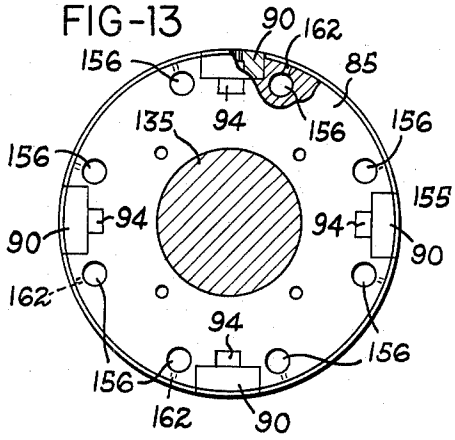


FIG-14

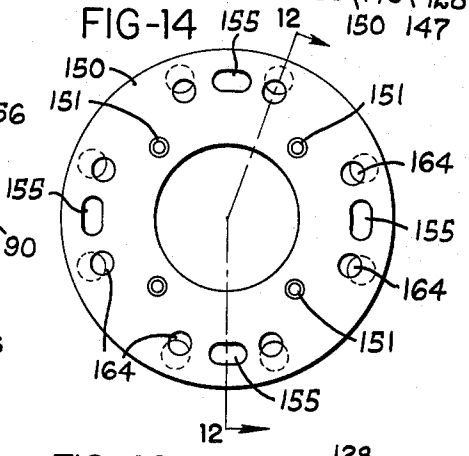


FIG-15

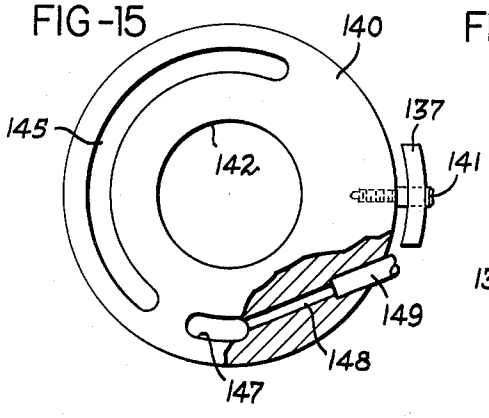


FIG-16

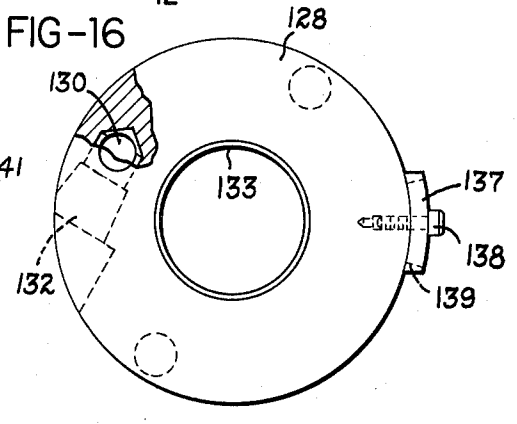
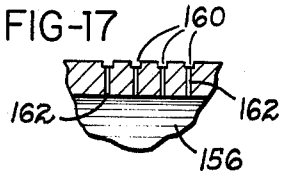


FIG-17



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United States Patent Office 3,232,808 Patented Feb. 1, 1966

3,232,808

METHOD AND APPARATUS FOR PRODUCING LOOSE-LEAF REINFORCED SHEETS

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Filed Aug. 16, 1962, Ser. No. 217,439
8 Claims. (Cl. 156—253)

This invention relates to a novel method and novel apparatus for producing loose-leaf sheets of the type having holes punched in a predetermined pattern along an edge or margin of the sheet, in which such holes are reinforced to insure long life of the sheets when engaged with a loose-leaf binder, particularly by avoidance of tearing the edge of the sheets engaged with the binder rings or similar apparatus.

The present invention is particularly directed to the so-called converting operation in which loose-leaf sheets, for example in the form of individual sheets as supplied in packets or packages, are provided from a relatively large and continuous web of sheet material, such as paper, which is supplied initially in a large roll. Broadly, the method and apparatus of this invention relate to the subdivision of this long web or roll of sheet material into individual sheets, a predetermined margin of which has been punched or formed with holes in a certain pattern for the purpose of engaging the rings of a loose-leaf binder or similar apparatus. Such sheets are particularly well known to be used by school children, although of course they are by no means limited to this particular use.

According to the invention a relatively large roll of sheet material, in the illustrated example a roll of paper, is unreeled and guided along a predetermined path in the form of a web, of single thickness, drawn from the roll and driven at relatively high linear speed. At predetermined areas on the web a patch of reinforcing material, preferably though not necessarily heat sealable, is placed upon the web and is adhered thereto to form a lamination or reinforced area which is subsequently punched or similarly formed with a hole, such areas subsequently becoming a predetermined margin of sheets which are cut from the traveling web.

Thus, the primary object of this invention is to provide a novel apparatus by means of which reinforced loose-leaf sheets, of paper or like material, are formed from a relatively long web of the material.

Another important object of this invention is to provide a novel method by means of which reinforced loose-leaf sheets are formed from a large web of sheet material.

Another important object of this invention is to provide a novel loose-leaf sheet, for example of the type which is supplied in packets or pads of sheets of this type, and in which the holes or perforations formed to engage the loose-leaf binder apparatus are reinforced to enhance the resistance of the loose-leaf sheets to tearing from the binder apparatus, and in which such reinforcement is limited to the immediate area of the holes or perforations in the individual sheets.

Another object of the invention is to provide novel apparatus for the aforestated purpose, in which the patching or reinforcing laminate material is supplied in the form of a continuous, or substantially lengthy, strip of material of a width corresponding to the width of the desired patch, together with apparatus for cutting such material into patches of the desired size for reinforcement, in combination with applicator apparatus which removes such patches from the supply of reinforcing material and applies the patches to a moving web of paper or the like at essentially the same speed at which the web is driven, and, in the case of heat sealable patches, apparatus for retaining the patches upon the web in the exact position at which they are placed while heat sealing of the reinforcing patches to the web is effected.

Another important object of this invention is to provide novel apparatus for applying reinforcing patches to the area of the holes of loose-leaf paper sheets, in which the patches are applied to areas of a continuously moving web of sheet material which are predetermined to become the areas where the holes or perforations are formed in one margin of the sheets to be cut from the web, and in which such patches are securely and permanently fastened, as by passing through nip rolls, so as to become effectively a thin reinforcing laminate which reduces the tendency of the sheet material to tear when binder apparatus is engaged with the holes formed through the reinforced patches.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawing:

FIG. 1 is a view of a typical reinforced loose-leaf sheet which is the end product of the present invention;

FIG. 2 is a perspective view, diagrammatic in form, which shows the overall arrangement of apparatus in accordance with the invention;

FIG. 2A is a view similar to FIG. 2, showing the manner in which the apparatus can be combined with conventional ruling and sheeting devices;

FIG. 3 is a side elevational view, on a somewhat larger scale than FIG. 2, showing the essential parts of the apparatus and the drive therefor;

FIG. 4 is a plan view of the segment of the web material, showing a typical manner in which reinforcing patches are applied to the moving web, and showing in dotted outline the ultimate sheet form into which the web is cut to produce the loose-leaf sheet product;

FIG. 5 is a side view on an enlarged scale, partly in section, showing details of the patch applicator, vacuum retainer, and heat sealing apparatus in accordance with the invention;

FIG. 6 is a sectional view taken generally through the entrance end of the apparatus, as viewed from the left of FIG. 5, and illustrating the feed reels for the reinforcing material to show a typical multiple arrangement thereof, as well as showing the manifolding for the vacuum connections to the apparatus and a preferred arrangement whereby two webs of sheet material are patched and subsequently formed into loose-leaf sheets simultaneously;

FIG. 7 is an enlarged and broken view, with a portion shown in section, of the feeder mechanism for the strips of reinforcing material;

FIG. 8 is an enlarged end view of one of the guide structures for the reinforcing strips;

FIG. 9 is an enlarged sectional view of one of the gripper heads on the applicator drum, showing also details of the cut-off knife which cooperates with the gripper head to sever the patch from the strip of reinforcing material;

FIG. 10 is a detail sectional view, on an enlarged scale, showing a cross-section of a pair of the vacuum retainer mainifolds which act through the moving web to hold an applied patch properly in the position in which it is applied to the web during the heat sealing operation;

FIG. 11 is a broken detail view, on a larger scale, showing a suitable arrangement of the face plate of the vacuum manifold retainer, which is also a part of the structure used to effect the heat sealing;

FIG. 12 is an enlarged detail view, with certain parts broken away and shown in section, illustrating the structure of a suitable applicator drum with gripper heads thereon;

FIG. 13 is a sectional view taken through one end of the applicator drum, with a segment broken away and shown in section, illustrating the arrangement of gripper heads about the periphery of the drum;

FIGS. 14, 15 and 16 are views on essentially the same scale, with parts broken away and shown in section in FIGS. 15 and 16, illustrating details of the rotary valving mechanism by means of which a retaining or guiding vacuum is directed to surface portions of the applicator drum and a vacuum for gripper purposes is directed cyclically to the gripper heads; and

FIG. 17 is a detailed sectional view of the vacuum retainer structure which extends about the applicator drum from one gripper head to the next.

Referring to the drawings, and particularly to FIG. 1, this figure shows a typical loose-leaf sheet **10** which is the ultimate product of the present invention. For purposes of illustration the sheet is shown as having five holes or perforations **12** formed therein, whereby the sheet will be accommodated in standard two-ring or standard three-ring loose-leaf binders. It should be understood, however, that the present invention is not limited to this particular type of sheet, but can be applied with equal facility to the manufacture of sheet suitable only for two-ring or for three-ring binder use, and also to sheets wherein the binder holes are at some other edge part of the sheet than the side shown. However, as a typical example the sheet shown in FIG. 1 is universally applicable to a wide variety of loose-leaf binders. The outermost holes, designated **12***a* and **12***b*, would be those engaged with the upper and lower retainer rings of a three-ring binder, and these holes are provided with reinforcing patches **15** in accordance with the invention, it being unnecessary and often undesirable to reinforce the center hole for this purpose. Since the sheet is also applicable to two-ring binders, the inner pair of holes **12***c* and **12***d* are also provided with patches **15**, these being the holes which would be operative when the sheet was placed in a standard two-ring binder.

In accordance with the invention the normal loose-leaf sheet is reinforced by application or lamination of the reinforcing patches to the above described holes only. Thus, the invention effects a considerable economy of product, since the relatively expensive reinforcing material, for example transparent plastic such as a commercially known Mylar film or its equivalent, is relatively expensive in comparison to the paper or like material from which the sheets are normally formed. It should also be noted that the sheet **10** is illustrated, for purposes of example, as a plain or unruled sheet. The present invention, however, is also fully applicable to ruled sheets as well, as will be apparent from the following description.

Thus, referring to FIG. 2 and FIG. 2A the sheet material, preferably or usually in the form of a roll **20** of paper, is unreeled over a plurality of guide rolls **22** and directed to a turning bar **23** over which the web is threaded and passed about the entry guide bars **24** of the apparatus provided by this invention. It should be understood that conventional drives for rotating the roll **20**, to overcome for example the inertia of the roll and to assure proper unrolling thereof, may be provided by any suitable conventional drive mechanism. From the guide bars **24** the web is passed to an applicator station, indicated by a general reference numeral **25**. It is at this station that the patches of reinforcing material are placed in predetermined proper position upon the traveling web **30**, which is being unrolled, under drive, from the roll **20**. Details of the applicator device are described hereafter.

Immediately following the applicator section, the web passes through a sealer section, indicated by the general reference numeral **32**, and from this section the web is threaded about a pair of guide bars or rolls **33** to extend between the entrance guide rolls **34** of a punching or hole forming mechanism, shown in its preferred embodiment as a rotary punch designated by the general reference numeral **35**. From the punching or hole forming section, the web may pass into a ruling apparatus **38** of conventional design and the details of which form no particular part of the present invention. It should be mentioned, however, that the drive for the ruling mechanism **38** is correlated to the drive for the remainder of the apparatus, as will be noted. It is also possible to rewind the web at this point and to pass the patched and perforated web through conventional ruling and/or sheeting apparatus at a different location.

From the ruling apparatus **38** the web **30** passes to cutter or sheeting mechanism including a slitter **40** and a rotary cutter **42**, which serve to sever the web **30** into a plurality of individual sheets, the resultant being the end product loose-leaf sheets which include the reinforced perforations or holes in the predetermined areas along one edge of the sheets.

It will be noted, particularly from FIGS. 2 and 3 of the drawing, that the present invention contemplates processing of two webs of paper or other sheet material simultaneously. Thus, the other or upper web **30***a* is fed into duplicate applicator apparatus at the station **25***a* over a guide roll or bar **24***a*. The web **30***a* then passes through sealer section **32***a* and over exit guide rollers **33***a* to meet with the web **30** in the area between the guide rollers **34**. The two webs then move together, in contact, and the timing of the applicator apparatus **25***a* is directly related to the applicator mechanism **25** such that the patches on the web **30***a* will overlie directly the patches on the web **30**. The two webs are moved together through the hole forming mechanism or punch **35**, after which the webs can be separated for rewinding, as mentioned, or to pass through the ruling apparatus **38**, and they can be again joined in the cutter mechanism where the webs are simultaneously divided into the individual loose-leaf sheets.

Thus, except for certain showings as in FIG. 3 to relate the arrangement of the upper and lower applicator and sealer mechanisms, it will be assumed that details of these two mechanisms are the same, and the detailed description is hereafter concerned with the details of the lower applicator and sealer mechanism only.

The general operation of the applicator means is as follows. A continuous film or the like, preferably a heat sealable material, for example a transparent film-like material known commercially as Mylar, is supplied in relatively long large rolls which are in turn mounted in suitable reels **50**. There is one reel **50** for each patch to be applied to a sheet, and in a preferred embodiment of the invention a web **30** is of sufficient width to form two sheets therefrom. Accordingly, as shown in FIG. 6, there are eight such reels **50** mounted so as to be freely rotatable about suitable axles **52**, which are shown both in FIG. 6 and in FIG. 5. The film, designated by the general reference numeral **55**, is threaded from each reel **50** over a stationary guide rod **56**, and thence over a feeder control or drive mechanism being provided for the purpose of unreeling the film **50** at a predetermined uniform speed. The unreeling mechanism includes the following members.

A stationary elongated cylinder member **60** (FIG. 7) is mounted across the path of travel of the web **30**, and considerably above the web as shown particularly in FIG. 5. In the portions of this cylinder member where the films **55** are to pass over, there are slots **62** which are of a width corresponding to the width of the film. In FIG. 7, an area is shown wherein the slot **62** is a little more than twice the width of a film **55**, since this corresponds to an area where two films from adjacent reels **50** (FIG. 6) are passed over the feeder mechanism. Within the cylinder **60** there is a rotary feed cylinder **65**, and in the areas where the film is to engage the cylinder there are a number of circumferential slots **66** which are connected through radially directed holes or passages **67** to the interior of the rotating member **65**. Within this member, providing a stationary support and also a con-

venient direct source of vacuum, there is a stationary mounted bar or rod **70**, preferably having the appearance in cross section as shown in FIG. 5.

This bar is of generally square cross-sectional configuration having the corners thereof rounded off according to the inner diameter of the cylinder **65**. A central vacuum supply passage **72** extends through the bar member **70**, and is connected to a suitable source of vacuum (described further on) which in turn is transmitted through the outward extending passage **73** to the interior of the cylinder **65**, from whence the vacuum is applied through the passages or holes **67** to the slots **66** on the feeding cylinder. In this manner, since the circumferential guide slots **62** are provided with flat end faces **74**, the film **55** extends over these faces and provides a running seal with the passages **66** whereby the vacuum is exerted directly on the film **55** and the rotating cylinder **65** is caused to feed the film forward at the predetermined speed of rotation of the cylinder.

From this feeding mechanism each film extends to a forward guide apparatus provided by a pair of side plates **76** mounted on a hub **77**. This hub in turn is supported on a cross rod **78**, and each hub carries a normally stationary guide rod or stub **80** over which the film **55** is threaded. From this guiding apparatus the film is passed forward to the applicator means, which includes as part of its mechanism the rotating applicator drum **85**. This drum is driven, in the direction shown by the arrow in FIG. 5, at a rate such that its peripheral speed corresponds to the linear speed of the moving driven web **30**. Thus, as patches of the reinforcing material are severed and guided onto the moving web **30**, the speed at which the patches are applied will be essentially the same as the speed of the moving web, there being practically no relative velocity therebetween, and thus essentially no relative movement between the patches and the web.

The applicator mechanism, as noted, includes the drum **85**, and in this drum there are a plurality of gripper means or members, preferably in the form of vacuum gripper heads. Details of one such head are shown in FIG. 9, while other portions of this head are shown also in FIG. 13. The gripper heads are designated by the general reference numeral **90**. Each of them includes the body or block **92** having a plurality of vacuum gripper passages **93** extending transversely through the block, and opening on the inner face of the block into a vacuum passage **94** which extends transversely, or (as viewed) along the drum **85**, with such passages being connected through suitable valving to the vacuum source. Details of the valving are explained further on.

The gripper block **92** is formed of relatively hard material, such as hardened steel, since it serves also as a backup plate or die plate against which the cutoff knife **95** acts to sever patches from the moving film **55**. The knife is mounted in a rotary cutoff drum **96** which, as shown in FIG. 5, is driven in the opposite direction from applicator drum **85**, and of course at the same speed. Preferably there are two such cutoff knife members **95**, at opposite sides of the drum **96**. Each includes the replaceable blade **95** and a clamping block **97** which is urged against the knife blade by an adjusting bolt **98**. Other equivalent cut-off means can also be used, such as a heated wire contacting the film at appropriate intervals.

As the knife blade engages the gripper body or block **92** it functions to sever a patch **100** (FIG. 9) from the film **55**. It will be understood that this is one of the patches **15** shown in FIG. 1 applied as a reinforcement patch to the loose-leaf sheet **10**. At this point passage **94** is connected to the vacuum source, in a manner to be explained, and thus the patch **100** is held on the vacuum gripper head **90**. As the knife blade is carried away from the gripper head block **92**, it may under some circumstances tend to carry the trailing edge of the patch **100** with it, and to avoid this and assure that the patch remains properly against the vacuum gripper head, a stripper wire **105** (FIG. 9) extends between the applicator drum **85** and the cutoff drum **96**, immediately beyond the nip therebetween.

The leading or forward edge of the patch **100** is held against block **92**, and it passes underneath the wire **105**. If the trailing edge of the now severed patch tends to follow the knife **95**, the wire will hold the patch away from the knife and assure that it remains properly on the gripper. The remainder of the film **55**, being constrained to move at a considerably lesser speed than the peripheral speed of the drums, will lag behind, and thus the gripper head will carry the severed patch away from the film and apply the patch to a predetermined area of the web **30**.

As shown particularly in FIG. 5, immediately after the gripper head with the patch carried thereon contacts the web, the web is guided over an elongated heater and retainer means, which is a part of the applicator mechanism, and which functions to hold the patch in position on the web as the gripper head is caused to release the patch onto the web. The heater and retainer apparatus includes a frame **110** provided with a number of elongated cavities **112** corresponding to the number of patches to be applied across the web. Each of these cavities is provided with a removable cover plate **115**, preferably of thin rigid metal such as brass which has good heat transmission characteristics but will retain its flat configuration. Within the cavities there are mounted infrared quartz heating elements **117**, carried on a plurality of insulator mountings **118**, and connected to a suitable energizing source of electricity (not shown) through the connectors **119**.

The cavities **112** are in turn connected through a suitable fitting **120** to a vacuum source, and the cover plates **115** are provided with a series of relatively small holes **122** (FIGS. 10 and 11) which connect the upper surface of these plates over which the web **30** is guided to the lower pressure section in the cavities. A retaining vacuum is thus exerted on and through the traveling web **30** tending to hold the patches **100** in the position where they were applied to the traveling web while heat radiates through the web and serves to heat seal the patches to the opposite or upper surfaces of the web **30** as viewed in FIG. 5. In some instances, heating may be accomplished from above the web, as by radiation directly onto the web and the patches thereon, but with the Mylar film described heating from below is preferred.

In a preferred emobdiment of the cover plates **115**, there are individual "tracks" or paths of the holes **122**, the holes being greater in number in the end of the plates toward the applicator drum, and decreasing in number along the direction of travel of the web. Also, the holes may be staggered along these paths in a ziz-zag configuration, as shown in FIG. 11, to induce a straightening of squaring action on the patches in the event that the patches might not be precisely aligned on the web when released by the applicator mechanism. This configuration is not an essential feature, as the apparatus has been found to function with complete satisfaction without this zig-zag pattern.

The web then passes between nip rolls **123** which press the patches against the web to assure a complete bonding of the patches to the web. A stream of cool air may be directed against these nip rolls to blow off any patches which might have been picked up by them. This cool air also serves to keep these nip rolls at a considerably lower temperature than the patch and web so that a brief chilling effect on the patches is obtained. This chilling can also be obtained, or enhanced, by using fluid cooled hollow nip rolls.

This means for controlling the connection of the vacuum gripper heads **90** is in the form of a rotary valve apparatus indicated in FIG. 12 by the general reference numeral **125**. The side frame member **126** of the machine provides a mounting for the satisfactory

or supply plate **128** of the valving mechanism, details of this plate also being shown in FIG. 16. It includes the vacuum supply passage **130** and a fitting shown generally at **132** by means of which a flexible hose coupling or the like can be connected thereto, such hose extending to a vacuum supply manifold (to be described later). As shown in FIGS. 12 and 16 the supply plate **128** is fitted with a bearing sleeve **133** which also provides support for the drive shaft **135** of the drum **85**.

The supply plate **128** is fastened in any suitable manner to the side frame **126**, and a bracket support bearing **137** (FIGS. 15 and 16) is fastened to the plate **128** by a bolt **138**. It should be noted that this bolt extends through an elongated slot **139** (FIG. 16) in the bracket **137**, such that the bracket can be adjusted to some extend along the periphery of the stationary supply plate **128**. The valving plate **140**, details of which are shown in FIG. 15, is carried by the bracket **137**, being fixed thereto by a bolt **141**. This plate **140**, since it is stationary during normal operation, is provided with a central opening **142** which will fit over the shaft **135** and permit free rotation of the shaft therein. A vacuum supply and control slot **145** is formed about a substantial portion of the valving plate **140**, such slot being formed on an arc which is concentric with the central hole **142** (and thus with the shaft).

The slot **145** preferably extends over slightly less than 180°, and it is always in communication with the vacuum supply passage **130** in the supply plate **128**. Adjacent the bottom of the plate **140** there is a separate pressure air supply slot **147** connected by a passage **148** to an externally projecting fitting **149** which may be connected to a source of air under pressure. The slots **145** and **147** are formed on the same radius, and thus will serve to connect the gripper heads **90** first with a source of vacuum, and then to a source of air under pressure, in the desired sequence.

To perform this function, the drum **85** carries a rotary valving plate **150**, details of which are shown in FIG. 14. This plate is fastened to the end of the drum **85** by one or more bolts **151**. The end of the drum **85** which receives the plate **150** is shown in FIG. 13, and the face configuration of the plate **150** is shown in FIG. 14. Thus, the drum is formed with the four (preferably) longitudinal extending passageways or slots **94**. Over these are mounted the gripper heads **90**, as shown in FIGS. 12 and 13, and in the sections between gripper heads suitable covers **154** seal the passage. Each of the passages **94** terminates at the rotary valving plate **150** in communication with a corresponding vacuum supply slot **155**, and these slots in turn will communicate with the stationary vacuum supply passage **145**, and, later on during rotation of the plate **150** (counterclockwise as viewed in FIG. 14) with the pressure supply passage **147**.

On opposite sides of each passage **94** in the drum **85** there are further vacuum supply passages formed, for example, as extended bores, all designated by the reference numeral **156**. In the areas where the gripper heads **90** are located the drum **85** has a plurality of circumferential grooves **160** formed therein, details of these grooves being shown in FIG. 17. Each groove is provided with a connection to all the passages **156** through small connecting passages **162**, and the passages **156** in turn lead at their ends into corresponding passages **164** in the rotary valving plate **150**. These passages in turn connect with the vacuum supply slots **145** to form a connection directly between the supply passage **130** on plate **128** and each of the grooves **160**, constituting a vacuum holding arrangement over a substantial extent of the slots **160**. The film **55** extends over these slots, particularly as shown in FIGS. 5 and 9, and a "sliding vacuum" arrangement obtains which holds the film in contact with the drum **85** and in proper alignment thereon for subsequent pickup by one of the heads **90**.

Thus, there will be an arrangement of slots **160** and corresponding pickup heads **90** for each of the film supply reels **50**, and the number of these arranged across the apparatus will vary according to the type of sheet end product desired. For example, if four holes are to be reinforced on each sheet, since the web ordinarily runs two sheets in width as shown in FIG. 4, then there will be eight such reels and pickup heads with attendant apparatus properly spaced across the machine, and eight patches will be placed on the moving web simultaneously, as shown in FIG. 4. Obviously, this number can be changed as desired.

Each film **55** threads over the vacuum retainer or tensioning apparatus **58** and passes thence over the guide members **80** onto the surface of the rotating applier drum **85**, the end of each film laying over (and part way around as shown in FIG. 5) a corresponding set of grooves **160**. The vacuum applied through these grooves tends to pull the film forward, but does permit slipping. On the other hand, the gripper heads **90**, once a patch has been severed from the film **55**, provide a positive gripping action on the patch, as previously described and as shown in FIG. 9, and thus the gripper head will carry the patch forward once it is severed, accelerating it with respect to the film **55** and applying the patch to the proper area of the moving web **30**.

Essentially at this time the pressure air supply through slot **147** (FIG. 15 and plate **140**) will be connected to that passage **94** of the gripper heads then carrying the patches, which have just contacted the web. A relatively short "burst" of air under pressure will thus be applied through the gripper heads **90** to assure that the patches are released onto the moving web **30**. The adjustment of bracket **137** on the stationary plate **128** provides for sufficient circumferential adjusting movement of the stationary valving plate **140** to attain the proper timing of this positive air pressure supply, and also to assure proper timing of the cutoff of the vacuum to the gripper heads, when the corresponding passage **155** moves beyond the lower end of the vacuum supply slot **145**.

The arrangement of conduits for supply of vacuum to the various parts of the apparatus is shown in FIG. 6. A suitable power driven vacuum pump, parts of which are shown at **170**, has its inlet **172** connected to a pair of vacuum manifold pipes **173** and **174**. These are of like size, one extending to the bottom half of the apparatus and the other extending to the top. As in the previous description, only the bottom portion will be explained in detail, with the understanding that the top half is in all essential respects a duplicate of the bottom. Thus, the manifold pipe **174** connects into the bottom vacuum supply manifold **175**, and it is provided with a plurality of nipples **177** which are connected through suitable conduit, such as flexible hose conduit shown schematically at **178**, to the fittings **120**. Further nipples **179** are connected by suitable flexible hose or the like (not shown) to the fitting **132**. The supply of air under pressure can be obtained from any suitable source, and therefore no specific pump or the like for this purpose is shown, it being understood that whatever air pressure source is used will be connected to the fitting **149** for the purpose previously described.

In order to maintain synchronism of the units, the entire apparatus is driven from a common drive motor, shown schematically at **180** in FIG. 2. This motor is provided with drive shafts **182** and **183**, shown schematically, to the line marking apparatus **38** and to the final cutter **42**, respectively. Likewise, the motor drives a line shaft **185** which is connected through suitable gears **186** to drive the rotary punch **35**, and which is also connected through bevel gearing **188** at its forward end to drive the drum **85** carrying the pickup heads. The cutoff knife drum **96** is gear driven at the same speed as drum **85**, by the gears **189**, and the drive for the feed or supply roller **65** is provided by suitable pulleys providing the desired

speed reduction, these pulleys being connected by timing belts, and the entire speed reduction and feed drive unit being shown schematically at **190**. In order to maintain synchronism of the upper and lower applicator devices, the upper drum **85***a* is driven through the timing belt drive **193**, or its equivalent such as a chain and sprocket drive, and the upper tape feed or supply mechanism is in turn driven from the shaft of the upper drum **85***a*.

It will be seen from the foregoing description that the present invention provides a novel method and apparatus whereby the holes in individual loose-leaf sheets are reinforced as a part of the process of manufacturing such sheets. The sheets of course may be ruled or not, and may have the conventional retainer hole configurations of two, three, or five appropriately spaced holes, or any other desired pattern, in any predetermined margin or margins of the sheet. The applicator apparatus is capable of operating speeds at least equal to punching and ruling machines, and there thus is no need to slow down the operation of these devices for the purpose of applying the reinforcing patches. The patches are applied to the moving web and heat sealed or laminated thereto while the web is moving continuously at high speed, for example at speeds in the order of 300 to 500 feet per minute. The usual size patch is a one-half inch square of transparent heat sealable material, such as a prestressed synthetic film known commercially as Mylar, of about 0.001 inch thickness.

The supply apparatus to the applicator drum operates at significantly slower speed, and the patches are cut from the moving film supply strip and accelerated to the speed of the moving web, such that when the patches are placed on the web there is essentially no speed differential between the patch and the web. Operating at these speeds, any increment or small section of the web material is in contact with the heated plates **115** for only a short period of time, approximately one and one-half to two seconds, and thus these plates can be heated to a normal running temperature in the neighborhood of 420 to 430° F. to achieve proper heat sealing without danger of scorching the web. The heat is preferably applied through the web, i.e., from the side of the web opposite to the applicator mechanism, since this has been observed to prevent curling of Mylar patches and assures a good seal between each patch and the web. The patches are capable of cooling or setting rapidly, such that they are satisfactorily adhered to the web by the time they reach the rotary punching apparatus **35**, and this apparatus can effectively punch the necessary holes through the patches and the web, without stripping the patches from the web as the web travels beyond the rotary punch.

Accordingly, the present invention provides a novel method and apparatus whereby loose-leaf sheets are effectively and economically reinforced using only that amount of reinforcing material necessary to reinforce the areas of the sheets around the retaining holes, and operating at such a rate that the application of the reinforcing patches is comparable to the normal operating speed of ruling and/or punching apparatus.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. The method of manufacturing sheets of paper and the like having reinforced holes for engaging retainers in a loose-leaf binder, comprising the steps of

(a) applying patches of thin reinforcing material to a moving web of paper at predetermined locations of holes in individual sheets to be formed from the web,

(b) holding the patches in their exact place on the web by a vacuum applied to the opposite side of the moving web from the side to which the patches are applied for an extended part of the path of travel of the web,

(c) heating the web during at least a substantial portion of said part of its travel path to bond the patches onto the web,

(d) forming holes through the combined patches and web, and

(e) separating the web into individual sheets.

2. In the manufacture of loose-leaf paper sheets having reinforced holes in the steps comprising,

(a) supplying paper to form the sheets in a continuous web guided along a predetermined path of travel,

(b) supplying at predetermined locations transversely of said web elongated strips of thin reinforcing material,

(c) severing reinforcing patches from said strips,

(d) laying said patches on the moving web spaced lengthwise of said web according to the desired size of sheets,

(e) holding the patches against the moving web in the precise position at which they were applied by creating a differential pressure on the patches tending to hold them in place on the moving web,

(f) adhering the patches to the moving web,

(g) forming holes in the web through all of said patches,

(h) and separating the web into sheets with the reinforcing holes along a margin thereof.

3. The method defined in claim **2**, in which the reinforcing patches are formed of heat-sealable material, including the additional step of

(i) heating the heat-sealable patches by applying heat through the web for a substantial interval after they are laid on the moving web to bond the patches to the web.

4. Apparatus for converting a web of sheet material into loose-leaf sheets having reinforced holes for engaging with a binder apparatus, comprising means for guiding a web of the sheet material to move along a fixed path lengthwise of the web, drive means for moving a web along said path, means forming an applicator section on said path including applicator mechanism adapted to bring patches of reinforcing material into contact with the web at regularly spaced locations therealong, means providing a sealer section immediately beyond said applicator section means in the direction of travel of said web, retainer means in said sealer section operative to maintain the patches in position on the web and to cause sealing of the patches to the moving web, and hole forming mechanism receiving the web passing from said sealer sections means and operating in timed relation to said applicator means to form holes through the patches and web of sheet material.

5. Apparatus for converting a web of sheet material into lose-leaf sheets having reinforced holes for engaging with a binder apparatus, comprising means for guiding a web of the sheet material to move along a fixed path lengthwise of the web, drive means for moving a web along said path, means forming an applicator section on said path including applicator mechanism adapted to bring patches of heat sealable material into contact with the web at regularly spaced locations therealong, means providing a sealer section immediately beyond said applicator section means in the direction of travel of said web, transfer means in said sealer section operative to maintain the patches in their locations on the moving web, heater means operating to heat the web to cause heat sealing of the patches to the moving web, and hole forming mechanism receiving the web passing from said sealer section and operating in timed relation to said drive means and to said applicator means to form holes through the patches and web of sheet material.

6. Apparatus for converting a web of sheet material into lose-leaf sheets having reinforced holes for engag-

ing with a binder apparatus, comprising means for guiding a web of sheet material to move along a fixed path, drive means for moving a web continuously along said path at substantial speed, means forming an applictor section on said path including a rotary applicator drum having a plurality of gripper heads adapted to bring patches of heat sealable material into contact with the moving web at regularly spaced locations therealong, means providing a sealer section immediately beyond said applicator section means in the direction of travel of said web, vacuum retainer means in said sealer section means operative through said web to maintain the patches in their locations on the web, heater means extending adjacent said retainer means and operative to cause heat sealing of the patches to the moving web, hole forming mechanism receiving the web passing from said sealer section means and operating in timed relation to said drive means and to said applicator means to form holes through the patches and web of sheet material, and cutter mechanism receiving the web from said hole forming mechanism and operating to sever the web material into individual sheets with the reinforced holes at a predetermined margin of each such individual sheet.

7. Apparatus for forming loose-leaf sheets having reinforced holes from a relatively long web of sheet material, comprising means for guiding a web of such sheet material along a fixed path lengthwise thereof, drive means for moving a web along said path, a rotary applicator drum driven at a peripheral speed equal to the speed of the moving web and mounted across the path of travel of the web to contact the web, gripper means on said drum, means supplying patches of heat sealable reinforcing material to said gripper means in timed relation to movement thereof against the web, controls for said gripper means causing release of a patch onto the moving web at substantially the same velocity as the moving web, a vacuum retainer manifold extending for a substantial distance lengthwise of said path from said applicator drum, means mounting said manifold on the opposite side of the moving web from said drum to exert a retaining vacuum through the web on patches placed on the web, a heater mounted to heat the parts of said manifold facing the web to transmit sufficient heat into and through the moving web to adhere the seat sealable patches to the web, a rotary punch driven in timed relation to the web according to the spaced placement of the patches for punching a hole through each patch and the area of the web where a patch is adhered thereto, and cutter mechanism receiving the web from said punch and operative to separate the web material into individual sheets with the reinforced holes at a predetermined margin of each such sheet.

8. Apparatus for forming loose-leaf sheets having reinforced holes from a relatively long web of sheet material, comprising means for guiding a web of such sheet material along fixed path lengthwise thereof, drive means for moving a web along said path, a rotary applicator drum driven at a peripheral speed equal to the speed of the moving web and mounted next to the path of travel of the web, gripper means on said drum, means supplying a strip of heat sealable reinforcing material to the surface of said drum, a cutoff knife operating on said strip in timed relation to movement of said gripper means and the web to sever patches from said strip for carrying by said gripper means against the web, controls for said gripper means causing release of the patches onto the moving web, a vacuum retainer manifold extending for a substantial distance lengthwise of said path from said applicator drum and on the opposite side of the moving web from said drum to exert a retaining vacuum through the moving web on patches placed on the web, a heater mounted coextensive with said manifold heating the parts of said manifold facing the web to transmit sufficient heat into and through the moving web to adhere the heat sealable patches to the web, and punch means driven in timed relation to the moving web according to the spaced placement of the patches for punching a hole through each patch and the area of the web where a patch is adhered thereto.

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