HIGH SPEED FOLDING APPARATUS WITH SEPARATED SIGNATURE DELIVERY

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The invention relates in general to high speed printing and is more particularly concerned with apparatus for cutting printed webs and forming them into folded signatures.

It is the general aim of the invention to provide an improved cutting and folding mechanism for producing double (transverse and longitudinal) folded signatures from printed webs coming from a print press at very high speeds.

An important object of the invention is to reduce progressively the traveling speeds of signatures as they are separated into groups and delivered to different points, thereby facilitating the use of slower units, such as chopper folders, to produce the final fold in the signatures.

It is a further object to provide such progressive slowdown of signatures in an arrangement which permits all rotating cylinders of the apparatus to be driven at the same angular speed.

Still another object is to separate the signatures received by a distributing cylinder and send alternate ones toward different delivery points through a novel arrangement of plural gripper means spaced about the cylinder and actuated to pick up signatures at a common angular point but to release them at different angular points.

Other objects and advantages will become apparent as the following description proceeds, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic side elevation of a rotary press equipped with folding apparatus embodying the features of the present invention;

FIG. 2 is a perspective illustration showing an exemplary arrangement of plates on a printing cylinder;

FIG. 3 is a diagrammatic end elevation of the folder employed in the press of FIG. 1;

FIG. 4 is a fragmentary perspective showing the assembly of superimposed printed webs pass are disposed immediately above a pair of first cylinders 34, 35. These first cylinders cut the webs into signature lengths, and fold each such signature along a line transverse to its direction of movement, as will be explained more fully below. Moreover, means are provided, and will be described in greater detail, to transfer alternate ones of such transversely folded signatures from the first cylinders 34, 35 to two distributing cylinders 36, 37 which are disposed adjacent the respective ones of the first cylinders. The distributing cylinders 36, 37 are provided with means to transfer alternate ones of the signatures which they receive to respective ones of two transfer cylinders 38, 39 and 40, 41 which are adjacent such distributing cylinders. The transfer cylinders 38-41, in turn, are associated with means to deliver the signatures which they receive to respective feeding devices 42, 43, 44 and 45 which produce longitudinal folds in the signature.

Referring to FIG. 7, the cylinders 34 and 35 are rotatably driven from the press by means (not shown) which make them have a peripheral speed equal to the linear speed of the web assembly 60 which is passed therebetween. Provision is made to cut the web assembly 60 into successive two page length and to fold such lengths transversely in the middle to form signatures like that illustrated in FIG. 5. Moreover, means are employed to transfer alternate ones of such signatures to the distributing cylinders 36 and 37.

To accomplish the foregoing, the first cylinders 34 and 35 are provided with four pairs of cutting elements and four pairs of folding elements, these elements being spaced about the peripheries of the cylinders so as to act alternately. As here shown, the four pairs of cutting elements include cutting knives 51a, 52a and 54a, 55a which are disposed respectively on the cylinders 35 and 34. These knives fit into and cooperate with blocks 52b and 54b, 55b which are respectively disposed on the cylinders 34 and 35. Thus, during each revolution of the cylinders 34 and 35 four cutting operations occur so that the web assembly 60 is cut into four successive lengths or signatures. The alternate signatures cut from the assembled webs may be designated A and B so that during each revolution of the cylinders 34, 35 four successive signatures A, B, A, B are cut from the web assembly.
Such four signatures are made up from pages printed during two revolutions of the printing cylinders, as described above.

Associated with each of the pairs of cutting elements are holding pins \(51c, 52c, 53c\) and \(54c\). Before cutting elements \(54a\) and \(54b\) act to sever a signature from the web as illustrated in Fig. 7, the pins \(54c\) pass through the web assembly \(60\), impaling \(55\) and holding the front end of the cylinder \(35\) until just before the web is folded into the jaws \(55b\) on cylinder \(34\) and cut again to form the next signature.

To perform the folding operation on the four successive signatures cut from the web assembly \(60\) during each revolution of the cylinders \(34, 35\) four folding means are spaced peripherally of the cylinder and intermediate the cutting means. As here illustrated, two tucker blades \(56a\) and \(56c\) are carried by the cylinder \(34\), and two tucker blades \(57a\) and \(57b\) are carried by the cylinder \(35\). These tucker blades are so located as to enter and cooperate with folding jaws \(56b\), \(58b\) and \(57b\) which are disposed on the respectively opposite cylinders \(35\) and \(34\). The freshly cut ends of the associated webs \(60\) are held by the pins associated with one set of cutter elements while the cylinders \(34, 35\) rotate to a position in which the tucker blade of the next set of cutting elements will force the center of the signature into the opening \(55b\) for pins \(54\) on the other cylinder. The pins are retracted to release the freshly cut end and the jaws then close, putting a transverse fold into the web assembly. As the cylinders continue to rotate, the web assembly will again be cut by the next set of cutting elements, and the signature will be carried around the cylinder is illustrated by the B signature in the jaws \(55b\) in Fig. 7.

The sequence of operation, then, for the elements on the first cylinders \(34\) and \(35\) may be summarized as follows. Before the cutter \(54a\) sever the trailing end of the B signature, the pins \(54c\) are projected outwardly to impale the associated webs and control the free end of the assembly \(60\) (Fig. 7). As the cylinders \(34, 35\), rotate through \(45^\circ\) from the position of Fig. 7, the pins \(54c\) will retract, the tucker blade \(56c\) will force the associated webs into the open jaws \(55b\) and the jaws \(55b\) will then close to fold the associated webs. As the cylinders rotate another \(90^\circ\) from the position of Fig. 7 to the position illustrated in Fig. 8, the knife \(51a\) will sever the web assembly, so that an A signature is now carried entirely by the folding jaws \(55b\), its opposite end having been released from the pins \(54c\). This is shown in Fig. 8, the first signature A is being carried by the jaws \(55b\) towards the distributing cylinder \(36\).

Prior to the operation of the cutting elements \(51a, 51b\) as shown in Fig. 8, the web assembly \(60\) is impaled on the pins \(51c\) and thus carried downwardly on the surface of the cylinder \(34\). When the cylinders have rotated another \(45^\circ\) from the position illustrated in Fig. 8, the tucker blade \(56a\) folds the web assembly into the open jaws \(56b\). As the cylinders rotate another \(45^\circ\) to the position illustrated in Fig. 9, the knife \(52a\) engages the block \(52b\) to sever the associated webs and form the second signature B, which is held in the jaws \(56b\).

Prior to severing the second B signature, the pins \(52c\) enter the web assembly \(60\) (Fig. 9) so that the free end will be carried downwardly on the surface of the cylinder \(35\). When the cylinders \(34, 35\) rotate through another \(45^\circ\) from the position illustrated in Fig. 9, the tucker blade \(57a\) will enter the associated webs \(57b\), and the latter will close to fold and hold the third signature A.

As the cylinders rotate another \(45^\circ\) to the position illustrated in Fig. 10, the cutter knife \(53a\) will sever the third signature A from the web assembly \(60\), so that such signature will be carried towards the distributing cylinder \(36\).

The severing action illustrated in Fig. 10 leaves the leading end of the web assembly \(60\) impaled on the pins \(53c\), so that this free end now travels downwardly on the surface of the cylinder \(34\). As the cylinder rotates through another \(45^\circ\) from the position illustrated in Fig. 10, the tucker blade \(58a\) will tuck the associated webs into the open jaws \(58b\) which will then close to transversely fold the web assembly, and the latter will be severed after the cylinders rotate through another \(45^\circ\) to the position illustrated in Fig. 7 by operation of the knife \(59\). Such results in a fourth signature B being held by the folding jaws \(58b\) and carried toward the distributing cylinder \(37\).

The foregoing illustrates how four successive signatures are cut and transversely folded during each revolution of the cylinders \(34, 35\). By alternating the elements of the folding and cutting means on the four folding jaws for alternate signatures are on different ones on the cylinders \(34, 35\), the cylinders are made to transfer alternate signatures toward the respective distributing cylinders \(36, 37\). Thus out of each set of four signatures, the two signatures \(A\) are carried by jaws \(55b\) and \(57b\), respectively, toward the distributing cylinder \(36\). In like manner, the two signatures \(B\) are carried by the jaws \(56a\) and \(58b\), respectively, toward the distributing cylinder \(37\).

The manner in which folding jaws may be automatically opened and closed as their cylinders rotate through predetermined angular positions is well known in the art. Similarly, mechanical means for advancing the impaling pins is well known. However, in an arrangement such as that illustrated by Figs. 7–10, it is necessary that the folding jaws on each cylinder \(34, 35\) be actuated at different peripheral locations than the impaling pins. So, as shown in Fig. 11, means are provided to actuate the folding jaws \(55b, 57b\) on the cylinder \(34\) at different angular locations than those at which the impaling pins \(51c\) and \(53c\) are actuated. As here shown, a box cam \(64\) is carried by the frame member \(65\) and engaged by cam followers \(66, 67\) mounted on shafts \(68, 69\). As the cylinders \(34, 35\) rotate through one revolution, the followers \(66, 67\) in riding on the interior surface of the box cam \(64\) cause the jaws \(55b\) and \(57b\) (Fig. 7) to be closed just as they pass the point of closest approach to the cylinder \(35\) (to grasp the fold tucked in by the cooperating blades \(56a\) and \(57a\)), and to be opened just as they approximate the distributing cylinder \(36\) (so that the folded products can be removed from the cylinder \(34\)). In like manner, a box cam \(70\) is carried on the frame \(71\) journaling the opposite end of the cylinder \(34\) and receives therein cam followers \(72, 73\), so that as the cylinder \(34\) and arranged to actuate the pins \(51c\) and \(53c\) (as shown in Fig. 7). The box cam \(70\) is so shaped that the pins \(51c\) and \(53c\) are extended just before the knives associated therewith sever the web assembly \(60\) (see Fig. 8), and so that they are retracted after approximately \(45^\circ\) of travel.

The distributing cylinders \(36, 37\) perform two functions. They take alternate ones of the signatures produced by the cylinders \(34, 35\) and split them into two groups which are released at four respective points. They also reduce the linear speed at which the signatures move, so that the signatures will be fed to transfer cylinders and then to the longitudinal folders at the four delivery points at approximately half the printing speed.

In order to slow down the signatures coming from the cylinders \(34, 35\), means are provided to drive the distributing cylinders \(36, 37\) at a peripheral speed less than that of the first cylinders \(34, 35\). In this instance, the cylinders \(36, 37\) are made smaller in diameter than the first cylinders \(34, 35\) and are driven at the same angular speed as the cylinders \(34, 35\) by any suitable means (not shown) well known to those skilled in the art.

In order to receive and distribute each of the signatures completed on the cylinder \(34\), the distributing cylinder \(36\) has two sets of grippers \(75, 76\) diametrically spaced thereon. In like manner, the distributing cylinder \(37\) has diametrically opposite grippers \(77, 78\). The cylinder \(36\) is so phased in its angular rotation that the gripper
76 cooperates with the folding jaws 57b, and the gripper 75 cooperates with the folding jaw 55b during each evolution. Likewise, the grippers 77 and 78 on cylinder 37 cooperate with the jaws 58c and 56d on the first cylinder 35.

These grippers on distributing cylinders are actuated so that they close at the proper moment to grip a signature released from one of the folding jaws. Each set of grippers is opened at a unique delivery point. For example, the grippers 76 are open as they approach the jaws 57b and close when in the position illustrated by FIG. 7 to grip and transfer a signature after it is released by the jaws 57b. The grippers then open as they approach the point of tangency with the transfer cylinder 39, so that they release the signature which they held to a set of grippers 80 on the transfer cylinder 39. The grippers 75 close so as to grip a folded signature which had been held by the jaws 55b, and then open so that a signature held in the grippers 75 is released to grippers 81 carried on the transfer cylinder 38. While the two signatures A are transferred from the cylinder 34 to the distributing cylinder 36, alternate signatures are transferred to respective ones of the transfer cylinders 38, 39. Specifically, the transfer cylinder 38 receives one A signature and the transfer cylinder 39 receives the alternate A signature.

It will be noted from the foregoing that the grippers 75 and 76 on the distributing cylinder 36 are not actuated identically. Rather, the grippers 75 and 76 are closed at the same angular locations relative to the axis of the cylinder 36, but are respectively opened as they approach the transfer cylinders 38 and 39. In order to differently actuate the grippers 75 and 76, the gripper actuating mechanism includes two box cans 84, 85 disposed at opposite ends of the cylinder 36 and mounted on the machine frame members 65 and 71 (FIG. 11). The box cans are engaged by followers 86, 87 which serve to produce the opening and closing movements of the grippers. The box cans 84 and 85 at opposite ends of the cylinder 36 thus individually control the opening and closing of the grippers 75 and 76. The grippers 77 and 78 for the distributing cylinders 37 are likewise controlled by individual box cans (not shown).

The transfer cylinders 38–41 also perform two functions. Each one serves to receive alternate ones of the signatures held on the associated distributing cylinder, and serves further to reduce the velocity at which the signatures move.

To accomplish such velocity reduction, provision is made to drive the transfer cylinders 38–41 with a peripheral speed slower than that of the distributing cylinders 36 and 37. In the present instance, the four transfer cylinders 38–41 are smaller in diameter than the associated distributing cylinders, and are driven at the same rotational speed by means which are well known and which need not be illustrated.

Each of the transfer cylinders 38–41 has one set of transfer means or grippers 80, 81, 82 and 83, respectively. The gripper 80 and 81 on the two transfer cylinders 36 and 39 associated with the distributing cylinder 36 are so phased as to cooperate with the grippers 76 and 75, respectively, thereby receiving the alternate A signatures. Likewise, the grippers 82 and 83 on the cylinders 40 and 41 are angularly phased as to cooperate with the grippers 78 and 77 on the cylinder 37, thereby transferring the alternate B signatures to separate points.

The grippers 88–83 on the transfer cylinders 38–41 are all arranged to close on signatures supplied by the cooperating grippers on the distributing cylinders, and to open as they pass respective delivery rolls 88–91 which take the signatures and send them through paired drive rolls where the respective engaging cylinders 32–45. Timing pulleys may be employed at appropriate locations as shown to assist in the transfer of signatures from one cylinder to another.

The transverse folding devices or chopper folders 42–45 have not been illustrated in detail in the present drawings, since their construction and operation are well known to those skilled in the art. It is sufficient here to note that the chopper folders receive each transferred signature and fold the signature into a "chopping" blade which produces a longitudinal fold in the signature, so that the final product is double folded as shown by the signature of FIG. 6. Such chopper folders are limited in their practical operating speed to about 200 strokes per minute, and thus one such folder could not handle the entire output of a high speed press producing, as in the present example, about 800 signatures per minute. The final products delivered out of the four chopper folders 42–45 in the present example are double folded signatures each containing forty-eight printed pages, inasmuch as the web assembly 60 led to the folding apparatus in the present instance includes six superimposed webs.

It will be appreciated that with the present arrangement all of the A signatures will contain the same printed subject matter, and all of the B signatures will contain the same printed subject matter. The A and B signatures may, however, contain different subject matter. Indeed, the A and B signatures may be intended for use in different books or pamphlets. If the press (FIG. 1) carries plate cylinders which print four signatures per revolution (instead of two as previously described) then the signatures delivered at each of the four folders 42–45 may have different printed contents.

Under these circumstances, there will be successive sets of four signatures A, B, C, D in the web assembly 60. The signatures A and C will be delivered to the distributing cylinder 36 on the left, and the signatures B and D will be delivered to the distributing cylinder 37 on the right. Thereafter, A signatures will pass to the folder 42 and the C signatures to the folder 43, while the B and D signatures pass respectively to the folders 44 and 45. This operation of folding and separating different signatures has been indicated in FIG. 7 by the parenthetical characters C and D adjacent the folders 43 and 45, respectively. The present folding and cutting apparatus thus accommodates successive sets of plural signatures having different content or subject matter, cuts and folds those signatures while delivering them at separate locations. The individual chopper folders need handle but one-fourth the output of the press, so that a total of about eight hundred signatures per minute are produced by four chopper folders working at about two hundred strokes per minute.

Moreover, the present cutting and folding arrangement is advantageous since the first pair of cylinders 34, 35 and the distributing cylinders 36, 37 as well as the transfer cylinders 38–41 may all be driven at the same rotational speed. But, because the cylinders 36 and 37 are smaller in diameter than the cylinders 34 and 35, slow-down in the velocity of the signatures occurs as an incident to transfer from the first cylinders to the distributing cylinders. Likewise, because the transfer cylinders 36–41 are smaller in diameter than the distributing cylinders 36, 37, further slow-down in the velocity of the signatures occurs as an incident to the transfer to cylinders 38–41. Thus, even though the web assembly 60 may be entering the folding apparatus at a very high linear velocity (e.g., 1500 feet per minute), the individual signatures leave the apparatus relatively slowly (e.g., 800 feet per minute) by the time they pass through the drive rolls 92–95 to the respective chopper folders 42–45. This slowing down in velocity eliminates destructive impacts as the signatures are brought to a halt in the chopper folders.

Merely by way of example, if the cylinders 34 and 35 are given a diameter of 29 inches and the web assembly 60 enters between at a speed of 1500 feet per minute, the speed of the signatures produced by the first cylinders 34 and 35 may be slowed down to a value of 1150 feet per minute by making the distributing cylinders 36, 37 have a diameter of 22¼ inches. Moreover, the speed of
3,033,335 7 signatures entering the chopper folders 42-45 is reduced to a speed of 800 feet per minute by making the transfer cylinders 38-41 have a diameter of 15% inches. Thus, the arrangement here described not only separates the successive signatures cut from a web assembly 60, but it also reduces their velocity so that they can be safely fed to and folded in the chopper folders. The four chopper folders need to operate through but one stroke for each revolution of the first cylinders 34, 35 even though the latter produce four signatures per revolution. In the present example, the four chopper folders each operate at approximately 200 strokes per minute.

In the arrangement of FIGS. 12 and 13, first cylinders 100, 101 are adapted to receive the web assembly 60 therebetween, to cut and transversely fold signatures, and to deliver alternate ones thereof to distributing cylinders 36 and 37. The distributing cylinders 36 and 37 deliver alternate ones of the signatures which they receive to transfer cylinders 36, 39 and 40, 41. These transfer cylinders, in turn, deliver signatures to chopper folders 42-45. Thus, the arrangement of FIGS. 12 and 13 is identical to the arrangement of FIGS. 7-10 insofar as the distributing and transfer cylinders are concerned.

It will be observed, however, that the cylinders 100 and 101 in FIG. 12 are of relatively small diameter, and together having only two sets of cutting and folding means thereon. Thus, a tucker blade 102a on cylinder 101 cooperates with folding jaws 102b on cylinder 100. Likewise, a tucker blade 103a cooperates with folding jaws 103b, the two being respectively carried by the cylinders 100 and 101. A cooperating knife 104a and block 104b are respectively disposed on cylinders 100 and 101, while a knife 105a on the cylinder 101 cooperates with a block 105b on the cylinder 100. Associated with the blocks 104b and 105b are pins 104c and 105c.

The cylinders 100 and 101, therefore, are arranged to cut and transversely fold two signatures for each revolution thereof. That is, the knife 104c will sever the trailing end of a signature previously tucked into the jaws 103b by the blade 103a, so that such signature will be delivered to the grippers 78 on the cylinder 37. The next signature will be cut from the web assembly 60 by the knife 105a after the assembly has been tucked into the jaws 102b by the tucker blade. 102a. The jaws 102b will release this signature to the grippers 76 on the cylinder 36.

To afford successful operation of the smaller cylinders 100 and 101, the latter are driven at twice the rotational speed of the distributing cylinders 36 and 37. This may be accomplished by choice of the ratios of gears (not shown) which rotationally drive the several cylinders. During one complete revolution of the transfer cylinder 36, the folding jaws 102b will first release a signature to the grippers 76, and then release a signature to the grippers 75. In like manner, during one rotation of the distributing cylinder 37, the first cylinder 101 will make two revolutions, and the folding jaws 102b will first release a signature to the grippers 78 and then release a signature to the grippers 77. Thus, the first cylinders 100, 101 in rolling at twice the speed of the distributing cylinders 36 and 37 release four successive signatures during each two revolutions. These four successive signatures are, however, released alternately to the distributing cylinders 36 and 37, and the latter split the signatures which they receive into two groups released alternately to the respective pairs of transfer cylinders 38, 39, 40, and 41. There is not only separation of the individual ones of the signatures in successive sets, but there is also a progressive slowing down of the velocity of such signatures. The peripheral speed of the distributing cylinders 36 and 37 is considerably less than that of the first cylinders 100 and 101, by virtue of the fact that the distributing cylinders are driven at one-half the speed of the cylinders 100, 101 and are considerably larger in diameter. Moreover, the distributing cylinders 36 and 37 are driven at the same rotational speed as the transfer cylinders 38-41, so that the peripheral speed of the latter is less than the peripheral speed of the distributing cylinders. Thus, the operation of the modification shown in FIGS. 12 and 13 is substantially the same as the operation of the first-described embodiment and the same advantages are achieved.

I claim:

1. In folding apparatus, the combination comprising a pair of first cylinders rotatably driven at a first peripheral speed and receiving a running web assembly therebetween, said first cylinders having means thereon to cut and transversely fold said webs into successive signatures, said distributing cylinders each adjacent a corresponding one of said first cylinders and rotatably driven at a second peripheral speed which is less than said first peripheral speed, two gripping means spaced circumferentially on each of said distributing cylinders, means for transferring alternate ones of the folded signatures produced by said first cylinders to respective ones of said distributing cylinders, said last-named means including means for transferring alternate ones of the signatures received by each distributing cylinder into respective ones of said second gripping means on that cylinder, two pairs of transfer cylinders respectively disposed adjacent to but being smaller in diameter than said second gripping means on the associated distributing cylinder, and means for delivering the signatures from each of said transfer cylinders to a separate delivery location.

2. In folding apparatus, the combination comprising a pair of first cylinders adapted to receive a running web assembly therebetween, four sets of cutting means and four sets of folding means alternately spaced around said first cylinders, four sets of transfer cylinders adjacent to said first cylinders, and four pairs of distributing cylinders adjacent to said first cylinders, means for transferring alternate ones of the folded signatures cut from the web assembly 60 by the knives 104a and 105a to the respective transfer cylinders, and means for delivering the signatures from each of said transfer cylinders to a separate delivery location.

3. In folding apparatus, the combination comprising a pair of first cylinders adapted to receive a running web assembly therebetween, two sets of cutting means and two sets of folding means alternately spaced around said first cylinders to produce two transversely folded signatures per revolution, said folding means including one set of jaws on each first cylinder for folding and holding alternate signatures on respective ones of the first cylinders, while the latter rotate through a portion of each revolution, two sets of distributing cylinders disposed adjacent to but being larger in diameter than said first cylinders, two gripping means spaced around the first cylinders at diametrically opposite ends of each cylinder, and means for driving said second gripping means in opposite directions during each revolution of the first cylinders, and means for delivering the signatures from each of said second gripping means to the respective pairs of transfer cylinders and to a delivery location, one cylinder being driven at a peripheral speed which is less than the peripheral speed of the transfer cylinders, and the other being driven at a peripheral speed which is greater than the peripheral speed of the transfer cylinders.
9. four longitudinal folders, means for transferring signatures from said transfer cylinders to respective ones of said folders, means for rotatably driving all of said cylinders with said distributing and transfer cylinders having the same angular speed and said first cylinders having an angular speed twice that of said distributing cylinders, and means for driving said folders through one cycle for each revolution of said transfer cylinders.

4. In folding apparatus, the combination comprising a pair of first cylinders receiving a running web assembly therebetween, each of said first cylinders having cutting means including holding pins and transverse folding means including jaws thereon, means at the opposite ends of each of said first cylinders for respectively actuating and releasing said pins and jaws as that cylinder rotates through each revolution, two distributing cylinders each adjacent one of said first cylinders, two grippers spaced about the periphery of each of said distributing cylinders, means at the opposite ends of each of said distributing cylinders for respectively actuating and releasing said two grippers on that cylinder, means for transferring alternate ones of the folded signatures produced by said first cylinders to respective ones of said distributing cylinders with alternate ones of such signatures received by a given distributing cylinder being held respectively by the two grippers thereon, two pairs of transfer cylinders, the transfer cylinders of each of said pairs being adjacent a corresponding one of said distributing cylinders, means for transferring the signatures held in the two grippers on each said distributing cylinder to respective ones of the adjacent transfer cylinders, and means for delivering the signatures from each of said transfer cylinders to a separate delivery location.

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