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Fahley

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[45] **Date of Patent: Jan. 18, 2000**

[54] **METHOD AND APPARATUS FOR MAGNET/ BACKIRON BONDING USING SLIP FIT PINS**

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[73] Assignee: **Seagate Technology, Inc.**, Scotts Valley, Calif.

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[22] Filed: **Dec. 3, 1997**

[51] **Int. Cl.**[7] **H05K 3/00**

[52] **U.S. Cl.** **156/539**; 156/556; 156/293

[58] **Field of Search** 156/297, 363, 156/293, 538, 539, 556; 29/281.1, 428

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,864,158 12/1958 Hake 29/406

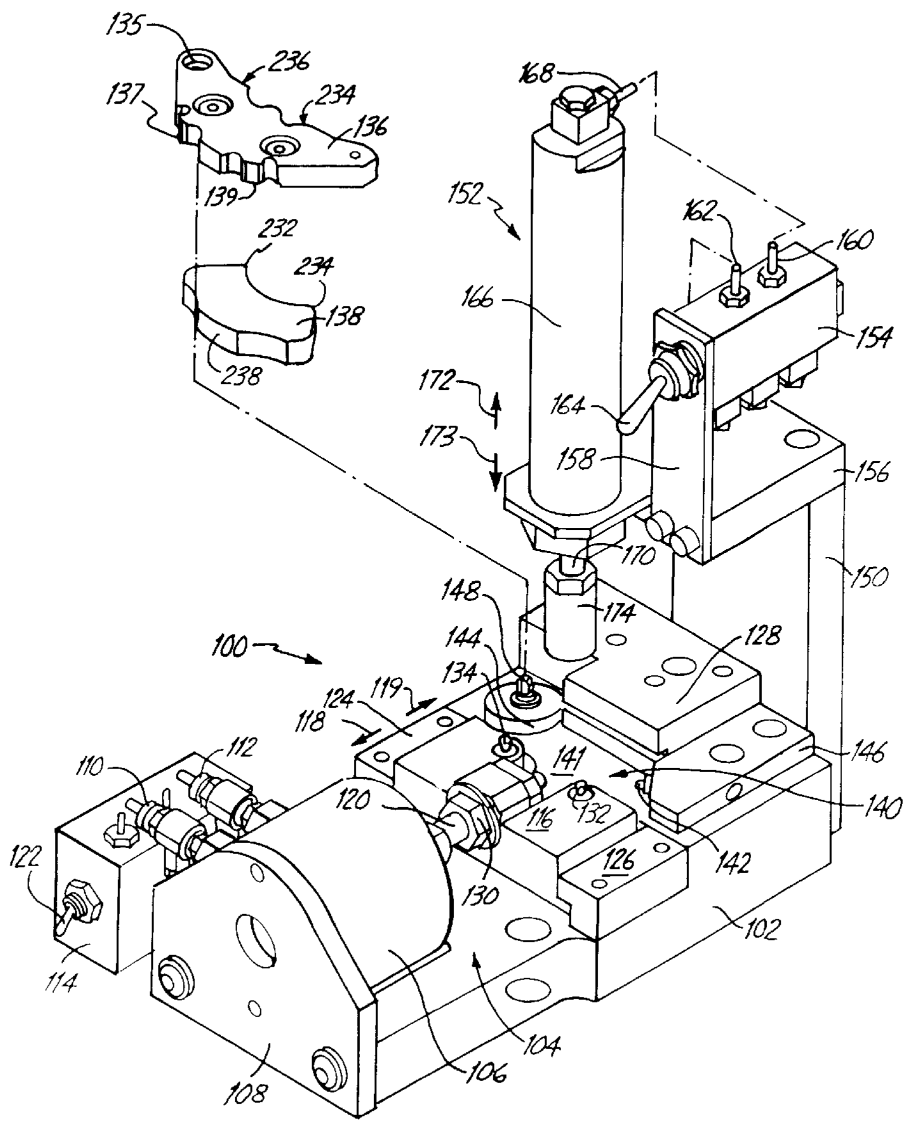
Primary Examiner—Francis J. Lorin

Attorney, Agent, or Firm—Westman, Champlin & Kelly, P.A.

[57] **ABSTRACT**

A bonding apparatus for bonding a magnetic piece to a backiron includes a base and a back assembly next to the base and having at least one back surface. A front assembly having a front surface facing the back assembly has at least one aperture for a locating pin. The locating pin is slip fit into the aperture of the front assembly. In addition, a method for replacing locating pins is provided.

14 Claims, 10 Drawing Sheets



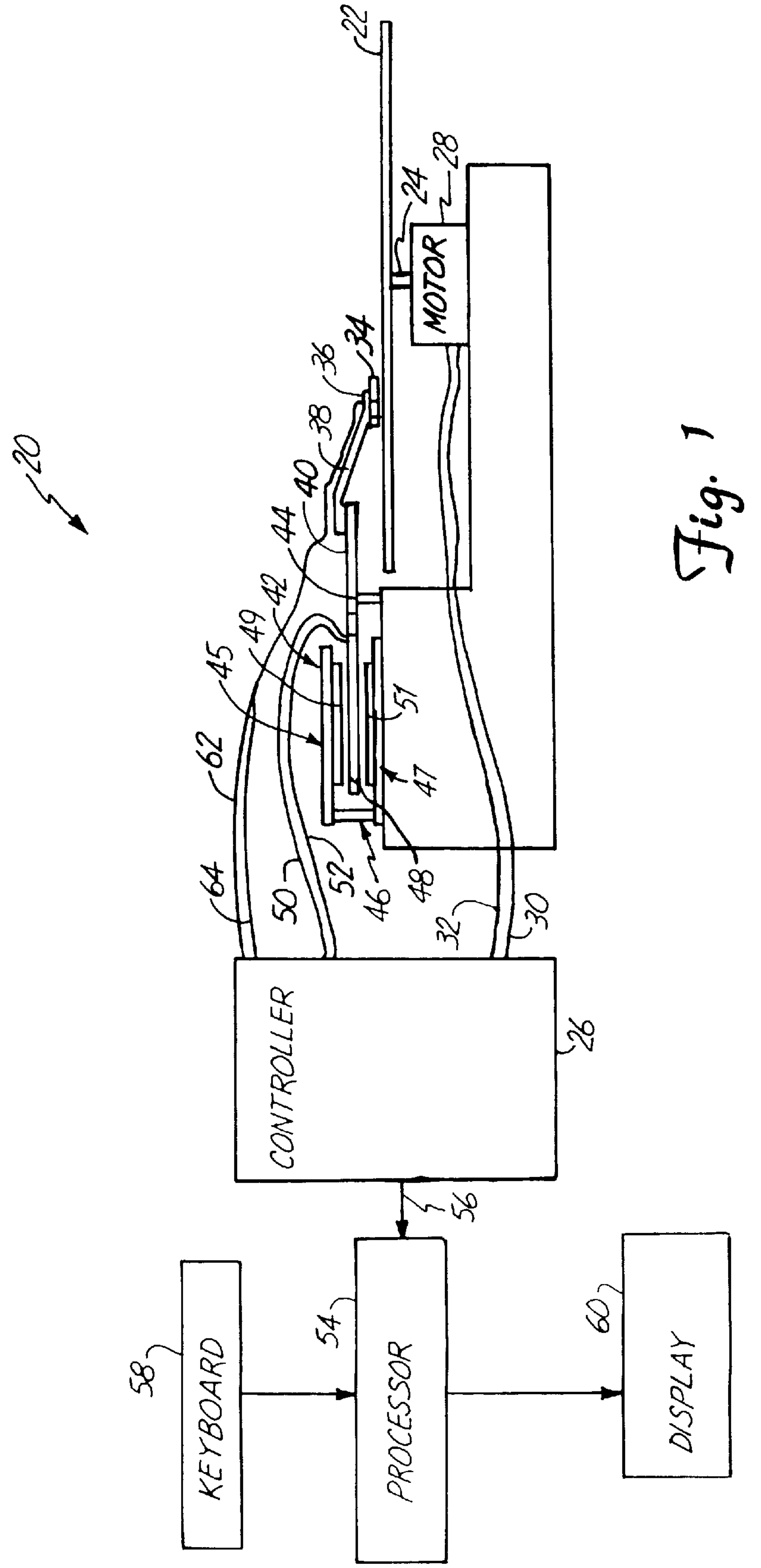

MOTOR
CONTROLLER
KEYBOARD
PROCESSOR
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Fig. 1

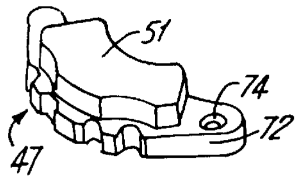


Fig. 2

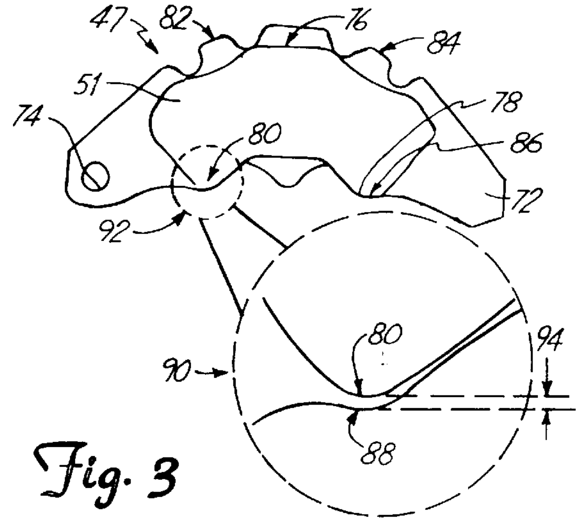


Fig. 3

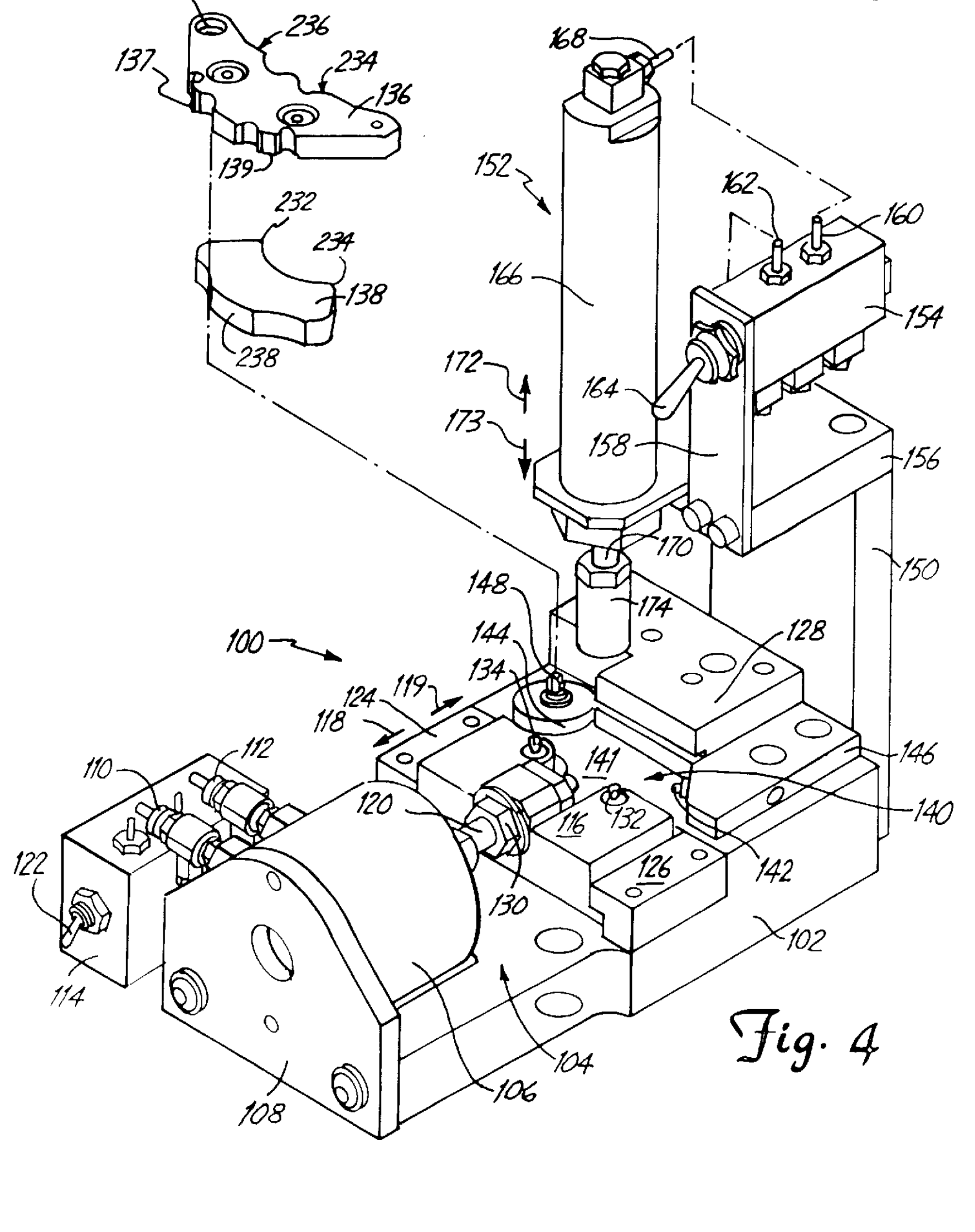


Fig. 4

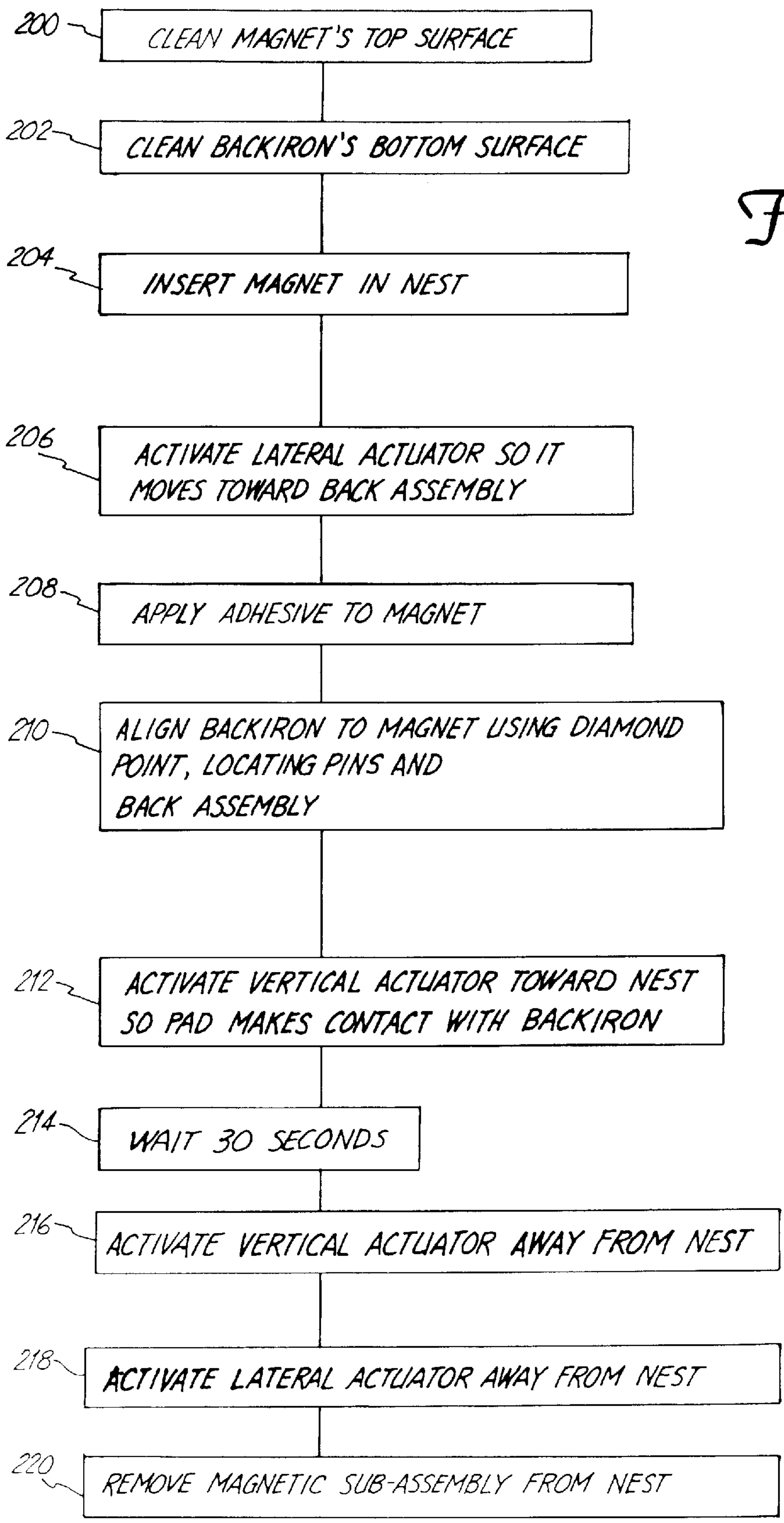
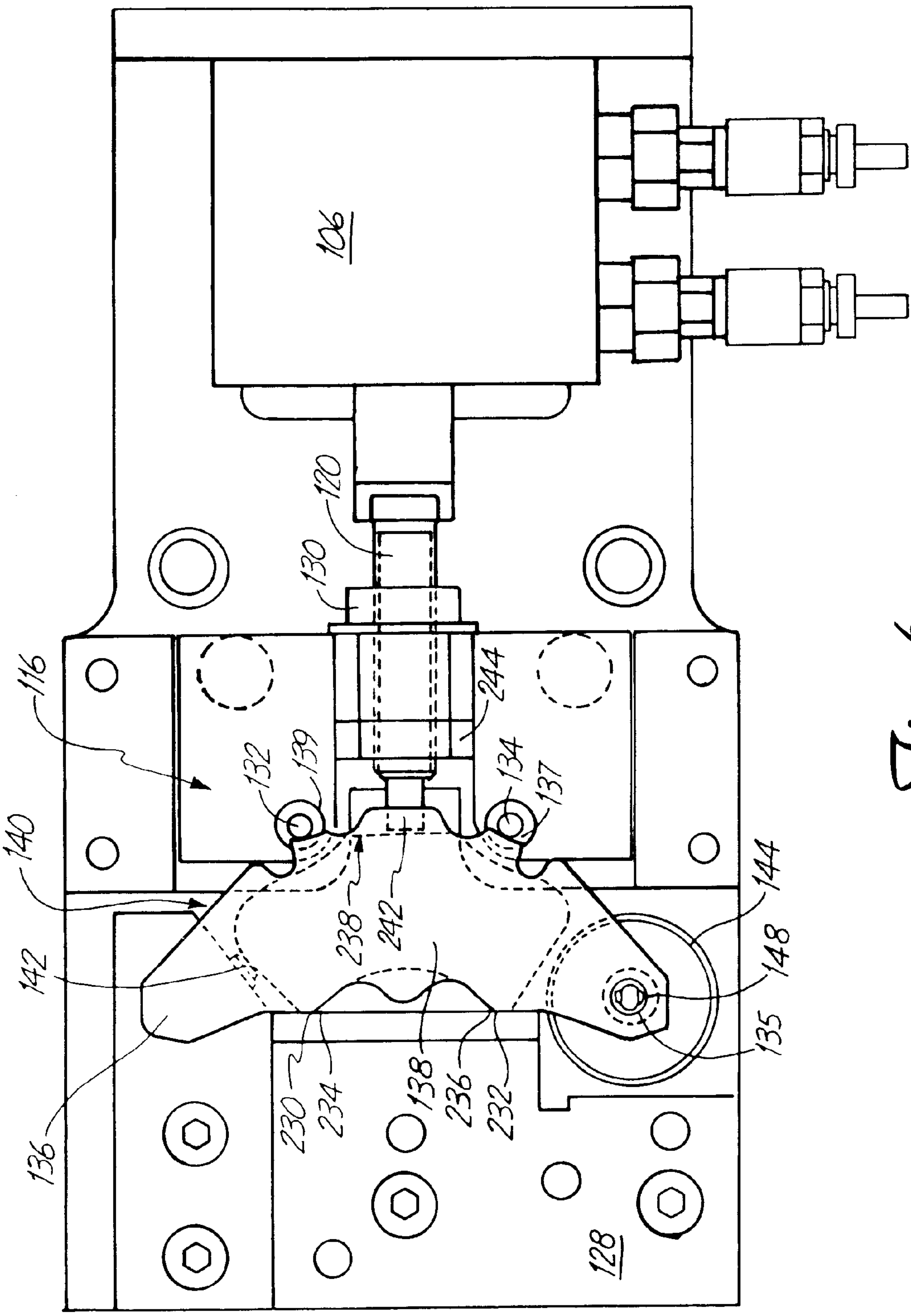

200
CLEAN MAGNET'S TOP SURFACE
202
CLEAN BACKIRON'S BOTTOM SURFACE
204
INSERT MAGNET IN NEST
206
ACTIVATE LATERAL ACTUATOR SO IT MOVES TOWARD BACK ASSEMBLY
208
APPLY ADHESIVE TO MAGNET
210
ALIGN BACKIRON TO MAGNET USING DIAMOND POINT, LOCATING PINS AND BACK ASSEMBLY
212
ACTIVATE VERTICAL ACTUATOR TOWARD NEST SO PAD MAKES CONTACT WITH BACKIRON
214
WAIT 30 SECONDS
216
ACTIVATE VERTICAL ACTUATOR AWAY FROM NEST
218
ACTIVATE LATERAL ACTUATOR AWAY FROM NEST
220
REMOVE MAGNETIC SUB-ASSEMBLY FROM NEST

Fig. 5


106
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130
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128

Fig. 6

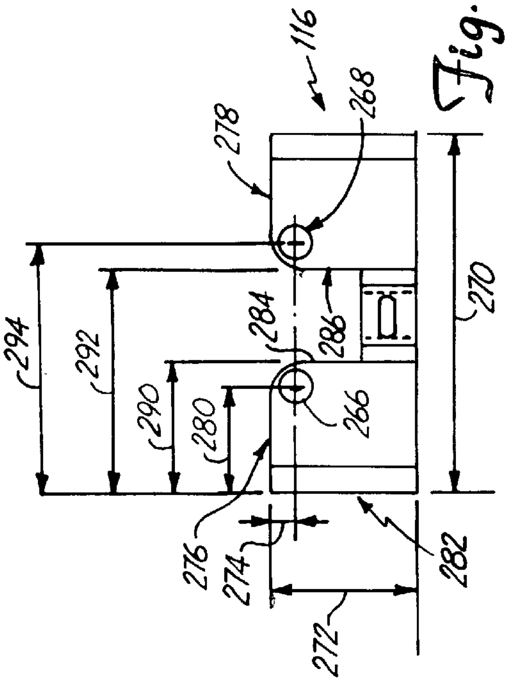


Fig. 8

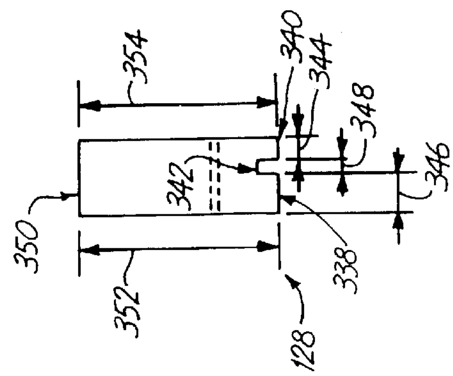


Fig. 11

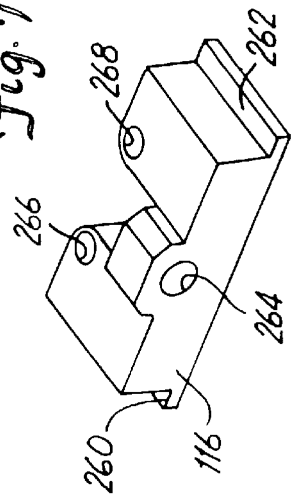


Fig. 7

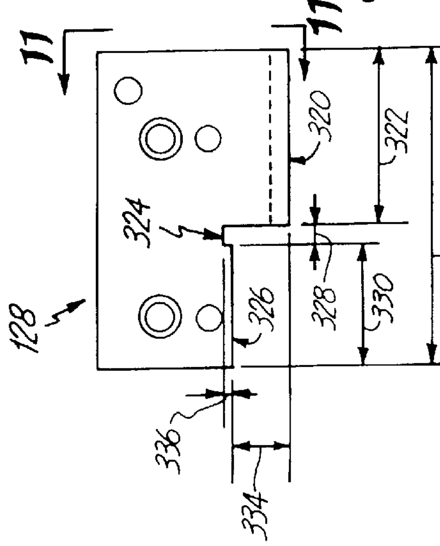


Fig. 10

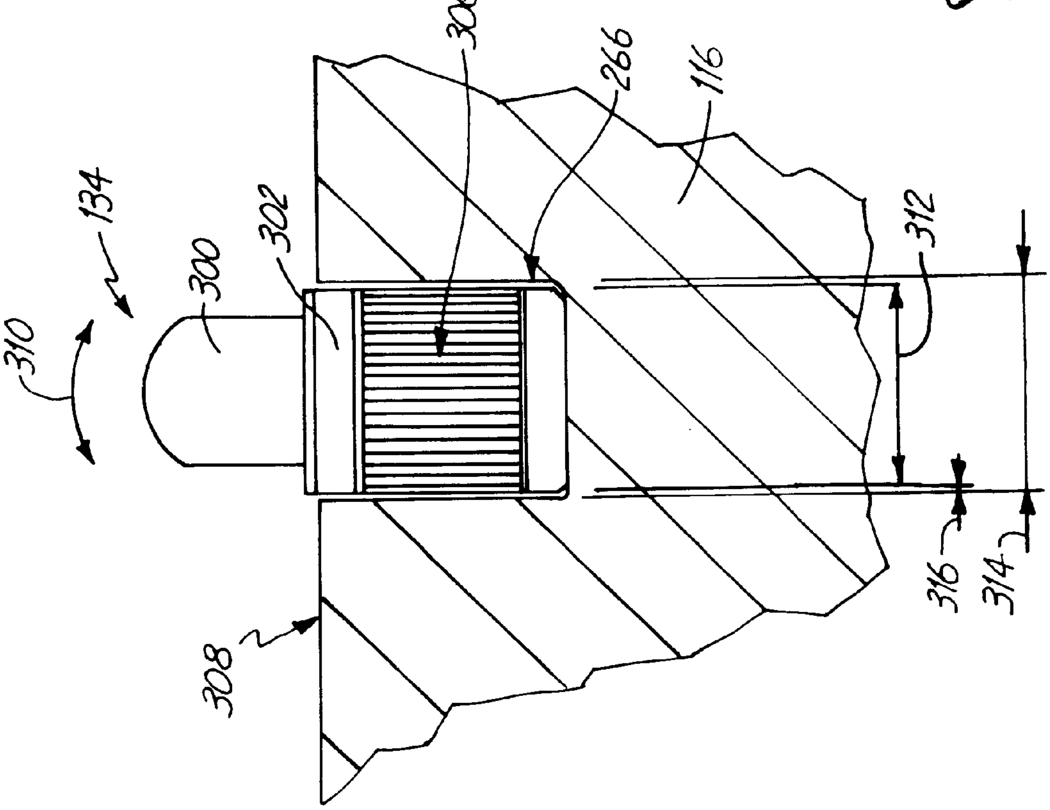


Fig. 9

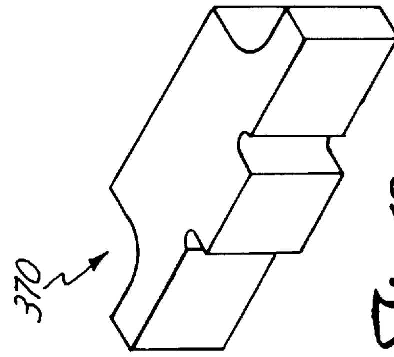


Fig. 12

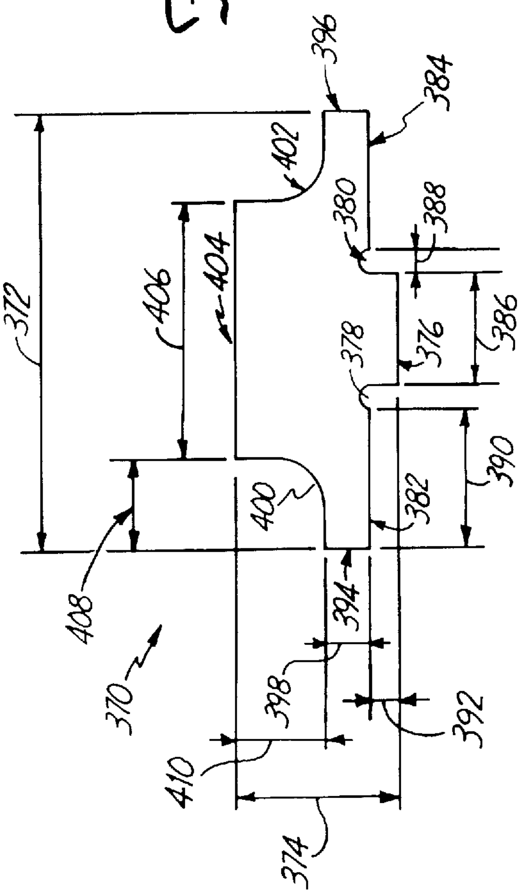


Fig. 13

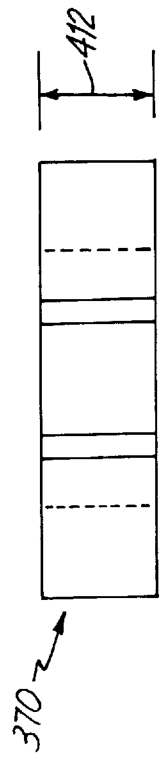


Fig. 14

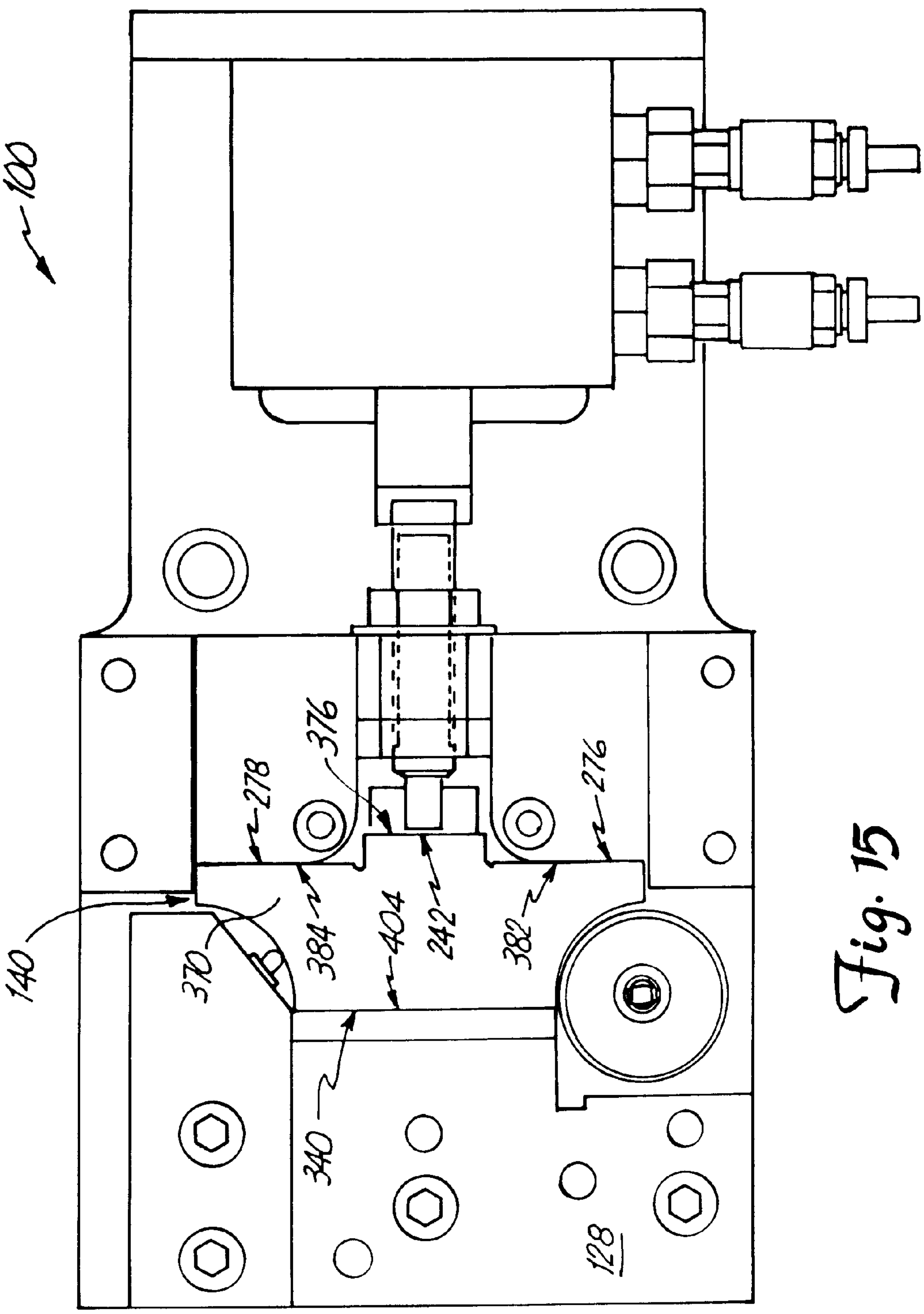


Fig. 15

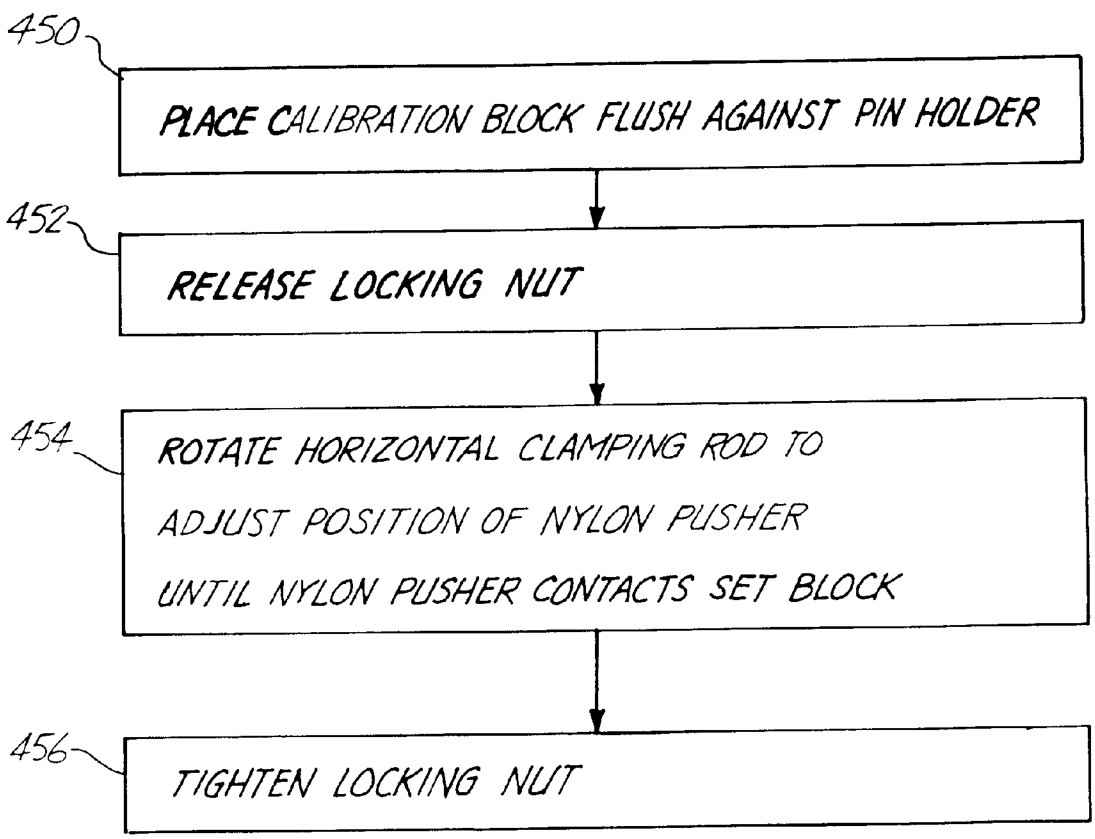
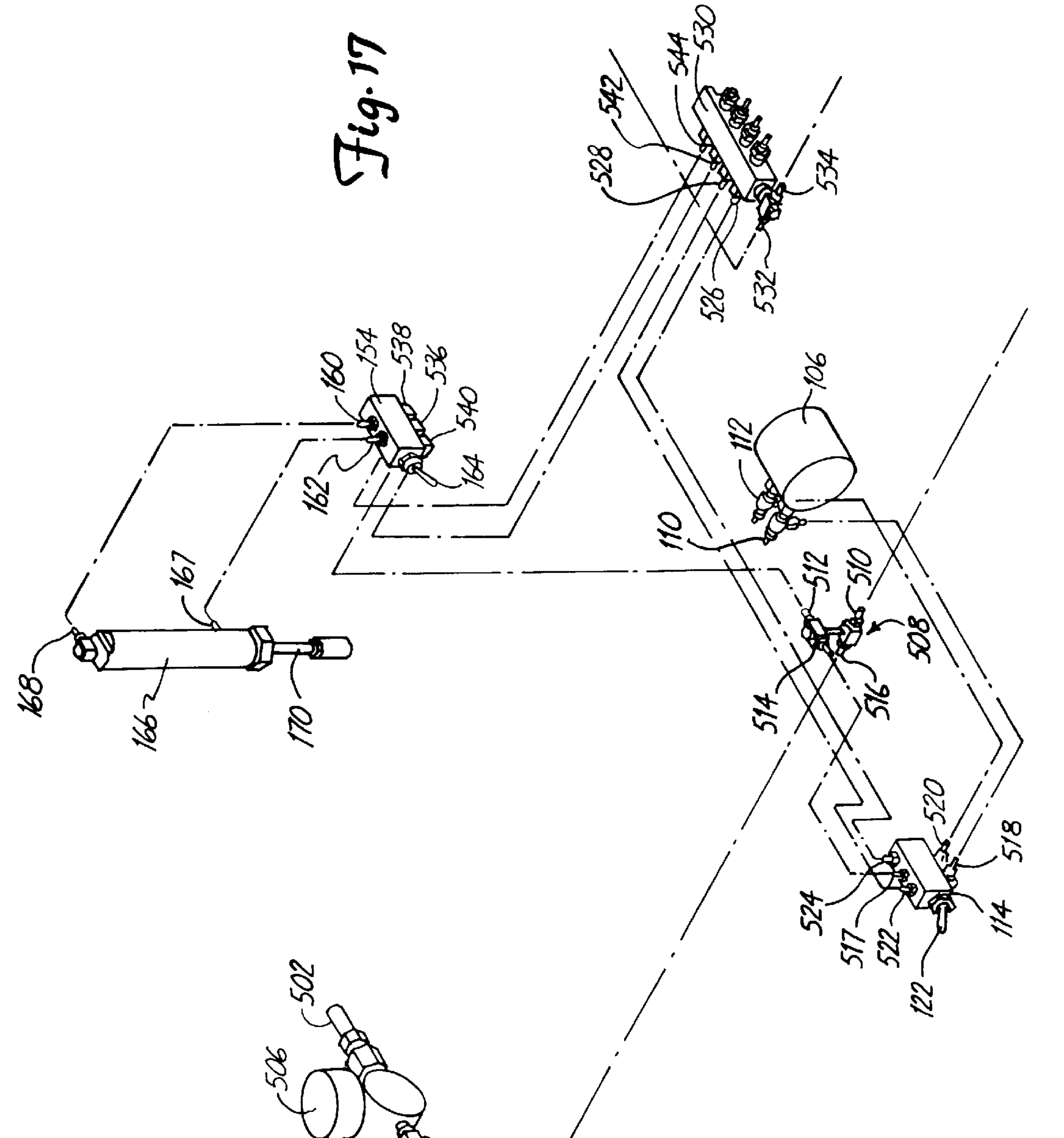

450
PLACE CALIBRATION BLOCK FLUSH AGAINST PIN HOLDER
452
RELEASE LOCKING NUT
454
ROTATE HORIZONTAL CLAMPING ROD TO ADJUST POSITION OF NYLON PUSHER UNTIL NYLON PUSHER CONTACTS SET BLOCK
456
TIGHTEN LOCKING NUT

Fig. 16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167
168
166
170
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518
524
517
522
114
122
502
506
500
504

Fig. 17

METHOD AND APPARATUS FOR MAGNET/ BACKIRON BONDING USING SLIP FIT PINS

REFERENCE TO CO-PENDING APPLICATION

This application is related to two U.S. applications filed on even date herewith entitled METHOD AND APPARATUS FOR CALIBRATING MAGNET/BACKIRON BONDING STATION, having attorney docket number S01.12-0411; and METHOD AND APPARATUS FOR MAGNET/BACKIRON BONDING USING TOP AIR CYLINDER, having attorney docket number S01.12-0383. All three applications are owned by a common assignee.

FIELD OF THE INVENTION

The present invention relates to bonding stations used to bond magnets to backirons. In particular, the present invention relates to robust bonding stations that precisely position the magnet relative to a backiron during bonding.

BACKGROUND OF THE INVENTION

In optical, magneto-optical and magnetic disc drives used for data storage, an actuator arm positions read or write heads over the disc to acquire information from the disc or store information to the disc. Movement of the actuator arm is typically controlled by a magnetic motor that includes a conductive coil position between a magnetic assembly. Typically, the magnetic assembly consists of two magnetic pieces bonded to two respective backirons that are maintained a fixed distance apart so that the conductive coil can move between the magnets.

To ensure consistent and predictable actuator arm movement, each magnetic assembly must be constructed with extreme precision so that variations between magnetic assemblies are minimized. In particular, the magnets must be precisely positioned relative to their respective backirons so that the position of the conductive coil relative to the magnet is consistent in each disc drive.

This type of accuracy and consistency cannot be achieved without the use of bonding stations that clamp the backiron and the magnet in a desired spatial relationship during bonding.

To position the backiron relative to the magnet, many bonding stations use locating pins that resiliently pivot laterally to allow the backiron to be "snapped" into place over an already properly position magnet. Once the backiron is inserted over the magnet, the locating pins apply a lateral force to the sides of the backiron to keep it properly positioned over the magnet.

In light of the forces placed on the locating pins, the manufacturers of the pins suggest press fitting the pins into a pin holder so that the pins do not become dislodge from the holder. To accommodate press fitting, the manufacturer of the locating pins includes deformable ridges around the perimeter of the pins. Press fitting is accomplished by forcing each locating pin into an aperture that has a diameter that causes the ridges of the pin to deform as they come into frictional contact with the side walls of the aperture. This deformation frictionally connects each locating pin to the sidewalls of its respective aperture.

Although press fitting locating pins is recommended by the manufacturer and provides a strong connection between the locating pin and the pin holder, it produces several problems. Most notably, press fitting makes it difficult to replace the locating pins. The present inventor has recognized that because of the heavy use that bonding stations experience in a manufacturing setting, the resilient portions of the locating pins tend to deteriorate over time and must be replaced. However, with a press fit locating pin, the friction between the pin holder and the locating pin will not allow the pin to be withdrawn from the movable assembly simply by pulling on the protruding portions of the locating pin. Instead, the lateral actuator and the movable assembly must be removed from the base so that the locating pin can be pushed out by inserting a rod through a hole in the bottom of the pin holder.

The present invention addresses these and other problems, and offers other advantages over the prior art.

SUMMARY OF THE INVENTION

A bonding apparatus for bonding a magnetic piece to a backiron includes a base and a back assembly next to the base and having at least one back surface. A front assembly having a front surface facing the back assembly has at least one aperture for a locating pin. The locating pin is slip fit into the aperture of the front assembly.

The locating pin preferably includes a pin having a portion within a housing and a portion extending external to the housing. In addition, the locating pin preferably includes a resilient member located within the housing and connecting the pin to the housing. Preferably the first and second portions of the pin are aligned along a pin axis and the resilient member opposes movement of the pin in a direction at an angle to the pin access.

In accordance with a method provided herein, the locating pin is replaced by grasping a pulling a protruding portion of a locating pin positioned in an aperture of the first block to remove the locating pin from the block. A second locating pin is then grasped and inserted in the vacated aperture of the front block. In preferred embodiments, the locating pin is inserted into the aperture by aligning the locating pin with the aperture and releasing the locating pin to allow gravity to fully seat the locating pin.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a combination side and block diagram of a disc drive storage system.

FIG. **2** is a perspective view of the magnetic sub-assembly of FIG. **1**.

FIG. **3** is a top view of the magnetic sub-assembly of FIG. **2**.

FIG. **4** is a perspective view of a bonding station in accordance with a preferred embodiment of the present invention.

FIG. **5** is a flow diagram of a method of bonding a magnet to a backiron in accordance with a preferred embodiment of the present invention.

FIG. **6** is a top view of the bonding station of FIG. **4**.

FIG. **7** is a perspective view of the pin holder of FIG. **4**.

FIG. **8** is a top view of pin holder **116** of FIG. **7**.

FIG. **9** is a partial cross-section of the pin holder of FIG. **7** showing a locating pin in an aperture.

FIG. **10** is a top view of the back assembly of FIG. **4**.

FIG. **11** is a side view of the back assembly of FIG. **10**.

FIG. **12** is a perspective view of a calibration tool for calibrating a bonding station of a preferred embodiment of the present invention.

FIG. **13** is a top view of calibration tool of FIG. **12**.

FIG. **14** is a side view of calibration tool **370** of FIG. **12**.

FIG. 15 is a top view of a bonding station with a calibration tool positioned in a nest.

FIG. 16 is a flow diagram for calibrating a bonding station.

FIG. 17 is a plan view of a pneumatic system used in a bonding station.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a combination block diagram and side view of a system **20** for retrieving and storing data on a disc. In system **20**, a disc **22** spins about a spindle **24** under the control of controller **26** acting through motor **28**. Controller **26** is connected to motor **28** through motor control lines **30** and **32**.

The rotation of disc **22** causes a head **34** to lift off the surface of disc **22**. Head **34** is positioned over the surface of disc **22** through a suspension assembly consisting of a gimbal **36**, flexure arm **38**, load beam **40** and actuator **42**. The suspension assembly pivots about pivot point **44** causing head **34** to move in an arc over the surface of disc **22**.

Actuator **42** includes magnetic assembly **46** and magnetic coil **48**. Magnetic assembly **46** has two magnetic sub-assemblies **45** and **47**, which have respective magnets **49** and **51**. Magnetic coil **48** is formed on an actuator arm extending opposite of load beam **40** across pivot point **44**. Conductors **50** and **52** are connected to magnetic coil **48** and to controller **26**. Through conductors **50** and **52**, controller **26** passes a current through magnetic coil **48** causing magnetic coil **48** to produce a magnetic field that interacts with the magnetic field generated by magnets **49** and **51** of magnetic assembly **46**. This interaction causes suspension assembly **20** to pivot about pivot point **44** and thereby moves head **34** in an arc across disc **22**. The position of the suspension assembly is such that head **34** may be positioned at any radial position along disc **22**.

The desired speed for motor **28** and the desired location for head **34** is communicated through controller **26** by a processor **54** that communicates to controller **26** through a bi-directional bus **56**. Processor **54** receives user input from keyboard **58** and produces perceivable output at display **60**. Note that the blocks of FIG. **1** are not to scale.

Embedded in head **34** is a read sensor and possibly a write sensor. The read sensor produces or effects an electrical signal that is carried on conductor **62** and **64**, which are connected to controller **26**. Controller **26** conditions the signal carried on conductors **62** and **64** by, for example, converting the signal from analog to digital before passing the digitized signal along bi-directional bus **56** to processor **54**.

FIG. **2** is a perspective view of sub-assembly **47** of FIG. **1** that includes magnet **51** and backiron **72**. Magnet **51** is bonded to backiron **72**, preferably by an adhesive. Backiron **72** includes a centering aperture **74** used to position the backiron in a bonding station as described further below.

FIG. **3** is a top view of magnetic sub-assembly **47** of FIG. **2**. Magnet **51** has a front datum surface **76** and two back datum surfaces **78** and **80**. Front datum surface **76** and back datum surfaces **78** and **80** are used to position magnet **70** in a bonding station as described further below. Backiron **72** includes front datum surfaces **82** and **84** and back datum surfaces **86** and **88**. Front datum surfaces **82** and **84** and back datum surfaces **86** and **88** are used to position backiron **72** in a bonding station relative to magnet **51**.

As shown in enlargement **90**, which is an enlargement of area **92** of backiron **72** and magnet **51**, back datum surface **80** of magnet **51** is separated from back datum surface **88** of backiron **72** by a distance **94**. Although not shown in detail in FIG. **3**, back datum surface **78** is similarly separated from back datum surface **88**. Preferably, distance **94** is 0.005 inches (0.127 mm) plus or minus 0.001 inches (0.025 mm).

To achieve this level of accuracy in positioning the magnet relative to the backiron, the present invention provides a bonding station **100** shown in FIG. **4**. In FIG. **4**, a magnet **138** and a backiron **136** are shown removed from the bonding station before bonding occurs. Backiron **136** includes aperture **135**, front datum surfaces **137** and **139**, and back datum surfaces and **143**. Magnet **138** includes front datum surface **238** and back datum surfaces **232** and **234**. During bonding, magnet **138** and backiron **136** are supported by a base surface **141** of a nest **140** in bonding station **100** and are restrained in the nest by a fluidly controlled lateral actuator **104** and a fluidly controlled vertical actuator **152**.

Bonding station **100** includes a base **102**, which supports lateral actuator **104** and vertical actuator **156**. Lateral actuator **104** includes a cylinder housing **106** connected to base **102** through a clamp bracket **108**. Cylinder housing **106** has two input ports **110** and **112** that are fluidly connected to a toggle valve **114**. In preferred embodiments of the present invention, cylinder housing **106** is a pneumatic cylinder that moves a pin holder **116** in directions **118** and **119** by moving a clamp rod **120** extending between cylinder housing **106** and pin holder **116**. Toggle valve **114** includes a toggle switch **122**, which toggles between an up position and a down position. When toggle switch **122** is in a down position, a positive air pressure is applied through port **110**, which forces clamp rod **120** to move pin holder **116** in direction **119**. When toggle **122** is in an up position, a positive air pressure is applied through port **112** causing clamp rod **120** to move pin holder **116** in direction **118**. Thus, lateral actuator **104** is a reversible actuator that can move pin holder **116** in opposite directions **118** and **119**.

Pin holder **116** has its movement partially controlled by guides **124** and **126**, which are bonded to base **102** and which have respective ledges extending over respective guide rails of pin holder **116**. Pin holder **116** contains two apertures that are filled with respective locating pins **132** and **134**. Locating pins **132** and **134** are used to position backiron **136** relative to magnet **138** as described further below.

During bonding, magnet **138** is inserted in nest **140**, which is formed between pin holder **116**, back assembly **128**, plunger **142** and rolling sleeve **144**. Magnet **138** is inserted into nest **140** while lateral actuator **104** is withdrawn. Toggle switch **122** is then toggled and lateral actuator **104** moves pin holder **116** toward back assembly **128**. Depending on its placement within nest **140**, magnet **138** may engage rollable sleeve **144** while lateral actuator **104** is moving magnet **138** toward back assembly **128**. If this occurs, rollable sleeve **144** will guide magnet **138** toward plunger **142**. As magnet **138** comes into contact with back assembly **128**, a surface of the magnet will depress plunger **142**, which is resiliently connected to a plunger holder **146**.

At the center of rollable sleeve **144** is a diamond point **148**, which with locating pins **132** and **134** positions backiron **136** above magnet **138**. After an adhesive is applied to magnet **138**, backiron **136** is pressed between back assembly **128** and locating pins **132** and **134** while locating hole **135** of backiron **138** is aligned with diamond point **148**.

A vertical bracket **150** is connected to base **102** and supports vertical actuator **152** and a vertical toggle valve **154**. Vertical toggle valve **154** is supported on bracket **150** by a horizontal bracket **156** and a toggle bracket **158**. Toggle valve **154** has two output ports **160** and **162** that alternately carry a positive pressure depending on the state of a toggle switch **164** in toggle valve **154**. When toggle switch **164** is down, positive pressure is carried by output port **160**, and when toggle switch **164** is up, positive pressure is carried by output port **162**.

Output ports **160** and **162** are fluidly connected to two respective input ports on vertical cylinder housing **166**. For clarity, only the fluid connection between input port **160** and input port **168** is shown in FIG. **4**. Vertical cylinder housing **166** is supported by horizontal bracket **156** and moves vertical clamp rod **170** in directions **172** and **173**. For instance, when output port **160** has carries a positive pressure, vertical cylinder housing **166** causes vertical clamp rod **170** to move in direction **173**. When output port **162** carries a positive pressure, vertical cylinder housing **166** causes vertical clamp rod **170** to move in direction **172**. At the end of vertical clamp rod **170** is a pad **174** that reduces wear on backiron **130** and clamp rod **170** during bonding.

In preferred embodiments, a majority of the bonding station is constructed from either aluminum or stainless steel, which are both non-magnetic. However, to reduce wear on the bonding station, back assembly **128** and pin holder **132** may be made out of hardened steel, which is magnetic, as long as magnet **138** has not had its magnetic moments aligned to produce unified magnetic fields. Once magnet **138** is bonded to backiron **176**, the magnet can be "charged" by exposing it to a strong magnetic field that aligns the magnetic moments of magnet **138**.

FIG. **5** is flow diagram of a method of bonding magnet **138** to backiron **136** using bonding station **100**. First, the bonding surface of magnet **138** is cleaned in step **200**. In a manufacturing setting, this step can be performed on a batch of magnets. In step **202**, the bonding surface of backiron **136** is cleaned. This step can also be performed on a batch of backirons. Once the magnet and backiron have been cleaned, magnet **138** is inserted into nest **140** in step **204**. At step **206**, toggle switch **122** is toggled causing lateral actuator **104** to move pin holder **116** toward back assembly **128**. When actuator **104** is fully extended, magnet **138** is properly positioned in nest **140**.

A small amount of adhesive is applied to the bonding surface of magnet **138** in step **208**. In step **210**, backiron **136** is pressed into place over magnet **138** by aligning aperture **135** of backiron **136** with diamond point **148** while bringing back datum surfaces **234** and **236** of backiron **136** into contact with back assembly **128**. Front datums **137** and **139** of backiron **136** are then pivoted downward to engage locating pins **132** and **134**, which provide a horizontal clamping force to hold backiron **136** in position. Once backiron **136** is in position, toggle switch **163** is toggled downward in step **212** causing vertical cylinder **166** to move pad **174** on vertical clamp rod **170** into contact with backiron **136** such that the downward force presses backiron **136** into the adhesive and magnet **138**.

In step **214**, the operator waits **30** seconds for the adhesive to bond backiron **136** to magnet **138** before moving on to step **216** where toggle switch **164** is toggled upward causing vertical actuator **152** to move clamp rod **170** away from backiron **136**. In step **218**, lateral actuator **104** is activated by toggling toggle switch **122** to cause pin holder **116** to move away from nest **140**. The completed magnetic sub-assembly is then removed in step **220**.

FIG. **6** is a top view of bonding station **100** of FIG. **4**, with backiron **136** and magnet **138** shown in nest **140**. A nylon pusher **242**, connected to the end of clamp rod **120**, presses against forward datum surface **238** of magnet **138**, causing rear datum surfaces **230** and **232** of magnet **138** to contact a back surface of back assembly **128**. Magnet **138** also contacts rollable sleeve **144**, thereby causing it to depress plunger **142**.

Aperture **135** of backiron **136** is centered about diamond point **148**. Front datum surfaces **139** and **137** contact locating pins **132** and **134**, respectively, which force rear datum surfaces **234** and **236** of backiron **136** into contact with a surface of back assembly **128**. As is described below, locating pins **132** and **134** are connected to resilient members within a housing that permit locating pins **132** and **134** to flex in a lateral direction as backiron **136** is pressed toward magnet **138**.

Clamp rod **120** is a threaded rod that threadably engages a jam nut **244** and a locking nut **130**. With locking nut **130** loosened so that it is not in contact with pin holder **116**, clamp rod **120** may be rotated about its long axis. Because of jam nut **244**, this rotation will change the position of nylon pusher **242** relative to locating pins **132** and **134**. With locking nut **130** tight against pin holder **116**, clamp rod **120** cannot rotate.

FIG. **7** is a perspective view of pin holder **116** of FIG. **4**. Two guide rails **260** and **262** extend from the lower portion of pin holder **116** and provide guide surfaces that are restrained by guides **124** and **126** of FIG. **4**. Pin holder **116** includes three apertures **264**, **266**, and **268**. Aperture **264** accommodates a portion of lateral clamp rod **120**, and apertures **266** and **268** receive locating pins **134** and **132** respectively.

FIG. **8** is a top view of pin holder **116** of FIG. **7**. Pin holder **116** has a width **270** and a length **272** that are equal to 2.75 inches (69.85 mm) and 1.156 inches (29.36 mm). The center of apertures **266** and **268** are located a distance **274** from leading surfaces **276** and **278**, respectively, of pin holder **116**. In preferred embodiments, distance **274** is equal to 0.188 inches (4.78 mm) plus or minus 0.001 inches (0.0254 mm). Preferably, apertures **266** and **268** each have a radius of 0.250 inches (6.35 mm). Aperture **266** is located a distance **280** from a side surface **282**. Preferably distance **280** is equal to 0.834 inches (21.18 mm). Two inner surfaces **284** and **286** of pin holder **116** are separated from side surface **282** by respective distances **290** and **292**. Preferably, distances **290** and **292** are equal to 1.022 inches (25.96 mm) and 1.728 inches (43.89 mm), respectively. Thus, the distance between inner surfaces **284** and **286** is equal to 0.706 inches (17.93 mm). The center of aperture **268** is located a distance **294** from side surface **282**, which is preferably equal to 1.916 inches (48.67 mm).

FIG. **9** is a cross-section of a portion of pin holder **116** showing locating pin **134** in aperture **266**. Locating pin **134** has pin **300** which is partially located within a housing **302**. Housing **302** includes a ridge exterior surface **306**. The bottom of housing **302** is in contact with the bottom of aperture **266**. Within housing **306** is a resilient member, that connects pin **300** to housing member **306** and allows the pin **300** to pivot in directions **310**.

Housing **306** has an outer diameter **312** that is less than the inner diameter **314** of aperture **266**. The difference in diameters creates an annular gap between aperture **266** and housing **306** that has a distance **316**. Specifically, diameter **314** is 0.250 inches (6.35 mm) and diameter **312** is equal to 0.245 inches (6.10 mm), making annular gap **316** equal to 0.0025 inches (0.0635 mm).

Because diameter **312** is less than diameter **314**, locating pin **134** is said to be slip fit into aperture **266**. Since neither housing **306** nor aperture **266** is deformed by inserting locating pin **134** in aperture **266**, it is clear to those skilled in the art that annular gap **316** permits locating pin **134** to be removed from aperture **266** simply by grasping pin **300** and withdrawing housing **306** from aperture **266** in a direction away from a surface **308** of pin holder **116**.

FIG. **10** is a top view of back assembly **128** of FIG. **4**. Back assembly **128** has contact area **320** first recess area **324**, and second recess area **326**, which have respective widths **322**, **328**, and **330**. Together, widths **322**, **328** and **330** equal the total width **332** of back assembly **128** and preferably have respective values of 1.376 inches (34.95 mm), 0.152 inches (3.86 mm) and 0.91 inches (23.11 mm). Recess area **326** is recessed a distance **334** from contact area **320** and recess area **324** is recessed a distance **336** from recess area **326**. Preferably, distance **334** is 0.4345 inches (11.04 mm) and distance **336** is 0.063 inches (1.60 mm).

As shown in FIG. **11**, which is a side view taken along lines **11** and FIG. **10**, contact area **320** is constructed of two contact surfaces **338** and **340** and a recess **342**. Contact surface **348** abuts the top surface of back assembly **128** and back surface **340** abuts the bottom surface of back assembly **128**. Recess **342** is positioned between contact surface **338** and contact surface **340**. Contact surfaces **340** and **338** have heights **344** and **346**, respectively, and recess **342** has a height **348**. Preferably, heights **344**, **346** and **348** have respective values of 0.218 inches (5.54 mm), 0.312 inches (7.92 mm), and 0.095 inches (2.41 mm). Contact area **338** is a distance **352** forward from a back surface **350** of back assembly **128**, and contact surface **340** is a distance **354** forward from back surface **350**. Preferably distance **352** is equal to 1.490 inches (37.846 mm) and distance **354** is equal to 1.495 inches (37.973 mm), so that the two surfaces are offset from each other.

In bonding station **100**, contact surface **340** makes contact with magnet **138** and contact surface **338** makes contact with backiron **136**. The difference between distance **352** and distance **354** results in a 0.005 inch (0.127 mm) offset between the magnet and the backiron.

FIG. **12** shows a perspective view of a calibration tool **370** for calibrating bonding station **100** of FIG. **4**. FIG. **13** shows a top view of calibration tool **370** which has a width **372** and a depth **374**. Width **372** is preferably 2.34 inches (59.436 mm) and depth **374** is preferably 0.91 inches (23.114 mm). Calibration tool **370** has a centrally located extending portion **376** flanked by two respective recesses **378** and **380** and two respective flat surfaces **382** and **384**. Extending portion **376** has a width **386** centered about a central axis of calibration tool **370** and having a preferred value of 0.60 inches (15.24 mm). Recess areas **378** and **380** each have a recess width **388**, which is preferably equal to 0.13 inches (3.12 mm). Flat surfaces **382** and **384** each have a width **390** that is preferably equal to 0.74 inches (18.796 mm). Extending portion **376** is a distance **392** forward from flat surfaces **382** and **384**. Preferably, distance **392** has a value of 0.156 inches (3.962 mm), and is critical to proper calibration of the bonding station.

Flat surfaces **382** and **384** abut side surfaces **394** and **396** respectively. Preferably, side surfaces **394** and **396** are at right angles to flat surfaces **382** and **384**, and have a depth **398** that is equal to 0.254 inches (6.452 mm). Two curve surfaces **400** and **402** abut side surfaces **394** and **396** and connect the side surfaces to a back surface **404**. Back surface **404** has a width **406** that is centered about a central axis of calibration tool **370** and is preferably 1.38 inches (35.052 mm). Side surfaces **394** and **396** are separated from back surface **404** by a lateral distance **408** and by a depth distance **410**. Preferably, lateral distance **408** is 0.48 inches (12.192 mm) and depth distance **410** is 0.5 inches (12.7 mm).

FIG. **14** is a side view of calibration tool **370** of FIGS. **12** and **13**. FIG. **14** shows that calibration tool **370** has a height **412** of preferably 0.63 inches (16.002 mm).

FIG. **15** shows a top view of bonding station **100** with calibration tool **370** located in nest **140**. Front surface **376** of calibration tool **370** makes contact with nylon pusher **242**. Flat surfaces **382** and **384** of calibration tool **370** contact leading surfaces **276** and **278** of pin holder **116**. Back surface **404** of calibration tool **370** contacts surface **340** of back assembly **128**.

During calibration of the bonding station, calibration tool **370** may either be located in nest **140** as shown in FIG. **15** or may be held against pin holder **116** by hand. The bonding station is calibrated when the end of nylon pusher **240** is a proper distance from locating pins **132** and **134**. Since apertures **266** and **268** are precisely positioned relative to leading edges **278** and **276**, the calibration can be accomplished by verifying the distance between the end of nylon pusher **240** and leading edges **278** and **276**. When the end of nylon pusher **240** is the proper distance from leading edges **278** and **276**, the bonding station is properly calibrated.

FIG. **16** is a flow diagram of a method for calibrating bonding station **100** using calibration block **370** of FIG. **12**. In step **450**, calibration block **370** is placed flush against leading edges **278** and **276** of pin holder **116**. Locking nut **130** is then released in step **452** and horizontal clamping rod **120** is rotated within jam nut **244** in step **454**. This rotation changes the position of nylon pusher **240** relative to extending portion **376** of calibration block **370**. Once nylon pusher **240** makes contact with extending portion **376**, locking nut **130** is re-tightened in step **456**.

FIG. **17** is a plan diagram for a pneumatic system useful in the bonding station of the present invention. A pressure regulator **500** receives a pressurized fluid, preferably air, at an input port **502**, and produces a regulated pressure at an output port **504**. Preferably, regulator **500** includes a display **506**, which displays the regulated pressure at output port **504**.

A distributor **508** has an input port **516** that is connected to output port **504** by a fluid connection line. Distributor **508** also includes three output ports **510**, **512** and **514**. Output port **510** distributes pressurized fluid from regulator **500** to additional bonding stations. Output port **514** provides pressurized fluid to input port **517** of toggle valve **114**. Depending on the state of toggle switch **122**, toggle valve **114** provides the pressurized fluid at input port **517** to either output port **520** or output port **518**. Output ports **520** and **518** are respectively connected to input ports **112** and **110** of horizontal clamp cylinder **106**, and thus provide pressurized fluid to actuate horizontal clamp cylinder **106**.

Toggle valve **114** also includes two exhaust ports **522** and **524** that provide connections to ports **526** and **528**, respectively, of an exhaust manifold **530**. Output ports **522** and **524** provide a pathway for air to exit horizontal clamp cylinder **106** through port **110** or port **112** so that pressure received on either port **110** or **112** can move horizontal clamp cylinder **106**. Exhaust manifold **530** includes an exhaust-air port **532** that is connected to an exhaust-air source. Output port **534** of exhaust manifold **530** is connected to further exhaust manifolds for further bonding stations if desired.

Output port **512** of distributor **508** provides regulated pressure from pressure regulator **500** to input port **536** of vertical toggle valve **154**. Vertical toggle **154** has two output ports **160** and **162** that are fluidly connected to be two input ports **168**, **167** of vertical clamp cylinder **166**. Depending on the state of toggle switch **164**, toggle valve **154** provides the regulated pressure from pressure regulator **500** to either input port **168** or input port **167** of vertical clamp cylinder **166** and thereby moves vertical rod **170**. Toggle valve **154** also has exhaust ports **538** and **540** that are connected to input ports **542** and **544** of exhaust manifold **530**.

In summary, a bonding apparatus **100** for bonding a magnet **138** to a backiron **136** includes a base surface **141**, a back block **128**, a front block **116**, and locating pins **132** and **134** that are slip fit into apertures **266**, **268** of front block **116**. Locating pins **132** and **134** include a housing **302**, a protruding pin **300**, and a spring mechanism.

The bonding station **100** includes a base **102** that supports a back assembly **128** and a front assembly **116**. A locating pin **132** is slip fit into an aperture **266** of the front assembly **266**.

It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the particular elements may vary depending on the particular application for the bonding station while maintaining substantially the same functionality without departing from the scope and spirit of the present invention. In addition, although the preferred embodiment described herein is directed to a bonding station for bonding a magnet to a backiron, it will be appreciated by those skilled in the art that the teachings of the present invention can be applied to other bonding systems for bonding other materials together, without departing from the scope and spirit of the present invention.

What is claimed is:

1. A bonding apparatus for bonding a magnet to a backiron, the apparatus comprising:

a base surface which supports the magnet in the bonding apparatus while the backiron is supported on the magnet;

a back block connected to the base surface and providing a least one back surface;

a front block having a front surface for pressing the magnet against a back surface and comprising at least one aperture; and

a locating pin slip fit into one of the apertures in the front block and having a portion protruding from the front block, the locating pin for pressing the backiron against a back surface.

2. The apparatus of claim **1** wherein the locating pin comprises:

a housing;

a protruding pin, partially in the housing and partially protruding out of the housing; and

a spring mechanism connected between the housing and the protruding pin.

3. The apparatus of claim **2** wherein the spring mechanism allows but opposes movement of the protruding pin as the protruding pin presses the backiron toward a back surface.

4. The apparatus of claim **1** wherein the back block has a first block surface in a first plane and a second block surface in a second plane, the first plane being different from but parallel to the second plane.

5. The apparatus of claim **1** wherein the front block is movable in a direction toward the back surface.

6. A bonding station for bonding a magnet to a backiron, the bonding station comprising:

a base;

a back assembly connected to the base and having at least one back surface;

a front assembly having a front surface facing the back assembly and having at least one aperture; and

a locating pin slip fit into an aperture of the front assembly.

7. The bonding station of claim **6** wherein the front block has two apertures and the bonding station further comprises a second locating pin slip fit into an aperture of the front block.

8. The bonding station of claim **6** wherein the front block is movable in a direction toward the back block.

9. The bonding station of claim **6** wherein the locating pin comprises:

a housing;

a resilient member located within the housing; and

a pin having a first portion within the housing and connected to the resilient member, the pin further having a second portion external to the housing.

10. The bonding station of claim **9** wherein the first portion and the second portion of the pin are aligned along a pin axis and the resilient member opposes movement of the pin in a direction at an angle to the pin axis.

11. The bonding station of claim **10** wherein the housing of the locating pin is inserted into an aperture of the front block in a direction parallel to the pin axis.

12. A method of replacing locating pins in a bonding station for bonding a magnet to a backiron, the bonding station having a front block facing a back block, the method comprising the steps of:

(a) grasping a protruding portion of a first locating pin positioned in a first aperture of the front block;

(b) pulling the protruding portion and the first locating pin out of the aperture;

(c) grasping the protruding portion of a second locating pin; and

(d) inserting the second locating pin in the first aperture of the front block.

13. The method of claim **12** wherein the second locating pin is inserted in the first aperture of the front block by aligning the locating pin with the aperture and releasing the locating pin to allow gravity to fully seat the locating pin.

14. A bonding apparatus for bonding a magnet to a backiron, the bonding apparatus comprising:

a nest partially defined by a base, a back assembly, and a front assembly; and

locating means, operatively coupled to the front assembly for positioning the backiron relative to the magnet.

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