Abstract: A machine (10) for manufacturing stackable laminations (4) for a magnetic core (6) is disclosed. The laminations are formed from a magnetic strip material (2). The machine (10) includes a first electromechanical cam drive for actuating a folder that folds the strip material (2) and a second electromechanical cam drive for actuating a cutter that cuts the strip material (2). The folder and the cutter are independently drivable between an uppermost position and a lowermost position. The folder may include a folder platen (130) having an associated folder bar (150) to fold said strip material (2). The cutter may include a guillotine platen (230) having an associated upper cutting blade (245) that cooperates with a fixed lower blade (255) for cutting said strip material (2). The electromechanical cam drive may include any suitable electric actuator (100,200) such as an electric motor.
MACHINE FOR MANUFACTURING LAMINATIONS FOR A MAGNETIC CORE

FIELD OF THE INVENTION

The present invention relates to the manufacture of magnetic cores, and in particular, to the manufacture of cores formed by stacking together individual laminations of a magnetic strip material. Stacked cores are often used in transformers to provide a path for the magnetic lines of flux.

BACKGROUND OF THE INVENTION

Transformer cores are produced for a variety of applications including general purpose and distribution transformers such as those used in electricity distribution networks to step the transmitted voltage up and down to appropriate levels. Transformer cores are usually formed by stacking together individual laminations which provides several benefits including increasing the resistivity of the core and reducing eddy current losses. The process of manufacturing stackable laminations may be automated by programmable machines that can perform required folding and cutting operations. As individual laminations are produced by such a machine, they are typically manually stacked or nested together by the machine operator.

In a machine for manufacturing laminations of a magnetic core, individual laminations are typically folded and cut according to predefined geometries from a continuous feed of magnetic strip material. Such a machine typically has a cutter and folding or bending means to form the laminations as desired before they are stacked together to form a core. The cutter and folder have previously been driven (actuated) hydraulically and/or pneumatically with varying degrees of success. Hydraulic and pneumatic actuation is often noisy and may result in undesired vibration levels in the machine which accelerates wear of parts and has the potential to cause damage and misalignment of key components. Having to replace parts will invariably result in machine downtime, which coupled with part replacement, can be very costly to a core manufacturer.

Pneumatic actuators often provide uncontrolled motion between mechanical stops and are most suitable for applications where point-to-point motion is required. The compressibility of the actuating fluid results in negligible system stiffness and therefore achieving accurate position control between the limits of stroke is most difficult for pneumatic actuators.

Hydraulic actuators have a large force capability and system stiffness compared to pneumatic actuators, however hydraulic systems have several inherent drawbacks. The hydraulic fluid is subject to dirt and contamination in an industrial environment and requires filtering and maintenance. There is also the possibility of fluid leakage which can lead to machine downtime and repair. Hydraulic cylinders also tend to have limited positional accuracy and repeatability as changes in temperature of
the hydraulic fluid for example may lead to performance variation. A hydraulic system also tends to require more space as support elements such as pumps, a fluid supplier, a connecting piping system, the hydraulic cylinders and necessary control valves are also required.

There is therefore a need for an improved folding and cutting actuation system in machines for manufacturing laminations of a magnetic core. An object of the present invention is to ameliorate one or more of the above described difficulties or at least provide a useful alternative to arrangements of the type discussed above.

Other advantages of the present invention will become apparent from the following description, taken in connection with the accompanying drawings, wherein, by way of illustration and example, a preferred embodiment of the present invention is disclosed.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:

- a first electromechanical cam drive for actuating a folder that folds the strip material; and
- a second electromechanical cam drive for actuating a cutter that cuts the strip material, wherein the folder and the cutter are independently drivable.

In one form, the first electromechanical cam drive includes:

- a first electric actuator having an output shaft;
- a first cam shaft securably engaged onto the output shaft of the first electric actuator; and
- a first linkage member coupled between the first cam shaft and the folder, wherein, in use, the cam drive converts rotational motion of the actuator into linear displacement of the folder.

In one form, the second electromechanical cam drive includes:

- a second electric actuator having an output shaft;
- a second cam shaft securably engaged onto the output shaft of the second electric actuator;
- a second linkage member coupled between the second cam shaft and the cutter; wherein, in use, the cam drive converts rotational motion of the actuator into linear displacement of the cutter.

In one form, the first linkage member has a first portion having a first aperture and a second portion having a second aperture, wherein the first and second portions are stepped apart.
In one form, at least one of the first or second electric actuators is a servo motor.

In one form, the folder includes a folder platen having an associated folder bar to fold said strip material, the platen reciprocally drivable between an uppermost position and a lowermost position.

In one form, the cutter includes a guillotine platen having an associated upper cutting blade, the platen reciprocally drivable between an uppermost position and a lowermost position.

In one form, the cutter further includes a fixed lower blade that cooperates with the upper blade of the guillotine platen to cut the strip material by shearing between the blades.

In one form, the machine further includes a clamping member for clamping said strip material.

According to a second aspect of the invention, there is provided a machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:

- a frame for housing a folder platen assembly and a guillotine platen assembly;
- a folder platen assembly having a folder bar for folding said strip material in at least one predetermined position;
- a guillotine platen assembly having a cutting blade for cutting said strip material at a predetermined position;
- a first electric actuator;
- a second electric actuator;
- a first cam shaft driven by the first electric actuator and coupled to the folder platen assembly;

and

- a second cam shaft driven by the second electric actuator and coupled to the guillotine platen assembly,

wherein, the folder platen assembly and guillotine platen assembly are independently drivable.

In one form, a first linkage member is coupled between the first cam shaft and the folder platen assembly.

In one form, a second linkage member is coupled between the second cam shaft and the guillotine platen assembly.

In one form, the first linkage member and folder platen assembly are coupled by a first pin element.
In one form, the second linkage member and guillotine platen assembly are coupled by a second pin element.

In one form, the folder platen assembly and guillotine platen assembly locate onto a pair of shafts that are housed in laterally opposed portions of the frame.

In one form, the folder platen assembly is slidably movable along the shafts.

In one form, the guillotine platen assembly is fixedly engaged to the shafts such that the platen and shafts are movable in unison.

According to a third aspect of the invention, there is provided a drive system for a machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the drive system including:

- a folder drive mechanism for controlling movement of a folder platen assembly that folds the strip material in at least one pre-determined position, the folder drive including:
  - a first electric actuator having an output shaft;
  - a first cam shaft adapted to be securably mounted onto the output shaft of the first electric actuator; and
  - a first linkage member coupled between the first cam shaft and the folder platen assembly,
    wherein, as the first cam shaft is rotated, a reciprocating linear motion is imparted to the folder platen assembly; and
- a guillotine drive mechanism for controlling movement of a guillotine platen assembly that cuts the strip material in a pre-determined position, the guillotine drive including:
  - a second electric actuator having an output shaft;
  - a second cam shaft adapted to be securably mounted onto the output shaft of the second electric actuator; and
  - a second linkage member coupled between the second cam shaft and the guillotine platen assembly,
    wherein, as the second cam shaft is rotated, a reciprocating motion is imparted to the guillotine platen assembly.

In one form, at least one of the first or second electric actuators is an electric motor.
According to a fourth aspect of the invention, there is provided a machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:

- a first pneumatic drive for actuating a folder that folds the strip material; and
- a first electromechanical cam drive for actuating a cutter that cuts the strip material, wherein the folder and the cutter are independently drivable.

According to a fifth aspect of the invention, there is provided a machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:

- a frame for housing a folder platen assembly and a guillotine platen assembly;
- a folder platen assembly having a folder bar for folding said strip material in at least one predetermined position;
- a guillotine platen assembly having a cutting blade for cutting said strip material at a predetermined position;
- a first electric actuator;
- a first cam shaft driven by the first electric actuator and coupled to the guillotine platen assembly; and
- a first pneumatic actuator coupled to the folder platen assembly;

wherein the folder platen assembly and guillotine platen assembly are independently drivable.

A specific embodiment of the invention will now be described in some further detail with reference to and as illustrated in the accompanying figures. This embodiment is illustrative, and is not meant to be restrictive of the scope of the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Various aspects of the present invention will be described in detail with reference to the following drawings in which:

- **FIGURE 1** is a perspective view of a machine for manufacturing laminations of a magnetic core;
- **FIGURE 2** is an embodiment of a magnetic core formed by stacking individual laminations manufactured by the machine;
- **FIGURE 3** is an exploded view of the main subassemblies of the machine;
- **FIGURE 4** is a perspective view of the head assembly of the machine;
- **FIGURE 5** is a front view of the head assembly of the machine;
- **FIGURE 6** is a semi-exploded view of the main components of the head assembly of the machine;
- **FIGURE 7** is a sectional view through A-A of **FIGURE 5** showing the folder drive mechanism;
- **FIGURE 8** is an exploded view of the cam shaft and linkage arrangement of the folder drive;
FIGURE 9 is a sectional view through B-B of FIGURE 5 showing the guillotine drive mechanism; FIGURE 10 is an exploded view of the cam shaft and linkage arrangement of the guillotine drive; FIGURE 11 is a sectional view through C-C of FIGURE 5 showing one of the main guide shafts; FIGURE 12 is a perspective view of the head assembly showing detail of the folder drive mechanism; FIGURE 13 is a perspective view of the head assembly showing detail of the guillotine drive mechanism; FIGURES 14a-14d depict a sequence of sectional views through the folder drive mechanism showing the cam shaft at 0° (Top Dead Centre (TDC)), 90°, 180° and 270° respectively; and FIGURES 15a-15d depict a sequence of sectional views through the guillotine drive mechanism showing the cam shaft at 0° (Top Dead Centre (TDC)), 90°, 180° and 270° respectively.

In the following description, like reference characters designate like or corresponding parts throughout the several views of the drawings.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENT

Referring to Figure 1, there is shown a machine 10 for manufacturing laminations of a magnetic core. Figure 1 depicts a machine 10 in a manufacturing environment with an associated decoiler 20. A coil of magnetic strip material 2 is unwound from the decoiler 20 and fed to the machine 10, where it is folded and cut to form an individual lamination 4 of a core 6 (see Figure 2). The machine 10 is used to manufacture laminations which are stacked or nested together to form a core, typically for use in a transformer. The machine 10 is programmable to produce a variety of user specified core geometries. An embodiment of a core 6 that may be manufactured by the machine 10 is shown in Figure 2. The core 6 shown in Figure 2 has been formed by stacking individual laminations 4 having 45° degree corner folds. The core 6 is formed by stacking these laminations together as each individual lamination is cut from the machine 10. The machine 10 may be configured to produce folds of varying angles including 30°, 45° and 90°.

The core 6 illustrated in Figure 2 is just one example of a possible core geometry which can be formed by the machine 10. Cores of different configurations including standard and end-overlap Distributed Gap, DUO core, Uncut, Butt, Step Butt and 90° cut laminations are examples of core types which may be manufactured by such a machine. Programming software is used to define the geometry of the core with adjustable parameters including strip width, strip thickness, corner angle, window length, window width, and build up as will be understood by those skilled in the art. The core 6 may be made from any grade of Grain Oriented Silicon Steel (GOSS) or Non-Oriented (NO) electrical steel with thickness from 0.2 to 0.35mm. The machine 10 is configurable to process a single strip of material or alternatively two narrower strips simultaneously.
Referring now to Figure 3, there is shown an exploded view of the main subassemblies of the machine 10. A cabinet assembly 60 forms the base of the machine and houses most of the electronic equipment. Mounted upon the cabinet assembly 60 is a feed assembly 30 which receives strip material 2 from the decoiler 20. The strip material 2 is guided between lower rollers 32 and upper rollers 34 and fed to the head assembly 40 where it is folded and cut. In this manner, the machine 10 can receive at least one strip of material 2. The head assembly 40 is mounted onto the feed assembly 30 by suitable fastening means, but preferably bolted into position. There is also a hood assembly 50 that substantially encloses the feed assembly 30 and the head assembly 40. At least one user control interface 52 is mounted onto the hood assembly 50 providing machine controls such as POWER ON, STOP, RUN and HOLD.

Referring now to Figures 4-6, there are shown views of the head assembly 40 of the machine 10. The head assembly 40 houses the components of the machine 10 that facilitate the folding and cutting of the strip material 2. The head assembly 40 is built up around a machined head frame 42 that forms the housing and support structure for the folder and cutter. Figures 4 and 5 provide an illustration of how the folder and cutter may be assembled within the head frame 42. The folder broadly comprises a folder platen assembly, which includes a folder platen 130, support plate 140 and folder bar 150. The folder platen 130 is located onto a pair of guide shafts 300 which are supported in laterally opposed portions of the head frame 42. The folder platen 130 is slidably engaged onto shafts 300 which guide the platen 130 up and down from an uppermost position to a lowermost position (the range of linear displacement is defined as the "stroke").

The folder platen assembly is actuated by an electromechanical cam drive system. An electric actuator 100 drives a cam shaft 110 securably engaged with a linkage member 120 that is coupled to the folder platen 130. As the folder platen 130 moves down towards the bottom of its stroke, the folder bar 150 contacts the strip material 2 and forms the programmed bend or fold. In this specification 'electromechanical' refers to an electric drive or actuator (i.e. the motive force is electric) coupled with mechanical components which thereby transmits electrical energy into mechanical motion.

The cutter broadly comprises a guillotine platen assembly, which includes a guillotine platen 230, upper blade holder 240 and upper cutting blade 245. The upper blade holder 240 is mounted to the base of the guillotine platen 230 such that the upper cutting blade 245 moves up and down with the guillotine platen 230. The guillotine platen 230 is also located on the guide shafts 300 but may be fixedly engaged. In this manner, the guillotine platen 230 and shafts 300 are movable in unison from an uppermost position to a lowermost position (the range of linear displacement is defined as the "stroke"). In alternative embodiments the guillotine platen 230 may be slidably movable with respect to the shafts 300. The guillotine platen assembly is actuated by an electromechanical cam drive system. An electric actuator 200 drives a cam shaft 210 securably engaged with a linkage member 220
that is coupled to the guillotine platen 230. As the guillotine platen 230 moves down towards the
bottom of its stroke, the upper cutting blade 245 contacts the strip material 2 and cooperates with a
fixed lower cutting blade 255 to cut or shear the strip material 2 clean through.

Although it is preferable that both the cutter and folder are actuated by an electromechanical cam drive
arrangement, there will be instances where spatial constraints may require the folder to be
pneumatically driven. For example, in a smaller variant of the machine, it may be preferable to utilize
the compact arrangement of a pneumatic drive to actuate the folder platen assembly. In such an
embodiment, the cutter would remain driven by an electromechanical cam arrangement, and therefore
the advantages associated with this form of actuation would still be realized in the overall performance
of the machine.

- Referring now to Figure 7 there is shown a sectional view through A-A of Figure 5 through the folder
drive mechanism. An electric actuator 100 is shown mounted onto the rear of the head frame 42. The
electric actuator 100 may be any suitable electric motor, but preferably a servo motor. A servo motor
advantageously provides the requisite level of control and accuracy while still providing sufficient
power and torque. An eccentric cam shaft 110 is securably mounted onto the output shaft 101 of the
servo motor 100. The output shaft 101 of the motor 100 has a raised key element 102 which slidably
engages into an internal keyway (not shown) of the cam shaft 100. Through this connection the key
102 prevents relative rotation between the two parts and allows torque to be transmitted from the
motor 100 to the cam shaft 110. A grub screw (not shown) is used to lock the cam shaft 110 onto the
output shaft 101 of the motor 100 through a threaded hole in the cam shaft 110. The cam shaft 110 is
rotatably supported by ball bearing 113 that is housed in head frame 42.

The cam shaft 110 is connected to a linkage member or rocker arm 120. This connection is illustrated
most clearly in Figure 8 which shows an exploded view of the cam shaft and linkage arrangement of
the folder drive. Figure 12 also provides detail of the folder drive arrangement (with cutter drive not
shown). The cam shaft 110 comprises an elongate shank portion 111 and a radially offset or eccentric
cam pin’112. The linkage member 120 includes a first aperture 127 and a second aperture 128. The
cam pin 112 is inserted through the first aperture 127 of the linkage member 120, and is rotatable
within ball bearing 121 that is mounted within the first aperture 127 of the linkage member 120 and
held by an internal circlip 122. The cam shaft 110 is secured to the linkage member 120 by a link
retainer or washer 123 that is mounted onto the surface of the linkage member 120 surrounding the
first aperture 127. A suitable fastener, for example a socket head screw is fastened through a threaded
hole of the link retainer 123 and into a threaded hole 115 in the cam pin 112. This connection
facilitates a direct coupling between the cam shaft 110 and the linkage member 120 such that as the
cam shaft 110 rotates, the linkage member 120 is driven between an uppermost position and a
lowermost position in a reciprocal manner.

The folder platen assembly is coupled to the linkage member 120 via a coupling element 126 that is
inserted through the second aperture 128 of the linkage member 120. The coupling element 126 may
be an elongate pin element. The coupling element 126 is inserted through a passageway 132 located in
the folder platen 130 and is supported by a bush 125 located in the second aperture 128 of the linkage
member 120. The outer surface of the coupling member 126 bears against the internal walls 133 of the
passageway 132 of the folder platen 130. Therefore, as the linkage member 120 is lowered or raised,
the coupling member 126 exerts a bearing force onto the passageway 132 of the folder platen 130,
resulting in a lowering or lifting of the folder platen 130.

Throughout this specification, the word 'platen' is used to describe a block or ram element of:
sufficient mass which when driven down towards the strip material, is capable of applying the force
required during the folding or cutting processes.

As the folder platen 130 is situated forward of the guillotine platen 230, in a preferred embodiment the
linkage member 120 is machined with an upper portion 129a having the first aperture 127 stepped
from a lower portion 129b having the second aperture 128, creating an offset in the fore-aft direction
between the upper portion 129a and the lower portion 129b. Forming the linkage member in this way,
enables commonality between the cam shafts of both the folder drive and the guillotine drive. If a
straight linkage were used (as for the guillotine drive), the cam shaft would need to be longer which
would result in higher loading at the base of the cam shaft and motor shaft which would create higher
cyclical stresses and reduce the fatigue life of the components. Providing the stepped linkage member
alleviates these problems and allows the first apertures of both linkages to be situated and driven in the
same vertical plane.

The folder platen assembly may also include a clamping member for clamping the strip material prior
to folding. As shown in Figure 7, a clamp bar 160 is secured beneath the folder platen 130, and at the
interface between the base of the folder platen 130 and the clamp bar 160 there are located a plurality
of compression springs 166. In one embodiment the clamp bar 160 includes a rubber block 165 (for
example a polyurethane elastomer) through which the compressive clamping force is transmitted to
the strip material 2. The rubber material acts to absorb or minimize vibration and reduce noise as the
clamp bar 160 contacts the strip which will help prevent damage to the strip material.

The folder bar 150 is fastened to an adjustable support plate 140 which is mounted to the front of the
folder platen 130. The support plate 140 is adjustably mounted to the folder platen 130 providing
ability to adjust the vertical position of the folder bar 150. The support plate 140 is located on cam followers 175 which maintain the alignment of the support plate 140 and allow up and down vertical adjustment. In one embodiment the adjustability is provided by thumb wheels 170 mounted through the folder platen 130 which, in use, are turned to move the support plate 140 up and down. This adjustability can vary how far the folder bar 150 travels on its down stroke, which can directly determine the quality of fold produced for certain fold angles. In one embodiment, the support plate 140 is formed by two interlocking plates, each with adjustability which can be advantageous when processing two strips simultaneously. In this embodiment, the folder bar 150 comprises two separate bars which each mount to one respective support plate 140.

In operation, as the folder platen 130 traverses downwards, the clamp bar 160 will first contact the strip and the springs 166 will act to apply a compressive clamping force to hold the strip 2 in position for the folder bar 150 to bend the material. As the folder platen 130 traverses further to the bottom of its stroke, the springs 166 are compressed further, allowing the folder bar 150 to travel below the clamp bar 160 and produce the bend or fold. The folding operation is performed about the edge of a carbide block 251 which is mounted into a recess in the lower blade holder 250. As the folder bar 150 is lowered, it contacts the strip material 2 at predetermined positions and produces a fold. The strip material 2 bends around the edge of the carbide block 251 and is formed by the folder bar 150 which has a defined radius of curvature about its folding edge. As the strip material 2 is fed through the head assembly 40, a plurality of folds are made at predetermined positions before the strip 2 is cut and a lamination 4 is produced.

Referring now to Figure 9 there is shown a sectional view through B-B of Figure 5 through the guillotine drive mechanism. The electric actuator 200 is shown mounted onto the rear of the head frame 42. The electric actuator 200 may be any suitable electric motor, but preferably a servo motor. A servo motor advantageously provides the requisite level of control and accuracy while still providing sufficient power and torque. An eccentric cam shaft 210 is securely mounted onto the output shaft 201 of the servo motor 200. The output shaft 201 of the motor 200 has a raised key element 202 which slidably engages into an internal keyway (not shown) of the cam shaft 210. Through this connection the key 202 prevents relative rotation between the two parts and allows torque to be transmitted from the motor 200 to the cam shaft 210. A grub screw (not shown) is used to lock the cam shaft 210 onto the output shaft 201 of the motor 200 through a threaded hole in the cam shaft 210. The cam shaft 210 is rotatably supported by ball bearing 213 that is housed in head frame 42.

The cam shaft 210 is connected to a linkage member or rocker arm 220. This connection is illustrated most clearly in Figure 10 which shows an exploded view of the cam shaft 210 and linkage arrangement of the folder drive. Figure 13 also provides detail of the guillotine drive arrangement.
(with folder drive not shown). The cam shaft 210 comprises an elongate shank portion 211 and a radially offset or eccentric cam pin 212. The linkage member 220 includes a first aperture 227 and a second aperture 228. The cam pin 212 is inserted through the first aperture 227 of the linkage member 220, and is rotatable within ball bearing 221 that is mounted within the first aperture 227 of the linkage member 220 and held by an internal circlip 222. The cam shaft 210 is secured to the linkage member 220 by a link retainer or washer 223 that is mounted onto the surface of the linkage member 220 surrounding the first aperture 227. A suitable fastener, for example a socket head screw is fastened through a threaded hole of the link retainer 223 and into a threaded hole 215 in the cam pin 212. This connection facilitates a direct coupling between the cam shaft 210 and the linkage member 220 such that as the cam shaft 210 rotates, the linkage member 220 is driven between an uppermost position and a lowermost position in a reciprocal manner.

The guillotine platen assembly is coupled to the linkage member 220 via a coupling element 226 that is inserted through the second aperture 228 of the linkage member 220. The coupling element 226 may be an elongate pin element. The coupling element 226 is inserted through a passageway 232 located in the guillotine platen 230 and is supported by a bush 225 located in the second aperture 228 of the linkage member 220. The outer surface of the coupling member 226 bears against the internal walls 233 of the passageway 232 of the guillotine platen 230. Therefore, as the linkage member 220 is lowered or raised, the coupling member 226 exerts a bearing force onto the passageway 232 of the guillotine platen 230, resulting in a lowering or lifting of the guillotine platen 230.

The guillotine platen 230 accommodates the mounting of an upper blade holder 240 which is adjustably mounted to the base of the guillotine platen 230. An upper cutting blade 245 is mounted in the upper blade holder 240 such that the cutting edge extends below the blade holder 240. In one embodiment the blade may be made from carbide. Mounting of the upper blade holder 240 is adjustable in the fore-aft direction with respect to the head assembly 40. Adjustment is achieved by die springs 241 which act between a lip of the upper blade holder 240 and the guillotine platen 230. The purpose of this adjustment is to obtain the desired separation between the upper cutting blade 245 and lower cutting blade 255. It has been found that a blade clearance of about 12 microns provides the machine 10 with optimal cutting characteristics. If the clearance exceeds about 12 microns the likelihood of a cut with burring increases and if the clearance is less than about 12 microns the likelihood of blade chipping increases.

As the guillotine platen 230 is lowered, the upper blade 245 will contact the strip material 2 immediately above a lifter plate 260. The guillotine platen 230 will compress the lifter plate 260 which is mounted on compression springs 265. As the guillotine platen 230 is driven further down towards the bottom of its stroke, the strip material 2 which is sandwiched between the upper blade 245 and
lifter plate 260 will be forced beneath the edge of the lower blade 255. This will shear the material right through and create a clean cut at a predetermined position. After the cut has been made, the guillotine platen 230 begins to rise and the compression springs 265 act to raise or lift the lifter plate 260 up above the lower blade 255. This lifting raises the strip 2 above the edge of the lower blade 255 and prevents the strip 2 which is being continuously fed to the head assembly 40 from catching on the rear side of the lower blade 255. As the strip material 2 fed to the head assembly 40 is from a wound coil, it has a tendency to coil or flick up even when unwound. To prevent this occurrence the upward stroke of the guillotine platen 230 may be limited such that the space wherein the strip 2 may have a tendency to want to warp or lift up is taken up by the upper blade holder assembly. This is another advantage of having an electric cam driven platen, as it is possible to accurately control the stroke of the platen.

Referring now to Figure 11 there is shown a sectional view through C-C of Figure 5 through the main guide shafts 300. The shafts 300 are received in apertures 330 in laterally opposed portions of the head frame 42. The shafts 300 are supported by bushes 310 inserted into apertures 330 of the head frame 42. Inserted inside the bushes 310 are peened ball cages 305 which are slidably engaged with the shafts 300. In one embodiment, the shafts 300 may be keyed to the cages 305 so that the shafts 300 and cages 305 move together, slidably inside the bushes 310. Alternatively, the cages 305 may be secured inside the bushes 310 by an interference fit such that the cages 305 remain stationary while the shafts 300 are slidable inside the cages 305. The shafts 300 are for the purpose of supporting the traverse of both the folder platen 130 and guillotine platen 230. The guillotine platen 230 locates onto the shafts 300 and may be coupled to the shafts 300 by screws 304 which locate through the guillotine platen 230 and into grooves 302 machined into the shafts 300. Screws 304 couple the movement of the guillotine platen 230 to the shafts 300, such that as the guillotine platen 230 traverses up and down, the shafts 300 also move up and down inside the cages 305. The folder platen 130 also locates onto the shafts 300 but is not locked or keyed onto the shafts 300 as the guillotine platen 230 is. The folder platen 130 is slidably engaged with the shafts 300 such that the folder platen 130 is slidably movable with respect to the shafts 300. A bush 320 and peened ball cage 315 is retained in shaft receiving portions of the folder platen 130 to facilitate this relative sliding.

Referring now to Figures 14a-14d, there is shown a sequence of views of the folder drive mechanism in operation. Figures 14a-14d illustrate the position of the folder platen 130 and folder bar 150 as the cam shaft 110 rotates through 0° (Top Dead Centre (TDC)), 90°, 180° (Bottom Dead Centre (BDC)) and 270°. There is a 5mm eccentricity or offset between the longitudinal axis of the shank portion 111 of the cam shaft 110 (attached to the output shaft 101 of the motor 100), and the longitudinal axis of the cam pin 112 (coupled to the first aperture 127 of the linkage member 120). This eccentricity results in a total stroke or travel of the folder platen 130 of 10mm between the TDC position of the cam pin
112 and the bottom dead centre (BDC) position. Mounted onto a plate directly above the linkage 120 is an inductive proximity switch 180 which detects when the cam pin 112 and linkage member 120 are at the TDC position and inputs this information to a programmed controller. In Figure 14a, the cam shaft 110 is at 0° (TDC) and the folder platen assembly is shown in its uppermost position. The support plate 140 and folder bar 150 are located above the top surfaces of the lower blade holder 250 and carbide block 251, the top surfaces located in horizontal datum plane Y. The vertical separation between the top of the linkage member 120 and the bottom of the proximity switch 180 defined as x mm. Figure 14b depicts the cam shaft 110 rotated through 90°. The folder platen assembly has been lowered 5mm (the eccentric offset) so that the separation between the top of the linkage member 120 and the bottom of the proximity switch 180 is now (x-5)mm. The base of the folder bar 150 is now substantially level with the top surface of the carbide block 251 (ie. co-planar with horizontal datum plane Y). Figure 14c depicts the cam shaft 110 at 180° (BDC) and the folder platen assembly at its lowermost position. The folder platen assembly has now been lowered 10mm so that the separation between the top of the linkage member 120 and the bottom of the proximity switch 180 is now (x-10)mm. In this position, the folder bar 150 has been lowered below horizontal datum plane Y and the strip 2 being fed through the head assembly 40 will have been folded about the carbide block 251. Figure 14d depicts the cam shaft 110 at 270° and shows the folder platen assembly moving upwards from BDC back towards TDC. The separation between the top of the linkage member 120 and the bottom of the proximity switch 180 is now (x-5)mm and the base of the folder bar 150 is again substantially aligned with horizontal datum plane Y. Figures 14a-14d further illustrate that as the cam shaft 110 and linkage member 120 are rotated, a reciprocating linear motion is imparted to the folder drive assembly.

Referring now to Figure 15a-15d, there is shown a sequence of views of the guillotine drive mechanism in operation. Figures 15a-l 5d illustrate the position of the guillotine platen 230 and upper cutting blade 245 as the cam shaft 110 rotates through 0° (Top Dead Centre (TDC)), 90°, 180° (Bottom Dead Centre (BDC)) and 270°. There is a 5mm eccentricity or offset between the longitudinal axis of the shank portion 211 of the cam shaft 210 (attached to the output shaft 201 of the motor 200), and the longitudinal axis of the cam pin 212 (coupled to the upper aperture 227 of the linkage member 220). This eccentricity results in a total stroke or travel of the guillotine platen 230 of 10mm between the TDC position of the cam pin 212 and the BDC position. Mounted onto a plate directly above, the linkage member 220 is an inductive proximity switch 280 which detects when the cam pin 212 and linkage member 220 are at the TDC position and inputs this information to a programmed controller. In Figure 15a, the cam shaft 210 is at 0° (TDC) and the guillotine platen assembly is shown in its uppermost position. The upper blade holder 240 and upper cutting blade 245 are located above the top surfaces of the lower blade holder 250, carbide block 251 and lower cutting blade 255, the top surfaces located in horizontal datum plane Y. The vertical separation between the top of the linkage member
220 and the bottom of the proximity switch 280 defined as xmm. Figure 15b depicts the cam shaft 210
rotated through 90°. The guillotine platen assembly has been lowered 5mm (the eccentric offset) so
that the separation between the top of the linkage member 220 and the bottom of the proximity switch
280 is now (x-5)mm. The base of the upper cutting blade 245 is now substantially level with the top
surface of the lower cutting blade 255 (i.e. co-planar with horizontal datum plane Y). Figure 15c
depicts the cam shaft 210 at 180° (BDC) and the guillotine platen assembly at its lowermost position.
The guillotine platen assembly has now been lowered 10mm so that the separation between the top of
the linkage member 220 and the bottom of the proximity switch 280 is now (x-10)mm. In this
position, the base of the upper cutting blade 245 has been lowered below horizontal datum plane Y
and the strip 2 being fed through the head assembly 40 will have been cut or sheared between lower
cutting blade 255. Figure 15d depicts the cam shaft 210 at 270° and shows the guillotine platen
assembly moving upwards from BDC back towards TDC. The separation between the top of the
linkage member 220 and the bottom of the proximity switch 280 is now (x-5)mm and the base of the
upper cutting blade 245 is again substantially aligned with horizontal datum plane Y. Figures 15a-l 5d
further illustrate that as the cam shaft 210 and linkage member 220 are rotated, a reciprocating linear
motion is imparted to the guillotine drive assembly.

It will be understood that the term "comprise" and any of its derivatives (e.g. comprises, comprising)
as used in this specification is to be taken to be inclusive of features to which it refers, and is not
meant to exclude the presence of any additional features unless otherwise stated or implied.

The reference to any prior art in this specification is not, and should not be taken as, an
acknowledgment or any form of suggestion that such prior art forms part of the common general
knowledge of the technical field.

While the present invention has been described in terms of preferred embodiments in order to facilitate
better understanding of the invention, it should be appreciated that various modifications can be made
without departing from the principles of the invention. Therefore, the invention should be understood
to include all such modifications within its scope.
THE CLAIMS:

1. A machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:
   a first electromechanical cam drive for actuating a folder that folds the strip material; and
   a second electromechanical cam drive for actuating a cutter that cuts the strip material, wherein the folder and the cutter are independently drivable.

2. The machine as claimed in claim 1 wherein the first electromechanical cam drive includes:
   a first electric actuator having an output shaft;
   a first cam shaft securably engaged onto the output shaft of the first electric actuator; and
   a first linkage member coupled between the first cam shaft and the folder, wherein, in use, the cam drive converts rotational motion of the actuator into linear displacement of the folder.

3. The machine as claimed in claim 1 wherein the second electromechanical cam drive includes:
   a second electric actuator having an output shaft;
   a second cam shaft securably engaged onto the output shaft of the second electric actuator; and
   a second linkage member coupled between the second cam shaft and the cutter, wherein, in use, the cam drive converts rotational motion of the actuator into linear displacement of the cutter.

4. The machine as claimed in claim 2 wherein the first linkage member has a first portion having a first aperture and a second portion having a second aperture, wherein the first and second portions are stepped apart.

5. The machine as claimed in either one of claims 2 or 3 wherein at least one of the first or second electric actuators is an electric motor.

6. The machine as claimed in claim 1 wherein the folder includes a folder platen having an associated folder bar to fold said strip material, the platen reciprocally drivable between an uppermost position and a lowermost position.
7. The machine as claimed in claim 1 wherein the cutter includes a guillotine platen having an associated upper cutting blade, the platen reciprocally drivable between an uppermost position and a lowermost position.

8. The machine as claimed in claim 7 wherein the cutter further includes a fixed lower blade that cooperates with the upper blade of the guillotine platen to cut the strip material by shearing between the blades.

9. The machine as claimed in claim 1 further including a clamping member for clamping said strip material.

10. A machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:

   a frame for housing a folder platen assembly and a guillotine platen assembly;
   a folder platen assembly having a folder bar for folding said strip material in at least one pre-determined position;
   a guillotine platen assembly having a cutting blade for cutting said strip material at a pre-determined position;

   a first electric actuator;
   a second electric actuator;
   a first cam shaft driven by the first electric actuator and coupled to the folder platen assembly; and
   a second cam shaft driven by the second electric actuator and coupled to the guillotine platen assembly,

   wherein the folder platen assembly and guillotine platen assembly are independently drivable.

11. The machine as claimed in claim 10 further including a first linkage member coupled between the first cam shaft and the folder platen assembly.

12. The machine as claimed in claim 10 further including a second linkage member coupled between the second cam shaft and the guillotine platen assembly.

13. The machine as claimed in claim 11 wherein the first linkage member and folder platen assembly are coupled by a first pin element.
14. The machine as claimed in claim 12 wherein the second linkage member and guillotine platen assembly are coupled by a second pin element.

15. The machine as claimed in claim 10 wherein the folder platen assembly and guillotine platen assembly locate onto a pair of shafts that are housed in laterally opposed portions of the frame.

16. The machine as claimed in claim 15 wherein the folder platen assembly is slidably movable along the shafts.

17. The machine as claimed in claim 15 wherein the guillotine platen assembly is fixedly engaged to the shafts such that the platen and shafts are movable in unison.

18. A drive system for a machine for manufacturing stackable laminations of a magnetic core, the laminations formed from magnetic strip material, the drive system including:

- a folder drive mechanism for controlling movement of a folder platen assembly that folds the strip material in at least one pre-determined position, the folder drive including:
  - a first electric actuator having an output shaft;
  - a first cam shaft adapted to be securably mounted onto the output shaft of the first electric actuator; and
  - a first linkage member coupled between the first cam shaft and the folder platen assembly,

wherein, as the first cam shaft is rotated, a reciprocating linear motion is imparted to the folder platen assembly; and

- a guillotine drive mechanism for controlling movement of a guillotine platen assembly that cuts the strip material in at least one pre-determined position, the guillotine drive including:
  - a second electric actuator having an output shaft;
  - a second cam shaft adapted to be securably mounted onto the output shaft of the second electric actuator; and
  - a second linkage member coupled between the second cam shaft and the guillotine platen assembly,

wherein, as the second cam shaft is rotated, a reciprocating motion is imparted to the guillotine platen assembly.

19. The drive system as claimed in claim 18 wherein at least one of the first or second electric actuators is an electric motor.
20. A machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:
   a first pneumatic drive for actuating a folder that folds the strip material; and
   a first electromechanical cam drive for actuating a cutter that cuts the strip material,
   wherein the folder and the cutter are independently drivable.

21. A machine for manufacturing stackable laminations for a magnetic core, the laminations formed from magnetic strip material, the machine including:
   a frame for housing a folder platen assembly and a guillotine platen assembly;
   a folder platen assembly having a folder bar for folding said strip material in at least one pre-determined position;
   a guillotine platen assembly having a cutting blade for cutting said strip material at a pre-determined position;
   a first electric actuator;
   a first cam shaft driven by the first electric actuator and coupled to the guillotine platen assembly; and
   a first pneumatic actuator coupled to the folder platen assembly;
   wherein the folder platen assembly and guillotine platen assembly are independently drivable.

22. A machine for manufacturing stackable laminations for a magnetic core substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

23. A drive system for a machine for manufacturing stackable laminations for a magnetic core substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.
Figure 8
INTERNATIONAL SEARCH REPORT

International application No. PCT/AU2011/000757

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
H01F 41/02 (2006.01)  H01F 27/24 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentary searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Google patents, WPI, EPODOC (keywords used: manufacture, lamination, magnet, actuate, fold, guillotine and the like terms)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 3,5 14,836 A (MASON) 2 June 1970 (Figs 1 - 16, abstract, column 1 lines 14 - 38, column 3 lines 69 - column 4 line 8, column 5 lines 68 - 72, column 6 lines 18 - 23, column 6 lines 52 - 57, column 7 lines 39 - column 8 line 3, column 8 line 69 - column 9 line 7, column 10 line 23 - 32, column 12 lines 28 - 31)</td>
<td>1 - 21</td>
</tr>
<tr>
<td>X</td>
<td>US 3,08 1,962 A (OLSEN et al.) 19 March 1963 (Figs 1 - 6, column 1 line 54 - column 2 line 3, column 2 lines 36 - 49, column 3 lines 4 - 16, column 3 lines 54 - 64, column 6 lines 28 - 51, column 12 lines 24 - 47, column 13 line 70 - column 14 line 4)</td>
<td>1 &amp; 20</td>
</tr>
<tr>
<td>A</td>
<td>US 3,25 1,208 A (MITTERMAIER) 17 May 1966</td>
<td></td>
</tr>
</tbody>
</table>

X Further documents are listed in the continuation of Box C  X See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 5 August 2011

Date of mailing of the international search report 08 August 2011

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustralia.gov.au
Facsimile No. +61 2 6283 7999

Authorized officer
Khalid Ahmad

AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No : +61 3 9935 9634

Form PCT/ISA/2 10 (second sheet) (July 2009)
**INTERNATIONAL SEARCH REPORT**

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
   - because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: 22 - 23
   - because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
   - These claims do not comply with Rule 6.2(a) because they rely on references to the description and/or drawings.

3. Claims Nos.:
   - because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.
**INTERNATIONAL SEARCH REPORT**

**International application No.**
PCT /AU2011/000757

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 3,875,787 A (MESCHERYAKOV) 8 April 1975</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 3,453,726 A (ROEN) 8 July 1969</td>
<td></td>
</tr>
</tbody>
</table>
This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>US 3514836</td>
<td>AU 57716/69</td>
</tr>
<tr>
<td></td>
<td>DE 1763668</td>
</tr>
<tr>
<td></td>
<td>FR 1574500</td>
</tr>
<tr>
<td>GB 1194085</td>
<td>US 3634932</td>
</tr>
<tr>
<td></td>
<td>US 3745394</td>
</tr>
<tr>
<td>US 3081962</td>
<td>GB 907725</td>
</tr>
<tr>
<td></td>
<td>US 3200476</td>
</tr>
<tr>
<td></td>
<td>US 3201732</td>
</tr>
<tr>
<td>US 3251208</td>
<td>NONE</td>
</tr>
<tr>
<td>US 3875787</td>
<td>NONE</td>
</tr>
<tr>
<td>US 3453726</td>
<td>NONE</td>
</tr>
</tbody>
</table>

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX