# United States Patent [19]

**Burge**

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[54] **BANDING MACHINES**


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[73] Assignee: **Crosfield Business Machines Limited,** Watford, England



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[30] **Foreign Application Priority Data**

Jan. 18, 1972 Great Britain ..... 2394/72

[52] **U.S. Cl.** ..... **53/198 R,** 93/93 DP

[51] **Int. Cl.** ..... **B65b 27/08**

[58] **Field of Search**... 53/3, 198 R; 93/93 M, 93 DP



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[57] **ABSTRACT**

A combined document bundling and banding machine is described in which documents are fed one by one into a banding station to form a stack or bundle of documents, the bundle of documents are urged across the path of a continuous banding strip extending across the banding station such that a portion of the strip is deflected out of its path around the front of the bundle, and the strip is reunited along the path at the rear of the bundle so that the resulting overlapped portions of the strip can be bonded to one another.


**5 Claims, 9 Drawing Figures**

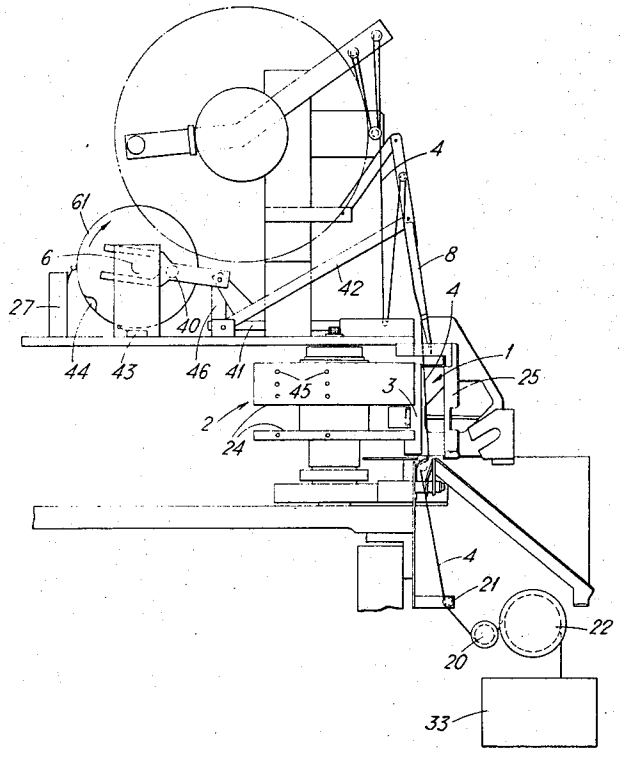


Fig. 1.

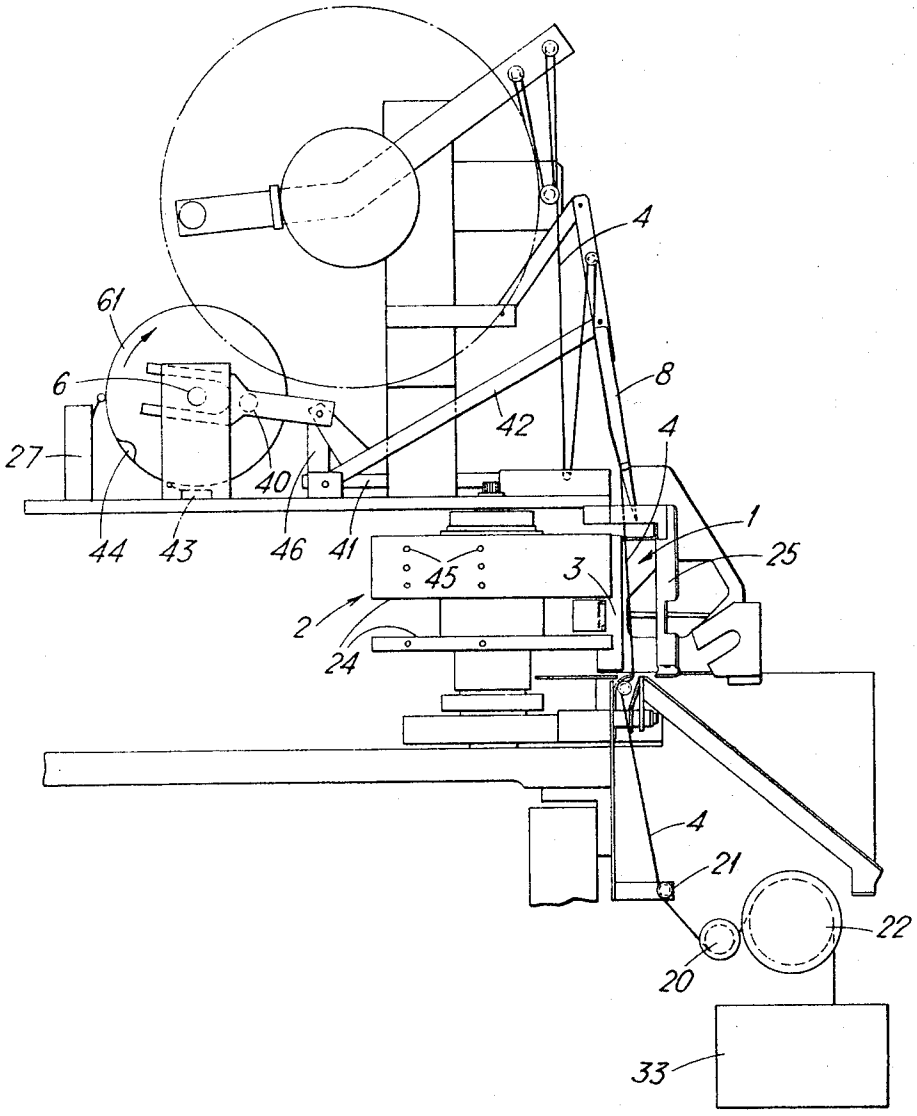


Fig. 2.

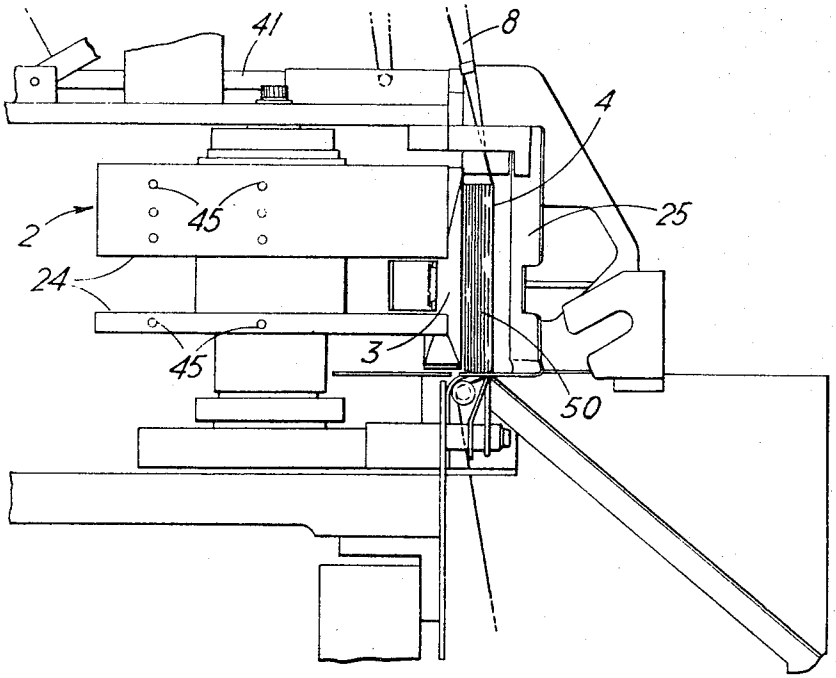
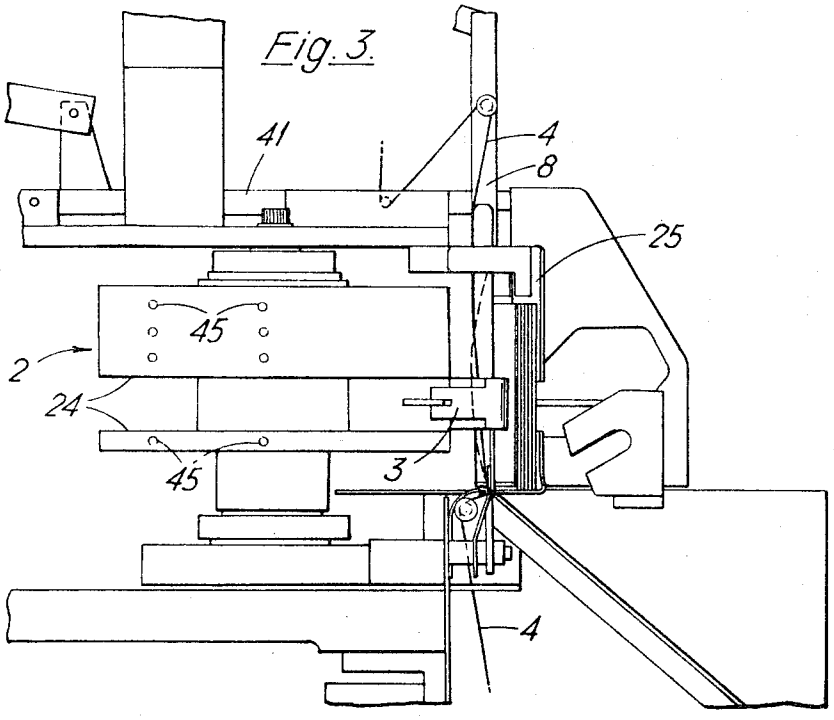



Fig. 3.



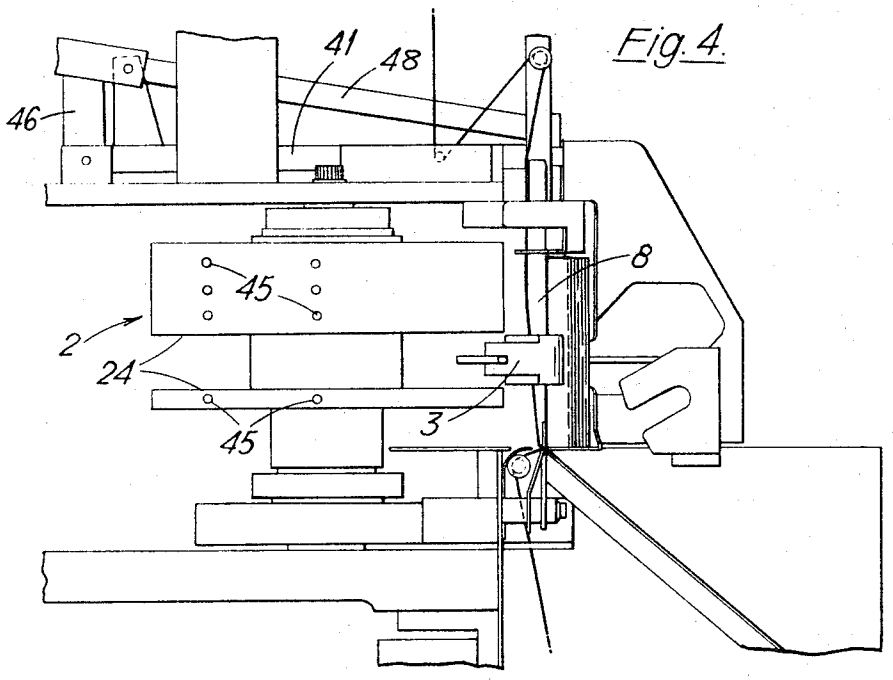



Fig. 4.

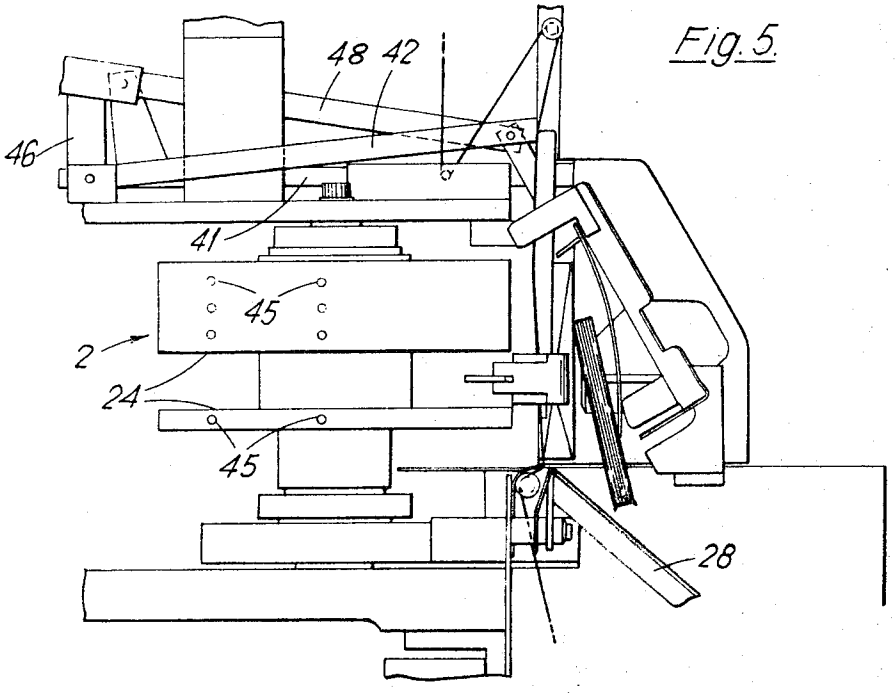



Fig. 5.

Fig. 6.

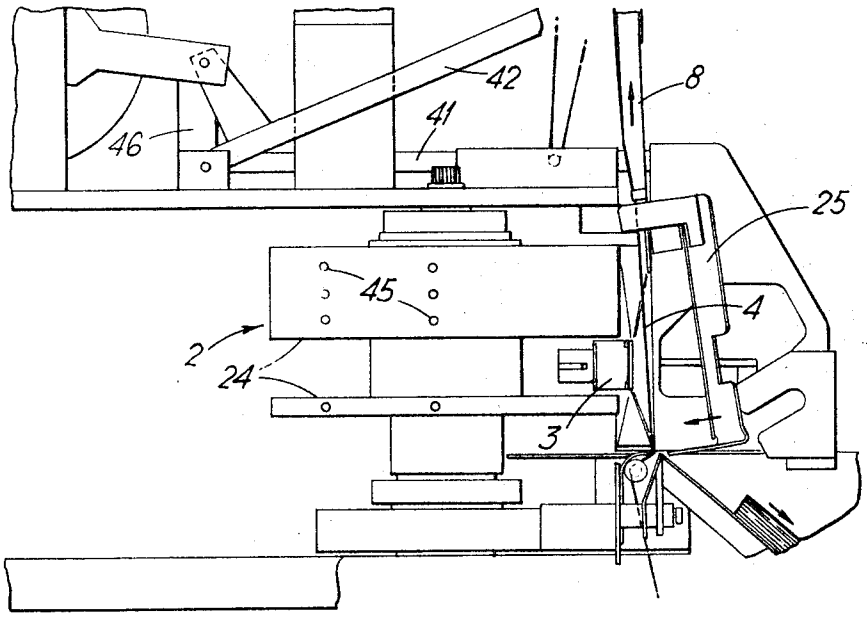



Fig. 7.

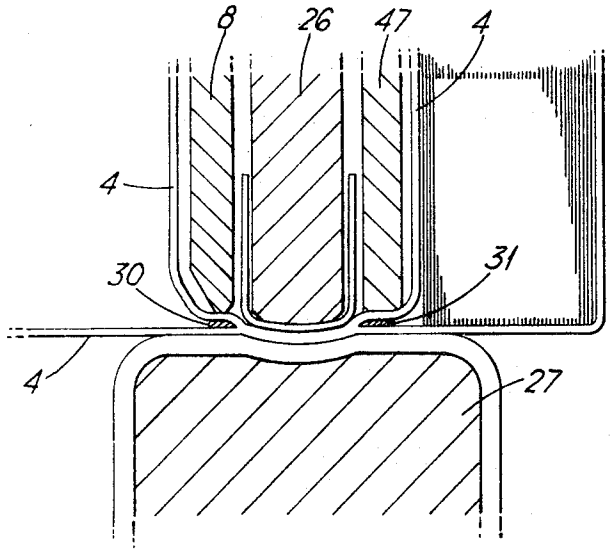


Fig. 8

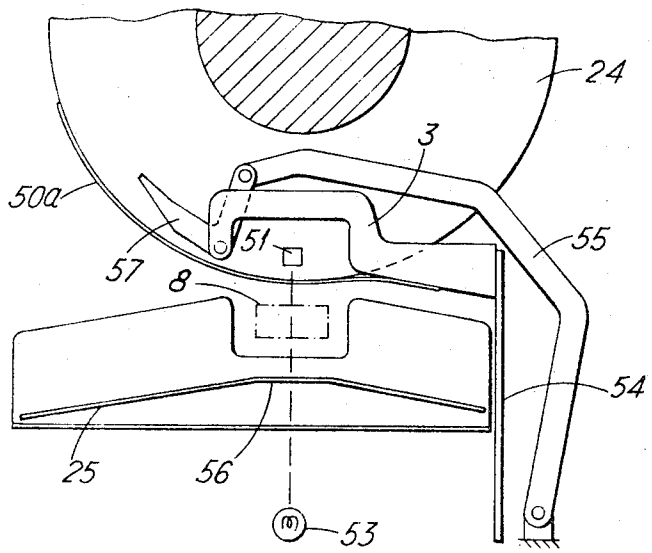
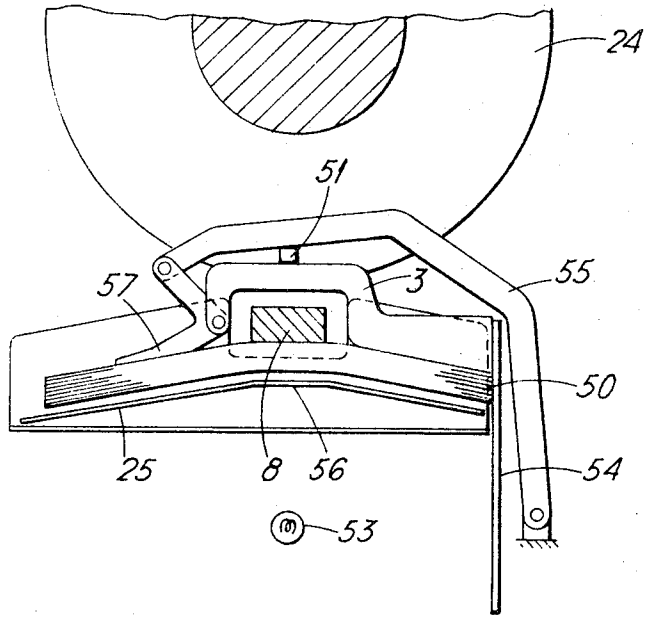



Fig. 9



# BANDING MACHINES

This invention relates to the automatic bundling and banding of sequences of documents such as bank notes.

In accordance with the present invention a method of banding a sequence of documents comprises feeding the documents one by one into a banding station to form a stack or bundle of documents, urging the bundle of documents across the path of a continuous banding strip extending across the banding station such that a portion of the strip is deflected out of its path around the front of the bundle, reuniting the strip along the path at the rear of the bundle and bonding the resulting overlapped portions of the strip to one another.

Preferably the joint between the overlapped portions of the strip is at least partially severed into a pair of joined edges during or after the bonding process, such that the banded bundle can be detached from the strip without destroying the continuity of the strip. The joined edges which are left behind along the main strip after a bundle has been detached are then advanced beyond the banding station by a continuous pull-down mechanism before the banding of the next bundle so that each banded bundle has only one joint.

In a preferred embodiment of the invention the documents are fed into the banding station by a rotating vacuum drum. The documents are peeled away from the periphery of the drum by a stripper plate, and, after a predetermined number of documents have been stacked, the stripper plate is moved from its stripping position adjacent the drum to a second position in which it holds the bundle of documents against a rigid backing member. This movement of the stripper from its first position to its second position urges the bundle across the path of the banding strip so that the deflected portion of the strip lies between the front of the bundle and the backing member.

A reciprocating guide finger initially positioned just in front of the banding strip then guides the deflected portion of the strip around the back of the bundle to complete the wrapping of the strip around the bundle. A welding electrode is placed beneath the overlapped portions of the strip and the guide finger carries a second electrode so that the overlapped portions are compressed between the electrodes as the guide finger brings the upper and lower strips into overlapping relationship. At the same time one of the electrodes is earthed and the overlapped portions are then welded together using radiofrequency dielectric heating. Preferably one or other of the electrodes acts as a blade and the weld is performed under pressure so that the resulting joint is at least partially severed by the blade into a pair of joined edges as the overlapped portions soften and fuse with one another during the welding process.

During the banding operation, the front of the bundle is curved about the straight centre section of a rigid backing member to increase the rigidity of the section of the bundle that is banded.

One example of the invention is shown in the accompanying drawings in which:

FIG. 1 illustrates a banding machine for banding bank notes, and shows the machine at rest before any notes have been fed into the banding station;

FIGS. 2–6 illustrate a detail of the bander of FIG. 1, each figure representing a certain stage in a banding cycle and the order of the figures following the actual sequence of events;

FIG. 7 is a detail of the banding machine illustrating the welding of the banding tape behind the bundle of notes;

FIG. 8 is a plan view of the document stripper mechanism in its stripping position, and

FIG. 9 is a view similar to that of FIG. 8 showing the document stripper in its banding position.



In the banding machine illustrated in these drawings, the banding cycle, the welding of the banding tape, and the subsequent removal of the banded notes are all initiated from a computer (not shown). The bander is designed to pass a PVC plasticised tape around a stacked bundle of 100 notes or documents and to weld the ends of the band together.

Initially the computer checks that the bander is ready and that a conveyor is available for transporting banded notes away from the banding station. On receipt of a clearance signal (which is only obtained when a photocell **51**, FIG. **8**, is uncovered the computer directs 100 bank notes **50**, FIG. **2**, into the pocket **1** by energising a vacuum transport drum **2**, the notes being peeled away from the periphery of the drum by means of a stripper plate **3**. The stripper plate initially occupies the position shown in FIG. **8** and is only moved to the position shown in FIG. **9** after 100 bank notes have been fed into the pocket.

In FIG. **1** a banding finger **8** is in its raised position and the PVC tape **4** is stretched across the pocket **1** with one end connected to an upper tape reel **5** and its other end connected to a continuous tape pull-down mechanism consisting of a small synchronous motor driving a crowned serrated drive roll **20**, a guide roll **21** and a large diameter rubber covered pressure roll **22**. The tape **4** has sufficient elasticity to accomodate the pull-down which is effected whenever the tape is subsequently clamped between the welding electrodes. The stripper plate **3** lies between flanges **24** of the drum **2** and a document backing plate **25** is in its lowered position. In FIG. **2** the 100 notes have been fed into the pocket **1** and are loosely stacked up against an end plate **54**, FIG. **8**, with the front sheet engaging the banding strip **4**.

At the commencement of a banding cycle, the bander motor rotates a cam shaft **6** which carries three cams one behind the other so that only the first cam **61** is visible in FIG. **1** of the drawings. Each cam includes a grooved cam track (not shown) within which rides a cam follower **40**. The movement of the cam follower in the first cam controls the movement of the banding finger **8** via a link **42**. The movement of the corresponding followers in the second and third cams control the movement of the stripper plate **3** via links **46** and **41** and of the backing plate **25** via a link **48** FIGS. **4** and **5**, respectively. Certain of the linkages are omitted in some of the figures for the sake of clarity.

Turning next to FIGS. **8** and **9**, initial rotation of the cam shaft **6** causes the second cam to urge the link **41** forward (from left to right as viewed in FIG. **1**) so that the arm **55** is moved from its position shown in FIG. **8** to that shown in FIG. **9**. In FIG. **8** the stripper plate **3** includes a portion lying between the flanges **24** which peels a document **50a** away from the periphery of the drum. It also includes a paddle **57** which is tucked away between the flanges out of the path of the document **50***a*. When the stripper **3** is moved from its stripping

position in FIG. 8 to that shown in FIG. 9 the paddle 57 and the stripping portion of the stripper are urged against the outermost portions of the notes so that the notes are moved forward and curved about the straight centre section 56 of the backing plate 25. Without this curvature the notes have a tendency to crumple during the banding operation. The forward movement of the notes deflects the banding strip out of its original path and the deflected portion of the strip is thereby held between the front of the bundle of notes and the straight centre section 56 of the backing plate 25. Just before the stripper plate reaches its full stroke, the banding finger 8 begins to move down and behind the bundle bringing with it the PVC tape to completely encircle the notes. The path of the banding finger is shown in FIG. 3 by a dashed line.

The banding finger carries with it an upper electrode 26 so that when the banding finger reaches the end of its downward stroke to complete the encircling of the notes the overlapping upper and lower tapes are held between the upper electrode 26 and a lower electrode 27 as shown in detail in FIG. 7. At the same time the upper electrode is earthed.

Further rotation of the cam shaft 6 causes a recess 44 in cam 61 to close a weld switch 27, FIG. 1, to initiate a weld cycle. The duration of the weld cycle is electronically controlled and the RF power is switched on for approximately half a second followed by a half a second cooling period. From FIG. 7 it can be seen that two weld beads 30, 31 are formed, one on each side of the upper electrode 26. The upper electrode is sufficiently narrow to act as a blade and the pressure on the upper electrode is such that a tear-seal is formed between the two weld beads. Further rotation of the cam shaft 6 causes the cam follower of the third cam to move a link 48 so that the backing plate 25 is pivoted outwards leaving the notes free to detach themselves from the strip and to drop down the chute 28 as shown in FIG. 5. Just after the backing plate begins to move, the banding finger starts to return to its raised position.

In FIG. 6 the stripper plate and the pressure plate have been returned to their rest positions. As soon as the bundle of notes has been released down the chute the photoelectric cell 51 is re-illuminated by the lamp 53 and a "pocket clear" signal is fed to the computer.

With the return of the stripper to its rest position, i.e., to its position between the flanges of the vacuum drum 2, a further micro-switch 43 is actuated by the cam 61 and a signal is fed to the computer indicating that the mechanical cycle has finished and that the bander is ready to receive further notes. The main bander motor is then de-energised.

The tape which is being continuously moved down to provide a fresh portion of tape for each bundle of notes at the banding station is fed by the tape pull-down mechanism into a waste disposal box 33.

In one alternative embodiment (not shown) a first "stripper" peels documents away from the periphery of the drum while a second "stripper" holds a previously stacked bundle of notes against the backing plate. At the end of each banding cycle the two "strippers" interchange their positions so that a more continuous operation is achieved.

I claim:

1. A document banding machine for banding a sequence of documents comprising a rotatable vacuum drum for feeding the documents one by one into a banding station to form a stack or bundle of documents, a continuous banding strip extending across the banding station, a device movable from a first position in which the device peels documents away from the periphery of the vacuum drum to a second position in which the device holds the bundle of documents against a rigid backing member, an acutator for moving the device from its first position to its second position after a predetermined number of documents have been stripped from the drum, the movement of the device urging the bundle of documents across the path of the continuous banding strip such that a portion of the strip is deflected out of its path around the front of the bundle, a reciprocating guide member movable from a first position to a second position to guide the strip around the back of the bundle and to reunite the strip along the path, and a bonding device for bonding the resulting overlapped portions of the strip to one another.

2. A document banding machine according to claim 1, in which the rigid backing member includes a straight centre section, the device including means for curving the bundle about the centre section of the backing member prior to the movement of the reciprocating guide member from its first position to its second position.

3. A document banding machine according to claim 1, in which the bonding device includes a pair of RF electrodes one of which is carried by the guide member such that movement of the guide from its first position to its second position simultaneously compresses the overlapped portions of the banding strip between the two electrodes to permit RF welding thereof.

4. A document banding machine according to claim 1, in which the continuous banding strip is elastic and in which the banding machine includes a continuous pull-down mechanism such that the banding strip is stretched across the banding station during the banding operation whereby the subsequent relaxation of the banding strip after the overlap portions have been bonded to one another tightens the strip around the bundle.

5. A document banding machine according to claim 3, in which one of the electrodes includes a blade such that the joint between the over lapped portions is at least partially severed during welding to form a tear-seal.

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