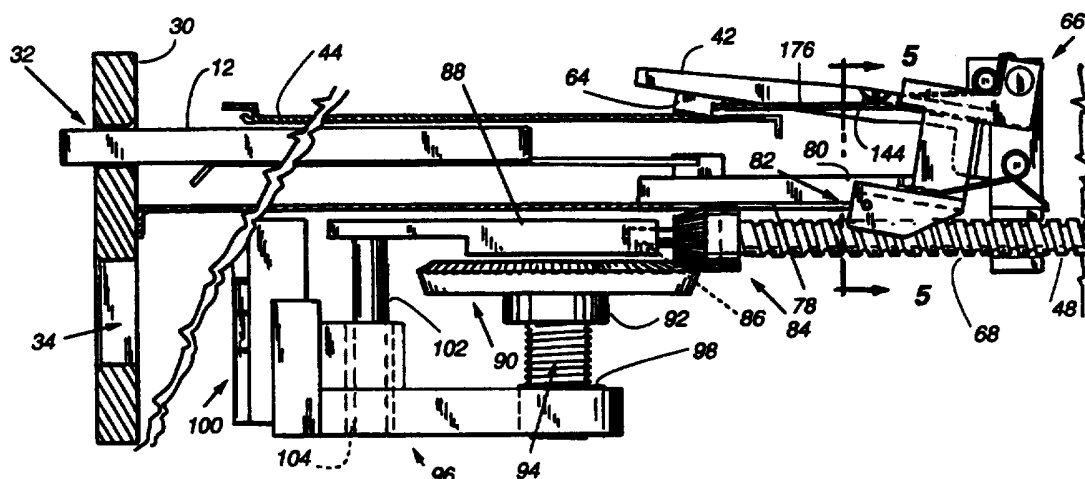




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(54) Title: TRANSDUCER POSITIONER SYSTEM AND METHOD FOR A COMBINED REMOVABLE RANDOM AND SEQUENTIAL ACCESS MEDIA DRIVE



(57) Abstract

A transducer positioner system and method for a combined removable random and sequential access media drive (10) utilizes a single positioner motor (40) to position a random access media transducer carriage assembly (66) as well as a sequential access media transducer carriage assembly (96). The random access media transducer carriage assembly (66) is selectively loadable to a first coarse placement resolution/high speed access lead screw (48) rotationally coupled to a fine placement resolution/low access speed lead screw (94). In a particular embodiment, the coarse lead screw (48) is utilized to position the read/write heads (64, 80) of a diskette (12) while the fine lead screw (94) is utilized to position a read/write head (100) for a tape cartridge (14).

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TRANSDUCER POSITIONER SYSTEM AND METHOD
FOR A COMBINED REMOVABLE RANDOM AND
SEQUENTIAL ACCESS MEDIA DRIVE

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CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of United States Patent Application serial number 08/072,919 filed June 7, 1993 entitled "Dual
10 Random and Sequential Access Media Drive" assigned to ComByte, Inc., Fort Collins, Colorado, assignee of the present invention, the disclosure of which is herein specifically incorporated by this reference.

FIELD OF THE INVENTION

15 The present invention relates, in general, to positioner systems for removable random and sequential access media drives.

BACKGROUND OF THE INVENTION

Personal computers, workstations, file servers
20 and other current computer equipment will generally incorporate at least one microdiskette or floppy disk drive to enable the loading of application software or files to the particular computer system, either for immediate execution or copying to the
25 computer's "fixed", "rigid", or hard drive. To a limited extent, microdiskettes or floppy disks may also be utilized to provide archival storage for the resident software or files.

However, because of the relatively smaller
30 capacity of such random access media and the comparatively greater cost and inconvenience experienced in archiving software and data files utilizing this method, many computers are now equipped with a separate tape drive by means of
35 which software and files resident on the internal hard drive may be archived and later re-read into the system as needed. The cost and convenience of such sequential access media for computer archival storage is far superior to the use of a large number
40 of microdiskettes, or floppy disks, of limited

capacity.

With the trend toward lower profile desktop and smaller footprint deskside systems, the number of user accessible drive bays is generally decreasing, despite the downward trend in drive form factors from full and half-height 5.25" floppy disk drives to half-height and one inch height 3.5" microdiskette drives and smaller. Currently, the addition of a tape drive will consume at least one additional user-accessible drive bay over and above the extant microdiskette drive, thereby perhaps precluding the addition of another removable random access media device such as a CDROM drive. In addition to the limited "real estate" available within most modern computer equipment, the addition of such stand-alone tape drives with their concomitant component counts, power requirements and resultant heat dissipation, render it highly desirable to find a way of providing a user with the requisite random and sequential access removable storage media needs in a cost-effective manner.

SUMMARY OF THE INVENTION

Disclosed herein is a transducer or "head" motion system utilizing a single motor to position two different types of data transducers for reading and/or writing information in a combined peripheral device as disclosed in the aforementioned United States Patent Application serial number 08/072,919. The transducer positioner system and method for a combined removable random and sequential access media drive herein disclosed provides a mechanism allowing a fine placement resolution/low access speed positioner for one type data transducer assembly in combination with a coarse placement resolution/high speed access positioner for a second type of data transducer pair. In the embodiment

described, the finer transducer positioning is utilized in conjunction with a 1/4" cartridge ("QIC") tape, while the faster transducer access and coarser placement resolution is utilized in conjunction with a 3.5" microdiskette.

Particularly disclosed herein is a transducer positioner system which comprises a motor for transforming electrical signals to a bidirectional rotational motion of a drive shaft thereof. First and second lead screws having corresponding first and second distal and proximal ends thereof respectively are also disclosed with the first lead screw being rotationally coupled adjacent the first proximal end thereof to the drive shaft of the motor. A coupling mechanism rotationally interconnects the second lead screw adjacent to the second distal end thereof to the first lead screw adjacent the first distal end thereof. A follower is coupled to the second lead screw between the second distal and proximal ends thereof and a transducer mount is responsive to the follower, the transducer mount being slidably constrained to motion in opposing translational directions in response to the bidirectional rotational motion of the drive shaft.

In a particular embodiment, the coupling mechanism comprises a pinion affixed adjacent the first distal end of the first lead screw and a corresponding gear affixed adjacent the second distal end of the second lead screw. Also disclosed is the aforescribed transducer positioner system in conjunction with an additional follower selectively coupled to the first lead screw between the first distal and proximal ends thereof. An additional transducer mount is responsive to the additional follower and may be slidably constrained to motion in opposing translational directions in

response to the bidirectional rotational motion of the drive shaft. The additional follower may be selectively loadable and unloadable to the first lead screw.

5 Further disclosed herein is a method for positioning a transducer mount which comprises the steps of providing a motor for transforming electrical signals to a bidirectional rotation of a drive shaft. A first lead screw is coupled to the
10 drive shaft of the motor and the first lead screw is rotationally coupled to a second lead screw. Rotational motion of the second lead screw is transformed to a translational motion of the transducer mount.

15 Still further disclosed herein is a removable storage media drive for reading data from, or writing data to, a storage media, the drive including a media drive motor for moving the storage media with respect to a data transducer and a
20 bidirectional transducer positioner motor for positioning the data transducer with respect to the moving storage media. The improvement, in combination, includes providing first and second lead screws having corresponding first and second
25 distal and proximal ends thereof respectively, the first lead screw being rotationally coupled adjacent the first proximal end thereof to a drive shaft of the transducer positioner motor. A coupling mechanism rotationally interconnects the second lead
30 screw adjacent its second distal end thereof to the first lead screw adjacent the first distal end thereof. A follower is coupled to the second lead screw between the second distal and proximal ends thereof and a transducer mount responsive to the
35 follower is slidably constrained to motion in opposing translational directions in response to the bidirectional rotational motion of the drive shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing, and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention
5 itself will be best understood by reference to the following description of a preferred embodiment taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is an isometric view of a combined
10 random and sequential access media drive utilizing the transducer positioner system of the present invention;

Fig. 2 is a partially cut-away, top plan view of the combined drive of Fig. 1 illustrating the use
15 thereof in conjunction with, for example, a 3.5" microdiskette and showing the upper access arm and upper read/write head positioned with respect to the rotating random access storage media;

Fig. 3 is a cut-away, side elevational view
20 taken substantially along section line 3-3 of Fig. 2 and illustrating the insertion of a random access media within the diskette insertion opening with the random access media transducer carriage assembly unloaded from the motor driven lead screw;

Fig. 4 is a cut-away, side elevational view of
25 the embodiment illustrated in Fig. 3 showing the random access media fully inserted within the combined drive causing the upper access arm to be lowered toward the storage media and the random access media transducer carriage assembly to be
30 simultaneously loaded to the motor driven lead screw;

Fig. 5 is a partial, cut-away, front
elevational view of the embodiment of Fig. 3 taken
35 substantially along section line 5-5 thereof and illustrating the disengagement of the loadable follower of the random access media transducer

carriage assembly from the motor driven lead screw when the combined drive is not utilized in conjunction with a random access media;

Fig. 6 is a partial, cut-away, front elevational view of the embodiment of Fig. 4 taken substantially along section line 6-6 thereof and illustrating the engagement of the loadable follower of the random access media transducer carriage assembly with the motor driven lead screw when the combined drive is utilized in conjunction with a random access media;

Fig. 7 is a partial, cut-away, side elevational view of the embodiment of Fig. 5 taken substantially along section line 7-7 thereof and illustrating the loadable follower in an unloaded position wherein the pin located within the slot thereof is disengaged from the motor driven lead screw;

Fig. 8 is a partial, cut-away, side elevational view of the embodiment of Fig. 6 taken substantially along section line 8-8 thereof and illustrating the loadable follower in a loaded position when the pin located within the slot thereof engages the concave helical thread of the motor driven lead screw;

Fig. 9 is a detailed, partial, side elevational view of the random access media transducer carriage assembly illustrated in Fig. 5 taken substantially along section line 9-9 thereof showing the upper access arm in a raised position against the bias of a spring to allow insertion of a random access media as well as the guide pin for insuring that the assembly tracks radially of the rotating storage media;

Fig. 10 is a detailed, partial, side elevational view of the random access media transducer carriage assembly illustrated in Fig. 6 taken substantially along section line 10-10 thereof showing the upper access arm in a lowered position

when the combined drive is utilized in conjunction with, for example, a 3.5" microdiskette;

Fig. 11 is a detailed, partial, cut-away, top plan view of the embodiment of Fig. 6 taken
5 substantially along section line 11-11 thereof illustrating the engagement of the pin within the slot of the loadable follower with the concave thread of the motor driven lead screw;

Fig. 12 is a partially cut-away, top plan view
10 of the combined drive shown in the preceding figures illustrating the use thereof in conjunction with, for example, a QIC tape cartridge and showing generally the media drive mechanism and sequential access media transducer carriage assembly for
15 positioning the tape read/write head with respect to the sequential access storage media;

Fig. 13 is a partial, cut-away, side elevational view of the embodiment of Fig. 12 taken
20 substantially along section line 13-13 thereof showing how the pinion gear affixed at the distal end of the motor driven lead screw engages a corresponding gear to rotate a second fine pitch lead screw to cause a translational motion of the sequential access media transducer carriage assembly
25 to allow the tape read/write head to be positioned with respect to the data tracks of the sequential access media;

Fig. 14 is an isometric view of the transducer positioner system of the present invention
30 illustrating the inter-relationship of the random and sequential access media transducer carriage assemblies to cause the former to be positioned longitudinally of the motor driven lead screw and the latter to be positioned perpendicularly to the same in response to a bidirectional rotation
35 imparted by the positioner motor;

Fig. 15 is an exploded, isometric view of the

random and sequential access media transducer carriage assemblies of the transducer positioner system of the present invention illustrating the inter-relationship of the various components thereof in relationship to the motor driven lead screw;

Figs. 16A and 16B are, respectively, partial isometric views of a leaf spring and an alternative structure utilizing the same serving to replace the spring and corresponding portions of the loadable follower of the random access transducer carriage assembly shown in the preceding figures for similarly ensuring engagement between the pin thereof with the concave thread of the coarse lead screw when loaded thereto; and

Figs. 17A and 17B are, respectively, partial, cut-away, side elevational views of the loadable follower corresponding to the views of Figs. 7 and 8 utilizing the leaf spring and alternative structure illustrated in Figs. 16A and 16B.

20

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference now to Fig. 1, a combined drive 10 is shown for utilization of the transducer position system and method of the present invention. Combined drive 10 may be used in conjunction with both random access media (such as microdiskettes, floppy diskettes, floptical disks, CDRoms, and the like) in addition to sequential access media (such as QIC tape, 8 mm. tape, DAT, data cassettes, and the like.) In the embodiment of the combined drive 10 disclosed herein, it should be noted that description is made only by way of example with respect to a 3.5 inch magnetic diskette 12 and a QIC tape cartridge 14 as shown.

The combined drive 10 is more fully described in United States Patent Application 08/072, 919 filed June 7, 1993, entitled "Dual Random and Sequential

Access Media Drive" assigned to ComByte, Inc., assignee of the present invention. As therein disclosed, the combined drive 10 comprises a user-accessible end 16 which allows for insertion of the diskette 12 or tape cartridge 14 in order to read and/or write data to the respective media. The combined drive 10 also presents an opposite end 18, a top-surface 20 and opposite and parallel disposed bottom surface 22. Combined drive 10 further presents a housing side 24 and opposite housing side 26.

In a particular application, the combined drive 10 may be inserted within a user-accessible drive bay of a computer, workstation, file server, or other similar computer equipment such that the user-accessible end 16 is available to insert either the diskette 12 or tape cartridge 14. In alternative applications, the combined drive 10 may be utilized in conjunction with a separate housing presenting an electrical interface for connection to a standard computer bus or peripheral interface such as PCMCIA.

The combined drive 10 incorporates a bezel 30 at the user-accessible end 16 thereof which includes a diskette insertion opening 32 and a tape cartridge insertion opening 34. In the particular half-height (1.625 inches) embodiment shown, the diskette insertion opening 32 and tape cartridge insertion opening 34 are separate and distinct apertures and a mechanism for precluding the insertion of one type of media when the other is currently inserted may also be employed. However, in a one inch height or smaller form factor, the diskette insertion opening 32 may be superimposed over the tape cartridge insertion opening 34.

Bezel 30 of the combined drive 10 also includes a drive activity light 36 which may be operative to

indicate to a user that the storage media within the diskette 12 or tape cartridge 14 is being moved. A media ejection button 38 is also included to enable removal of the diskette 12 from the diskette
5 insertion opening 32 of the combined drive 10. In most applications utilizing a QIC tape cartridge 14, the tape cartridge, when fully seated within the combined drive 10 protrudes through the tape cartridge insertion opening 34 sufficiently to allow
10 a user to grasp the tape cartridge 14 to effectuate its removal.

The combined drive 10 utilizes a common positioner motor 40 to drive the transducer positioner system of the present invention. In the
15 embodiment disclosed and hereinafter described in more detail, positioner motor 40 may comprise a stepper motor effective to provide a 20-step per revolution bidirectional rotational motion to the drive shaft thereof, wherein a BIOS command to move
20 one track is translated into two steps from the stepper motor and one track change in conjunction with a diskette 12 wherein the track spacing equals .007382 inches. As shown generally in this figure, the transducer positioner system of the present
25 invention includes an upper access arm 42 for use in conjunction with the diskette 12 and a diskette shuttle mechanism 44 for loading the diskette 12 to the combined drive 10 as will be more fully described hereinafter. The combined drive 10
30 further includes a shutter actuator 46 for causing the spring-loaded shutter of the diskette 12 to be opened upon the proper seating of the diskette 12 within the combined drive 10. Positioner motor 40 is operative to cause a bidirectional
35 rotation of a lead screw 48 affixed to the positioner motor 40 shaft as will also be more fully described hereinafter. The lead screw 48, when used

in conjunction with a 20-step per revolution stepper positioner motor 40 and a conventional 3.5 inch diskette 12, will preferably have a pitch of 13.546 threads/inch.

5 Referring additionally now to Fig. 2, the combined drive 10 of Fig. 1 is shown when utilized in conjunction with a diskette 12. With respect to the illustration of Fig. 2, like structure to that above-described with respect to Fig. 1 is like
10 numbered and the foregoing description thereof shall suffice herefor.

The combined drive 10 utilizing the transducer positioner system of the present invention includes a common drive motor 50 for driving the random
15 access media or sequential access media past the respective transducers for reading data from and/or writing data to the corresponding media. Drive motor 50 is utilized to impart a rotational motion to a drive wheel 52 which, in turn, frictionally
20 engages and turns an idler wheel 54. Idler wheel 54, which in a preferred embodiment may be fixed in position within the combined drive 10, rotates about an axis of rotation 56. As shown, the idler wheel 54 engages the central hub of the
25 media 55 within the diskette 12 to cause it to rotate therein. The media 55 is shown as presenting a media inner diameter 58 and a media outer diameter 60, between which diameters data may be read from and/or written to the media 55. When
30 utilized in conjunction with a tape cartridge 14, the idler wheel 54 is utilized to drive a puck within the tape cartridge 14 as will be more fully described hereinafter.

Upon insertion of a diskette 12 within the
35 diskette insertion opening 32 of the combined drive 10 sufficient so that it is fully seated therein, the diskette shutter 62 of the diskette 12

is opened such that at least one diskette data transducer, or upper read/write head 64 is accorded access to the media 55 of the diskette 12. In this particular embodiment, a corresponding data
5 transducer is concurrently accorded access to the lower surface of the media 55 as will be shown and described more fully hereinafter.

The transducer positioner system of the present invention includes a random access media transducer
10 carriage assembly 66 which is selectably loadable or unloadable to the lead screw 48 as driven by the positioner motor 40. The random access media transducer carriage assembly 66 is operative to engage the helical concave thread 68 of the lead
15 screw 48 when a diskette 12 is fully positioned within the combined drive 10. Alternatively, when the combined drive 10 is not utilized in conjunction with a diskette 12, such as when utilized in conjunction with a tape cartridge 14, the random
20 access media transducer carriage assembly 66 does not engage the concave thread 68 of the lead screw 48 as will be more fully described hereinafter.

As previously described, the diskette
25 shutter 62 of the diskette 12 is opened upon insertion of the diskette 12 within the combined drive 10 by means of an arm 70 pivotally mounted about a post 72 and biased toward housing side 24 by means of a spring 74. A distal end 76 affixed to
30 the arm 70 engages the diskette shutter 62 in a conventional manner and forms the shutter actuator 46 generally described with respect to Fig. 1. Upon removal of the diskette 12 from the combined drive 10, the spring loaded diskette
35 shutter 62 closes to provide a protective cover to the media 55 therewithin. The shutter actuator 46 then returns by pivoting about post 72 under the

bias of spring 74 to a position to engage the diskette shutter 62 of the diskette 12 when reinserted within the combined drive 10.

5 With reference additionally now to Figs. 3 and 4, the transducer positioner system of the present invention for the combined drive 10 is shown. With respect to the structure illustrated in Fig. 3, a diskette 12 is shown as being inserted within the combined drive 10 through the diskette
10 insertion opening 32 wherein the upper access arm 42 is displaced upwards from the plane of the diskette 12 and the random access media transducer carriage assembly 66 is unloaded from the lead screw 48. In Fig. 4, the diskette 12 is shown as
15 fully inserted and seated within the combined drive 10 such that the drive motor 50 can rotate the media 55 within the diskette 12 and the random access media transducer carriage assembly 66 is loaded to the lead screw 48 as driven by the
20 positioner motor 40. With respect to the structure illustrated in Figs. 3 and 4, like structure to that previously described with respect to the preceding figures is like numbered and the foregoing description thereof shall suffice herefor.

25 As illustrated in these figures, the random access media transducer carriage assembly 66 further includes a lower access arm 78 to which is affixed a lower read/write head 80 corresponding to the upper read/write head 64 affixed to the upper access
30 arm 42. The lower read/write head 80 is utilized to read data from and/or write data to the media 55 of the diskette 12.

Loading and unloading of the random access media transducer carriage assembly 66 to the lead
35 screw 48, as well as its positioning longitudinally thereof when loaded to the lead screw 48, is effectuated by means of a loadable follower 82 as

shown. The engagement of the loadable follower 82 to the concave thread 68 of the lead screw 48 will be more fully described hereinafter with respect to Figs. 5-8 and 11.

5 The transducer positioner system of the present invention includes a pinion gear 84 affixed adjacent a distal end 86 of the lead screw 48 as journaled within a fixed plate 88. The pinion gear 84, in conjunction with a corresponding gear 90, causes a
10 90 degree, or right angle, change in the rotation imparted to the lead screw 48 by means of the positioner motor 40 to cause positioning of the tape cartridge 14 data transducer as will also be more fully described hereinafter. Gear 90 presents a
15 collar 92 which is affixed to one end of a fine pitch lead screw 94 such that rotational motion imparted to the gear 90 by the pinion gear 84 causes rotation of the lead screw 94. A sequential access media transducer carriage assembly 96 forming a
20 portion of the transducer positioner system of the present invention is coupled to the lead screw 94 by means of a follower nut 98 such that the sequential access media transducer carriage assembly 96 is caused to move in a translational motion in response
25 to the rotational motion of the lead screw 94 imparted to it by the bidirectional rotation of the lead screw 48 as driven by the positioner motor 40.

 A sequential access media data transducer comprising a tape read/write head 100 is affixed to
30 the sequential access media transducer carriage assembly 96 for reading data from and/or writing data to a tape cartridge 14 seated within combined drive 10 such that the idler wheel 54 rotationally coupled to the drive motor 50 causes the sequential
35 access media to be driven past the tape read/write head 100. The sequential access media transducer carriage assembly 96 is constrained to translational

motion perpendicular to the direction of movement of the sequential access storage media by means of a guidepost 102 extending from the plate 88 through a corresponding channel 104 in the sequential access media transducer carriage assembly 96.

When utilized in conjunction with a QIC tape cartridge 14, the track spacing between the 28 tracks (0-27) thereof is substantially .0085 inches. Conventionally, track 0 is located at an offset of one track pitch from the center of the tape media with the odd number tracks preceding therefrom to the lower tape edge and the even numbered tracks preceding therefrom to the upper tape edge. The ratio of the pinion gear 84 to the gear 90 has been chosen with respect to the use of a 20-step per revolution positioner motor 40 to be 5:1 in the particular embodiment shown, resulting in a .00025 inch step resolution. It should also be observed that other means for providing a right angle power transmission between lead screw 48 and lead screw 94 may be chosen such as the use of a worm gear configuration, spiroid gears and the like. Still further, in effectuating the implementation of a combined drive 10 in a one inch height or lesser form factor, the pinion gear 84 may be positioned beneath the gear 90 to provide a more compact vertical dimension between the top surface 20 and lower surface 22 of the combined drive 10 as illustrated in Fig. 1.

With reference additionally now to Figs. 5-8 and 11, the operation of the random access media transducer carriage assembly 66, and particularly the loadable follower 82 thereof, forming a portion of the transducer positioner system of the present invention is shown. With respect to the structure illustrated in these figures, like structure to that previously described with respect to the preceding

figures is like numbered and the foregoing description thereof shall suffice herefor.

The loadable follower 82 of the random access media transducer carriage assembly 66 includes a
5 slot 110 which partially surrounds the upper surface of the lead screw 48 as shown particularly in Figs. 5, 7 and 11. A pin 112 extends across the slot 110 of the loadable follower 82 for engaging the concave thread 68 of the lead screw 48 and is disposed at an
10 angle corresponding to the pitch of the helical concave thread 68. When the upper access arm 42 is disposed upwardly from the plane to be occupied by the diskette 12, the loadable follower 82 is also caused to be raised by the engagement of tab 114
15 (shown in more detail in Figs. 1 and 14), by pivoting about its pivot hole 116 as rotationally coupled to pivot block 118. In this position, as shown in Figs. 3 and 5, the pin 112 is displaced upwardly of the concave thread 68 of the lead screw
20 48 such that rotational motion of the lead screw 48 imparted by the positioner motor 40 will not cause the random access media transducer carriage assembly 66 to be moved longitudinally of the lead screw 48. Alternatively, when the diskette 12 is fully
25 inserted within the combined drive 10 and is seated therewithin such that the upper read/write head 64 and lower read/write head 80 are in position to read data from and/or write data to the media 55, the loadable follower 82 is allowed to descend under
30 spring bias as the upper access arm 42 pivots downward and tab 114 follows, such that the pin 112 within the slot 110 will engage the concave thread 68 of the lead screw 48. It should be noted that in most instances, the positioner motor 40 must rotate
35 the lead screw 48 somewhat in order for the pin 112 to engage the concave thread.

The upper access arm 42 is in an upwardly

disposed position when the diskette shuttle mechanism 44 is also in an upward position for receiving the diskette 12. As the diskette shuttle mechanism 44 moves in conjunction with the diskette 12 into a position inwardly and concurrently downwardly within the combined drive 10, the upper access arm 42 is allowed to descend as the lift tabs 144 thereof follow the shuttle lips 176 of the diskette shuttle mechanism 44 as is shown particularly with respect to Figs. 3-8. The upper access arm 42 is biased in a downward direction by means of a spring 128 surrounding a spring tang 120 as shown particularly in Figs. 1 and 14. The spring 128 is maintained on top of the upper access arm 42 by means of prongs 146 and the assembly hole 126 of the pair of assembly holes 124, 126 of the pivot block 118 as will be more fully described hereinafter. The loadable follower 82 of the random access media transducer carriage assembly 66 pivots about pivot post 122 inserted through pivot hole 116 which is located behind the pivot point for the upper access arm 42 as shown in Fig. 3. The use of the tab 114 in conjunction with the upper access arm 42 as will be more fully described hereinafter, allows any vibrational motion or disturbances imparted to the loadable follower 82 by the lead screw 48 to be decoupled from the upper access arm 42 as the random access media transducer carriage assembly 66 tracks longitudinally of the lead screw 48 when a diskette 12 is utilized in conjunction with the combined drive 10. The loadable follower 82 of the random access media transducer carriage assembly 66 is itself biased in a downward position by means of a spring 160 circumferentially surrounding spring tang 158 for providing a bias on surface 166 of the loadable follower 82 as shown particularly with respect to Figs. 7 and 8.

As shown particularly in Figs. 5-6 and 9-10, a guide pin 184 is inserted within a guide hole 178 of the random access media transducer carriage assembly 66 as directly coupled to the structure of the lower access arm 78. By means of the guide pin 184 and corresponding guide hole 178, the random access media transducer carriage assembly 66 is constrained to accurate radial tracking of the data tracks of the media 55 of the diskette 12, in response to the bidirectional rotation of the lead screw 48 by means of the positioner motor 40.

With particular reference to Figs. 9 and 10, a portion of the random access media transducer carriage assembly 66 in a diskette 12 inserted, and diskette 12 not-inserted positions respectively is shown. With respect to the structure illustrated in Figs. 9 and 10, corresponding structure to that previously described with respect to the preceding figures is like numbered and the foregoing description thereof shall suffice herefor. In these figures, it can be seen that the upper access arm 42 is hingedly secured to a block portion 154 affixed to the lower access arm 78 to enable the upper access arm to pivot upwardly in response to pressure applied to the lift tabs 144 thereof by means of the shuttle lips 176 as well as to descend downwardly when the diskette shuttle mechanism 44 in conjunction with a diskette 12 is fully inserted within the combined drive 10 under the influence of spring 128. A number of representative assembly screws 180 and 182 are also shown in Fig. 9. The flexible hinge 138 allows the upper access arm 42 to be positioned with respect to the plane of the random access media, or diskette 12, by flexing with respect to the block portion 154 of the random access media transducer carriage assembly 66.

With reference particularly now to Figs. 14 and

15, the transducer positioner system of the present invention utilized in conjunction with the combined drive 10 is shown to better facilitate understanding of the various elements thereof. Pivot block 118
5 includes a spring tang 120 and pivot post 122 as previously described. Assembly holes 124, 126 are utilized to secure the pivot block to the block portion 154 of the lower access arm 78 also as shown. As previously described, spring 128 provides
10 a downward bias force to the upper access arm 42. A plate 130 having a pair of holes 132, 134 also forms a portion of the random access media transducer carriage assembly 66. The plate 130 further includes a notch 136 which corresponds to the tab
15 114 of loadable follower 82 as shown in Fig. 14 in conjunction with a corresponding notch 168 adjacent recessed surface 148. The flexible hinge 138 includes two pairs of holes 140 and holes 142. Holes 140 of the flexible hinge 138 correspond to
20 the assembly holes 124, 126 of the pivot block 118 while holes 142 correspond to the holes 132, 134 of the plate 130. Flexible hinge 138 is affixed between pivot block 118 and the block portion 154 of the lower access arm 78. The remaining portion of
25 the flexible hinge 138 is secured between the plate 130 and the recessed surface 148 of the upper access arm 42. Holes 150 of the upper access arm 42 correspond to the holes 142 of the flexible hinge 138 and the holes 132, 134 of the plate 130.

30 As also shown in conjunction with Figs. 9 and 10, the lower access arm 42 further includes a stop 152 comprising a right-angled protrusion to serve to prevent the upper access arm 42 from being biased, or otherwise caused to be lowered, below the plane
35 of the media 55 of the diskette 12 by its engagement with the block portion 154 of the lower access arm 78. The block portion 154 includes a pair of holes

156 which line up with holes 140 of the flexible hinge 138, and assembly holes 124, 126 of the pivot block 118. As previously described, the block portion 154 incorporates a spring tang 158 for
5 retaining a spring 160 to provide a downward bias to the surface 166 of the loadable follower 82 of the random access media transducer carriage assembly 66. The block portion 154 further includes a guide fork 162 having a slot 164 therethrough for partially
10 circumferentially surrounding the lead screw 48 providing, in conjunction with the guide pin 184 and corresponding guide hole 178 of the lower access arm 78, a means for serving to ensure that the random access media transducer carriage assembly 66 tracks
15 accurately with respect to the media 55 of the diskette 12.

With reference additionally now to Figs. 12 and 13, the transducer positioner system of the present invention for use with a tape cartridge 14 is shown.
20 With respect to the structure illustrated in these figures, like structure to that previously described with respect to the preceding figures is like numbered and the foregoing description thereof shall suffice herefor.

25 As previously described, the drive motor 50 causes a rotational motion of the drive wheel 52 which frictionally engages a fixed idler wheel 54 for driving a driven wheel, or puck, 190 within the tape cartridge 14. The fixed idler wheel 54 rotates
30 about an axis of rotation 56 and includes a diskette chucking mechanism 186 and drive pin 188 for engaging and driving the media 55 within a diskette 12 as previously described. The rotational motion imparted to the internal puck 190 causes the
35 sequential access media, or tape, 192 to be moved past the tape read/write head 100 such that the sequential access media transducer carriage assembly

96 can position the tape read/write head 100 to select the appropriate one of the data tracks thereon. Upon insertion of the tape cartridge 14 within the tape cartridge insertion opening 34 of the combined drive 10, the cartridge door 194 is caused to be opened to accord access to the tape 192 by the tape read/write head 100. As shown particularly with respect to Fig. 13, the sequential access media transducer carriage assembly 96 is caused to move in a direction perpendicular to the movement of the tape 192 by means of follower nut 98 affixed to the sequential access media transducer carriage assembly 96 by means of a pin 196. A sleeve 170 which surrounds guide post 102 and is co-extensive with channel 104 constrains the sequential access media transducer carriage assembly 96 to accurately position the tape read/write head 100 with respect to the tracks of the tape 192. The tape read/write head 100 is secured within a head receptacle 172 of the sequential access media transducer carriage assembly 96 as shown particularly in Fig. 14. Also illustrated in Fig. 14 is an idler cut-out 174 for allowing the idler wheel 54 to engage the puck 190 as well as allow the diskette chucking mechanism 186 and drive pin 188 to engage the corresponding structure on the diskette 12.

Utilizing the transducer positioner system and method of the present invention, the combined drive 10 may be utilized in conjunction with either a diskette 12 or tape cartridge 14. Although not shown, both the upper and lower read/write heads 64, 80 and tape read/write head 100 have position sensors such that the associated computer mass storage controller will always know where the random access media transducer carriage assembly 66 and sequential access media transducer carriage assembly

96 are positioned relative to each other. By means of the loadable follower 82 in the embodiment shown, there may be provided approximately 5 or 6 zones that the tape read/write head 100 can be positioned where the upper and lower read/write heads 64, 80 of the random access media transducer carriage assembly 66 may go through their full motion from the media inner diameter 58 to the media outer diameter 60. Thus, potential misplacement of the heads is accounted for in the event of power loss to the combined drive 10. For example, should power be lost, associated firmware or software can be utilized to instruct a user to disengage the diskette 12 from the combined drive 10 when the tape read/write head 100 is positioned such that the random access media transducer carriage assembly 66 may not be accorded full travel. By disengaging the diskette 12, the random access media transducer carriage assembly 66 will be unloaded from the lead screw 48 and can then be repositioned with respect to the sequential access media transducer carriage assembly 96 such that full travel between the media inner diameter 58 and media outer diameter 60 will be accorded.

Another important aspect of the present invention is the ability of the random access media transducer carriage assembly 66 and sequential access media transducer carriage assembly 96 to "ratchet" at the end of their respective limits of travel inasmuch as they might possibly lose their original, factory-set synchronization in the course of operation. In this regard, the follower nut 98 of the sequential access media transducer carriage assembly 96 is allowed to "run off" the thread of the fine pitch lead screw 94 to enable the lead screw 94 to continue to rotate in the same direction. In this position, a spring force biases

the follower nut 98 towards the lower end of the lead screw 94 such that it will automatically rethread itself back onto the lead screw 94 when its direction of rotation is reversed. Similarly, the configuration of the loadable follower 82 allows the lead screw 48 to continue to rotate even at the limit of travel for the random access media transducer carriage assembly 66 as the pin 112 becomes disengaged from the concave thread 68. The spring force imparted to the loadable follower 82 will thereafter cause the pin 112 to re-engage the concave thread 68 of the lead screw 48 when a proper orientation between the two is again achieved. At this point, the random access media transducer carriage assembly 66 may again travel in a reverse direction in response to a reversal of the rotational direction of the lead screw 48 imparted by the positioner motor 40.

What has been provided is a transducer positioner system and method for a combined removable random and sequential access media drive incorporating a random access media transducer carriage assembly 66 which is selectively loadable to a lead screw 48 as driven by a positioner motor 40. The random access media transducer carriage assembly 66 includes a loadable follower 82 selectively engaging the lead screw 48 when the combined drive 10 is utilized in conjunction with a diskette 12 or other random access media. A second lead screw 94 is rotationally coupled to the lead screw 48 to drive another follower to cause a translational motion to be imparted to the sequential access media transducer carriage assembly 96 to position a tape read/write 100 with respect to the data tracks of a tape cartridge 14.

With reference additionally now to Figs. 16A and 16B, an alternative embodiment of the loadable

5 follower 82 is shown in which a leaf spring 198 is
secured within a spring retaining block 200
extending between the downwards extending sides of
the loadable follower 82 retaining pin 112 within
10 the slot 110. As illustrated, the lead screw 48
extends through the slot 110 and between the
loadable follower 82 and the spring retaining block
200 such that the leaf spring 198 will bias the
loadable follower 82 towards the lead screw 48 in
15 order to cause the pin 112 to be engaged within the
concave thread 68 thereof. In this alternative
embodiment of the loadable follower 82, the leaf
spring 198 replaces spring 160 and spring tang 158
shown in the preceding figures and provides a spring
20 force to the random access media transducer carriage
assembly 66 loadable follower more directly in line
with the axis of the lead screw 48.

With reference additionally now to Figs. 17A
and 17B, the engagement between the leaf spring 198
25 with the lead screw 48 with the loadable follower 82
in both an unloaded and loaded positions thereof.
With respect to the alternative embodiment of the
loadable follower shown in Figs. 16A-16B and 17A-
17B, like structure to that previously described
25 with respect to the previous figures is like
numbered and the foregoing description thereof shall
suffice herefor.

While there have been described above the
principles of the present invention in conjunction
30 with specific apparatus, it is to be clearly
understood that the foregoing description is made
only by way of example and not as a limitation to
the scope of the invention. Particularly, the
preceding embodiment has been described with respect
35 to the use of a 3.5" micro-diskette and a QIC tape
cartridge as a representative example only. The
principles of the present invention also relate to a

transducer positioner system and method for use with other random access computer media such as 5.25" floppy disks (or other form factors), floptical disks, CDROMs and the like. In like manner, the principles of the transducer positioner system and method of the present invention are likewise applicable to other types of sequential access media such as 8 mm. tape, DAT, data cassettes and the like.

Moreover, while a combined drive in accordance with the present invention has been disclosed with respect to specific embodiments utilizing a single random access media and a single sequential access media, the principles of the transducer positioner system and method of the present invention are likewise applicable to the use of the same techniques described and shown with respect to drives incorporating one or more random access media in conjunction with one or more sequential access media.

What is claimed is:

CLAIMS

1. A transducer positioner system comprising:
 - a motor for transforming electrical signals to a bi-directional rotational motion of a drive shaft thereof;
 - 5 first and second lead screws having corresponding first and second distal and proximal ends thereof respectively, said first lead screw being rotationally coupled adjacent said first proximal end thereof to said drive shaft of said motor;
 - 10 a coupling mechanism rotationally interconnecting said second lead screw adjacent said second distal end thereof to said first lead screw adjacent said first distal end thereof;
 - a follower coupled to said second lead screw between
15 said second distal and proximal ends thereof; and
 - a transducer mount responsive to said follower, said transducer mount being slidably constrained to motion in opposing translational directions in response to said bi-directional rotational motion of said drive shaft.
- 20 2. The transducer positioner system of claim 1 wherein said motor comprises a stepper motor.
3. The transducer positioner system of claim 1 wherein said first and second lead screws have differing thread pitches.
- 25 4. The transducer positioner system of claim 3 wherein said first lead screw has a coarser pitch than said second lead screw.
5. The transducer positioner system of claim 1 wherein said coupling mechanism comprises a pinion affixed
30 adjacent said first distal end of said first lead screw and a corresponding gear affixed adjacent said second distal end of said second lead screw.
6. The transducer positioner system of claim 1 wherein said first and second lead screws are substantially
35 orthogonal to each other.
7. The transducer positioner system of claim 1 wherein said follower circumferentially surrounds said second

lead screw.

8. The transducer positioner system of claim 1 wherein said second lead screw comprises a shaft having a helical, outwardly extending thread.

5 9. The transducer positioner system of claim 1 wherein said transducer mount is secured to said follower.

10. The transducer positioner system of claim 1 wherein said transducer mount is slidably constrained by means of a pin secured in a substantially parallel and spaced
10 apart relationship to said second lead screw.

11. The transducer positioner system of claim 10 wherein said pin extends through a corresponding channel in said transducer mount.

12. The transducer positioner system of claim 1 wherein
15 said transducer mount further comprises a data transducer.

13. The transducer positioner system of claim 12 wherein said data transducer comprises a sequential access media data transducer.

20 14. The transducer positioner system of claim 1 further comprising:

an additional follower selectively coupled to said first lead screw between said first distal and proximal ends thereof; and

25 an additional transducer mount responsive to said additional follower, said additional transducer mount being slidably constrained to motion in opposing translational directions in response to said bi-directional rotational motion of said drive shaft.

30 15. The transducer positioner system of claim 14 wherein said additional follower is selectively loadable and unloadable to said first lead screw adjacent said first proximal end thereof.

35 16. The transducer positioner system of claim 14 wherein said additional transducer mount is slidably constrained by means of a guide pin secured in a substantially parallel and spaced apart relationship to said first lead

screw.

17. The transducer positioner system of claim 16 wherein said guide pin extends through a corresponding aperture in said transducer mount.

5 18. The transducer positioner system of claim 14 wherein said additional transducer mount comprises at least one cantilevered access arm.

19. The transducer positioner system of claim 18 wherein said at least one cantilevered access arm comprises a
10 pair of first and second spaced apart access arms.

20. The transducer positioner system of claim 19 wherein said first access arm is hingedly secured at a proximal end thereof to said additional transducer mount, said first access arm being movable between a first position
15 thereof forming an acute angle with respect to said second access arm and a second position thereof lying in a generally parallel relationship with respect to said second access arm.

21. The transducer positioner system of claim 18 wherein said additional follower is selectively loadable and
20 unloadable to said first lead screw when said first access arm is in said second and first positions thereof respectively.

22. The transducer positioner system of claim 18 wherein said additional transducer mount further comprises at
25 least one additional data transducer secured adjacent a distal end of said access arm.

23. The transducer positioner system of claim 22 wherein said at least one additional data transducer comprises
30 random access media data transducer.

24. The transducer positioner system of claim 1 wherein said follower may become disengaged from said second lead screw after said second lead screw has continued to rotate in a first rotational direction thereof for a
35 predetermined time, said follower thereafter becoming re-engaged with said second lead screw upon said second lead screw beginning to rotate in a second opposite rotational

direction thereof.

25. The transducer positioner system of claim 14 wherein said additional follower may become disengaged from said first lead screw after said first lead screw has continued to rotate in a first rotational direction thereof for a predetermined time, said additional follower thereafter becoming re-engaged with said first lead screw upon said first lead screw beginning to rotate in a second opposite rotational direction thereof.

26. A method for positioning a transducer mount comprising the steps of:

providing a motor for transforming electrical signals to a bi-directional motion of a drive shaft;
coupling a first lead screw to said drive shaft of said motor;

rotationally coupling said first lead screw to a second lead screw;

transforming a rotational motion of said second lead screw to a translational motion of said transducer mount.

27. The method of claim 26 wherein said step of providing is carried out by means of a stepper motor.

28. The method of claim 26 wherein said step of coupling is carried out by the step of:

threading said drive shaft of said motor within a proximal end of said first lead screw.

29. The method of claim 26 wherein said step of rotationally coupling is carried out by the steps of:

affixing a pinion to a distal end of said first lead screw;

securing a gear corresponding to said pinion to a distal end of said second lead screw; and

intermeshing said pinion and said gear such that rotational motion of said first lead screw is transferred to said second lead screw.

30. The method of claim 29 wherein said step of transforming is carried out by the steps of:

introducing a follower to said second lead screw,

said follower moving axially of said second lead screw in response to bi-directional rotation thereof,

securing said transducer mount to said follower; and
slidably constraining said transducer mount to
5 motion in opposite translational directions generally parallel to said second lead screw.

31. The method of claim 30 wherein said step of slidably constraining is carried out by the steps of:

securing a pin in a substantially parallel and
10 spaced apart relationship to said second lead screw; and
extending said pin through a corresponding channel in said transducer mount.

32. A removable storage media drive for reading data from, or writing data to, a storage media, said drive
15 including a media drive motor for moving said storage media with respect to a data transducer and a bi-directional transducer positioner motor for positioning said data transducer with respect to said moving storage media wherein the improvement, in combination, comprises:

20 first and second lead screws having corresponding first and second distal and proximal ends thereof respectively, said first lead screw being rotationally coupled adjacent said first proximal end thereof to a drive shaft of said transducer positioner motor;

25 a coupling mechanism rotationally interconnecting said second lead screw adjacent said second distal end thereof to said first lead screw adjacent said first distal end thereof;

a follower coupled to said second lead screw between
30 said second distal and proximal ends thereof; and

a transducer mount responsive to said follower, said transducer mount being slidably constrained to motion in opposing translational directions in response to said bi-directional rotational motion of said drive shaft.

35 33. The drive of claim 32 wherein said transducer positioner motor comprises a stepper motor.

34. The drive of claim 32 wherein said first and second

lead screws have differing thread pitches.

35. The drive of claim 34 wherein said first lead screw has a coarser pitch than said second lead screw.

36. The drive of claim 32 wherein said coupling
5 mechanism comprises a pinion affixed adjacent said first distal end of said first lead screw and a corresponding gear affixed adjacent said second distal end of said second lead screw.

37. The drive of claim 32 wherein said first and second
10 lead screws are substantially orthogonal to each other.

38. The drive of claim 32 wherein said follower circumferentially surrounds said second lead screw.

39. The drive of claim 32 wherein said second lead screw comprises a shaft having a helical, outwardly extending
15 thread.

40. The drive of claim 32 wherein said transducer mount is secured to said follower.

41. The drive of claim 32 wherein said transducer mount is slidably constrained by means of a pin secured in a
20 substantially parallel and spaced apart relationship to said second lead screw.

42. The drive of claim 41 wherein said pin extends through a corresponding channel in said transducer mount.

43. The drive of claim 32 wherein said transducer mount
25 further comprises a data transducer.

44. The drive of claim 43 wherein said data transducer comprises a sequential access media data transducer.

45. The drive of claim 32 further comprising:

an additional follower selectively coupled to said
30 first lead screw between said first distal and proximal ends thereof; and

an additional transducer mount responsive to said
additional follower, said additional transducer mount being slidably constrained to motion in opposing
35 translational directions in response to said bi-directional rotational motion of said drive shaft.

46. The drive of claim 45 wherein said additional

follower is selectively loadable and unloadable to said first lead screw adjacent said first proximal end thereof.

5 47. The drive of claim 45 wherein said additional transducer mount is slidably constrained by means of a guide pin secured in a substantially parallel and spaced apart relationship to said first lead screw.

10 48. The drive of claim 47 wherein said guide pin extends through a corresponding aperture in said transducer mount.

49. The drive of claim 45 wherein said additional transducer mount comprises at least one cantilevered access arm.

15 50. The drive of claim 49 wherein said at least one cantilevered access arm comprises a pair of first and second spaced apart access arms.

20 51. The drive of claim 50 wherein said first access arm is hingedly secured at a proximal end thereof to said additional transducer mount, said first access arm being movable between a first position thereof forming an acute angle with respect to said second access arm and a second position thereof lying in a generally parallel relationship with respect to said second access arm.

25 52. The drive of claim 51 wherein said additional follower is selectively loadable and unloadable to said first lead screw when said first access arm is in said second and first positions thereof respectively.

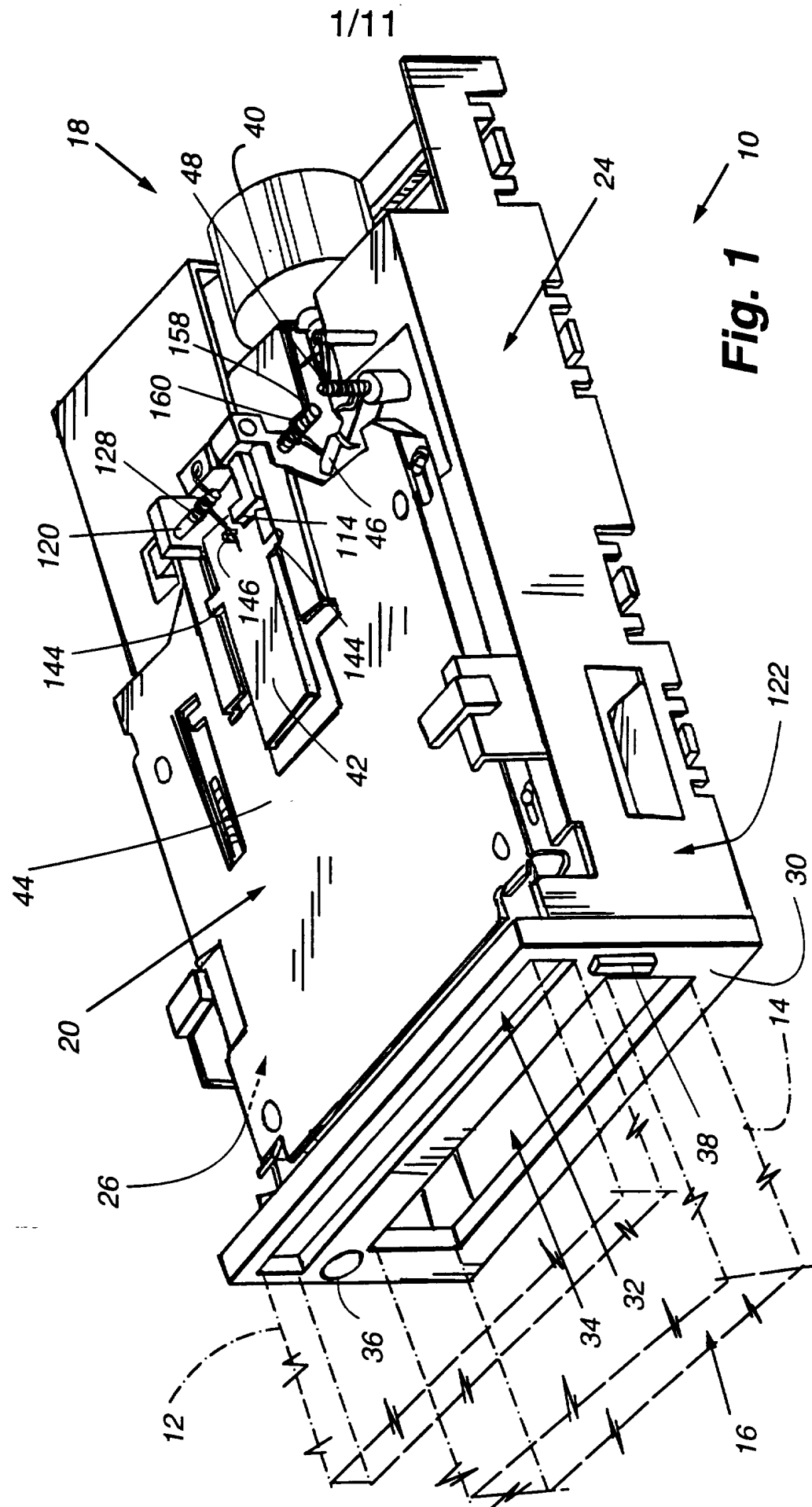
30 53. The drive of claim 45 wherein said additional transducer mount further comprises at least one additional data transducer secured adjacent a distal end of said access arm.

54. The drive of claim 53 wherein said at least one additional data transducer comprises a random access media data transducer.

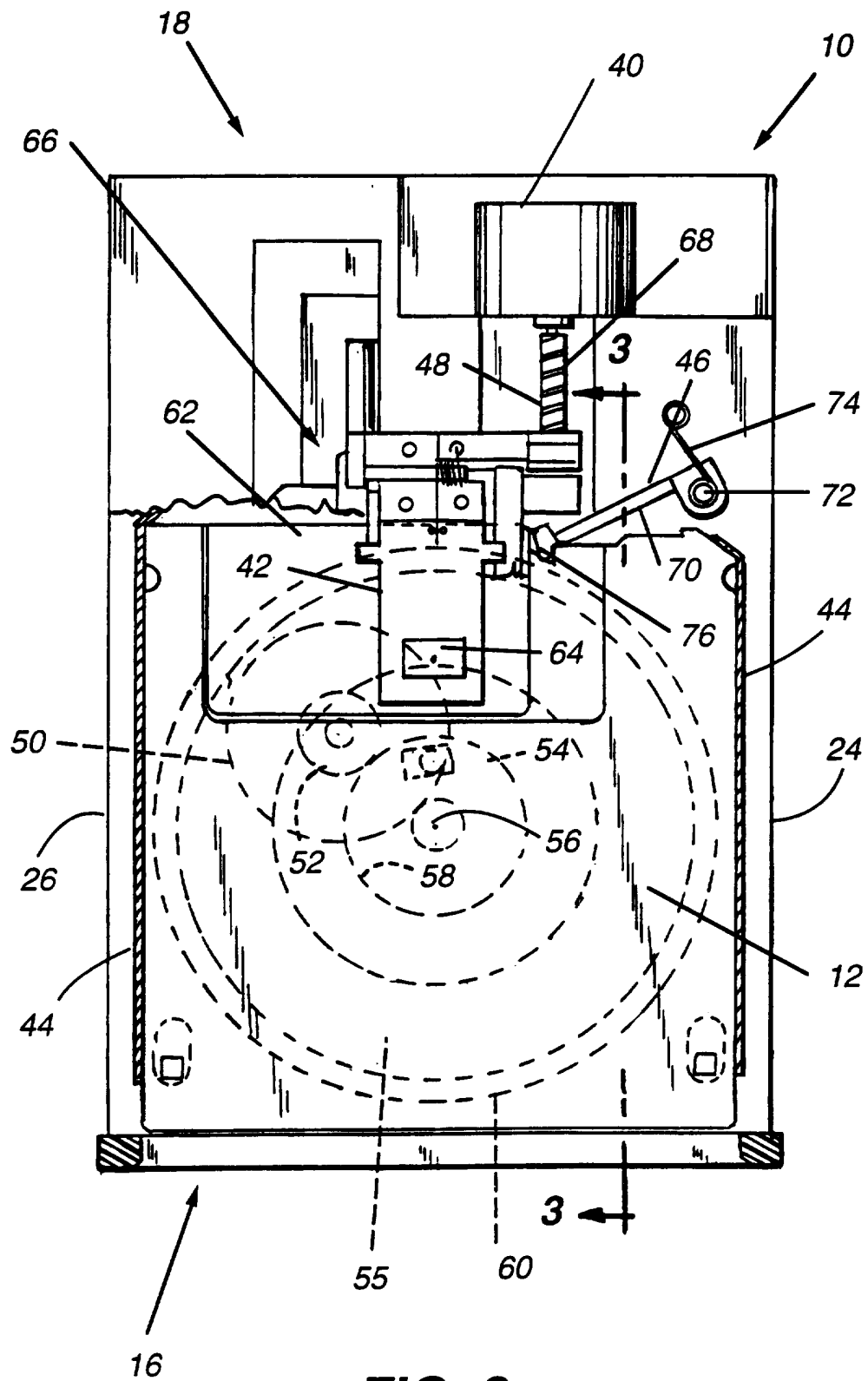
35 55. The drive of claim 32 wherein said follower may become disengaged from said second lead screw after said second lead screw has continued to rotate in a first

rotational direction thereof for a predetermined time,
said follower thereafter becoming re-engaged with said
second lead screw upon said second lead screw beginning
to rotate in a second opposite rotational direction
thereof.

5 56. The drive of claim 45 wherein said additional
follower may become disengaged from said first lead screw
after said first lead screw has continued to rotate in a
first rotational direction thereof for a predetermined
10 time, said additional follower thereafter becoming re-
engaged with said first lead screw upon said first lead
screw beginning to rotate in a second opposite rotational
direction thereof.



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**FIG. 2**

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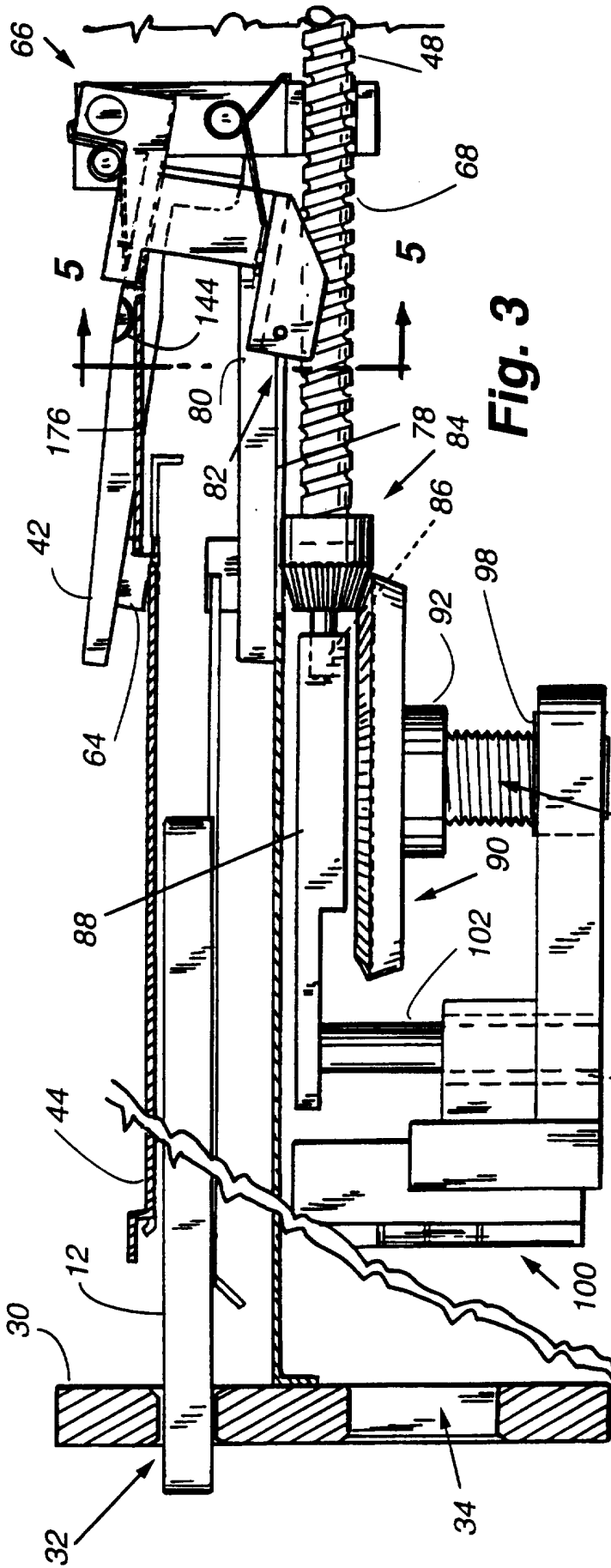


Fig. 3

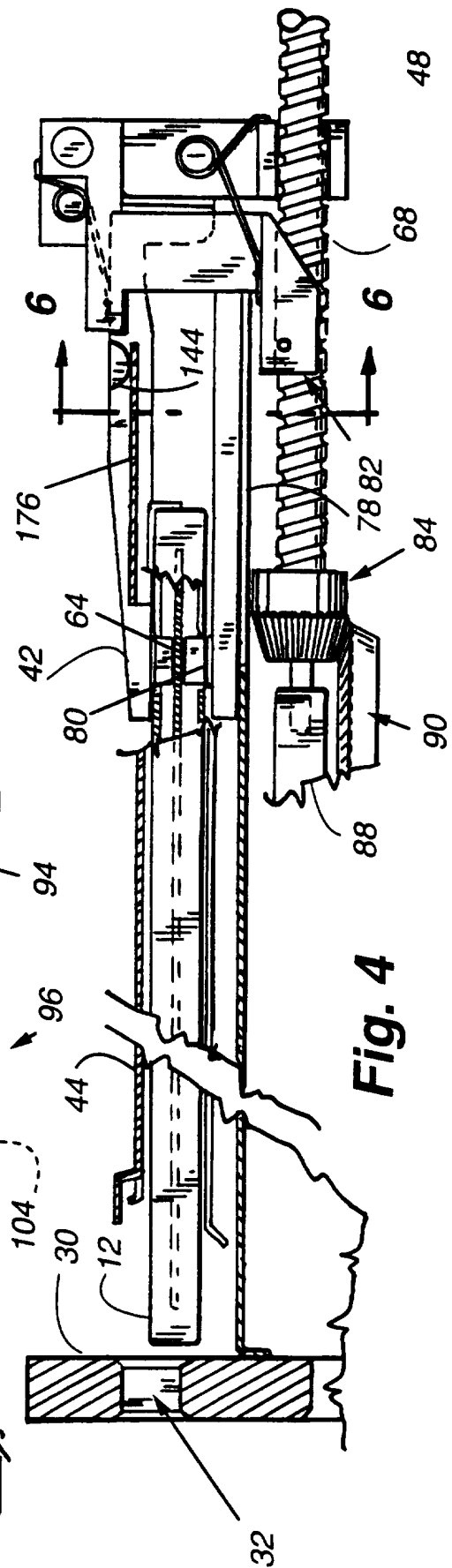


Fig. 4

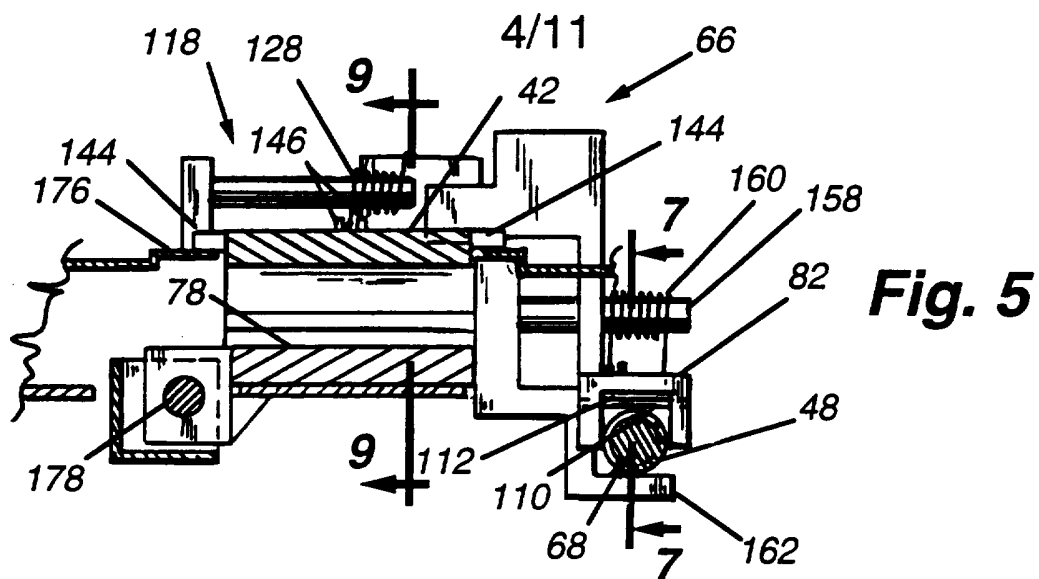


Fig. 5

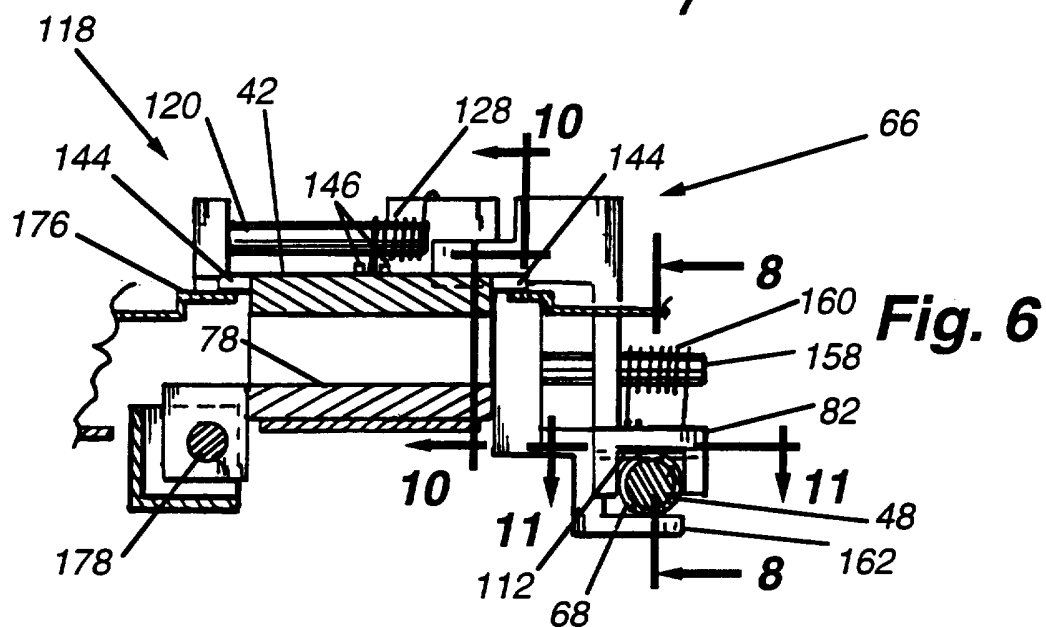


Fig. 6

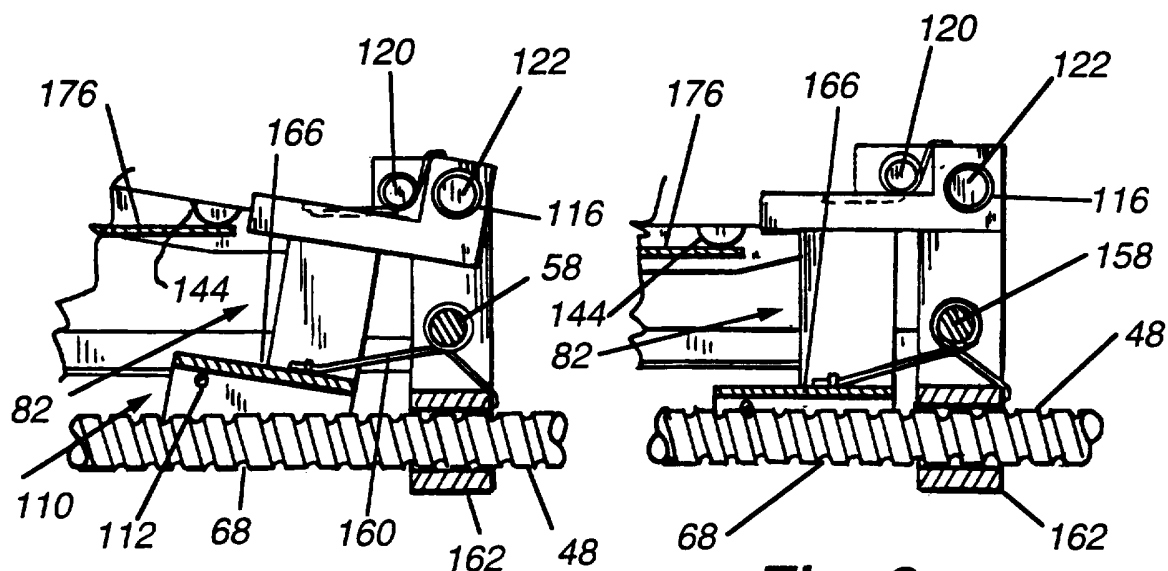
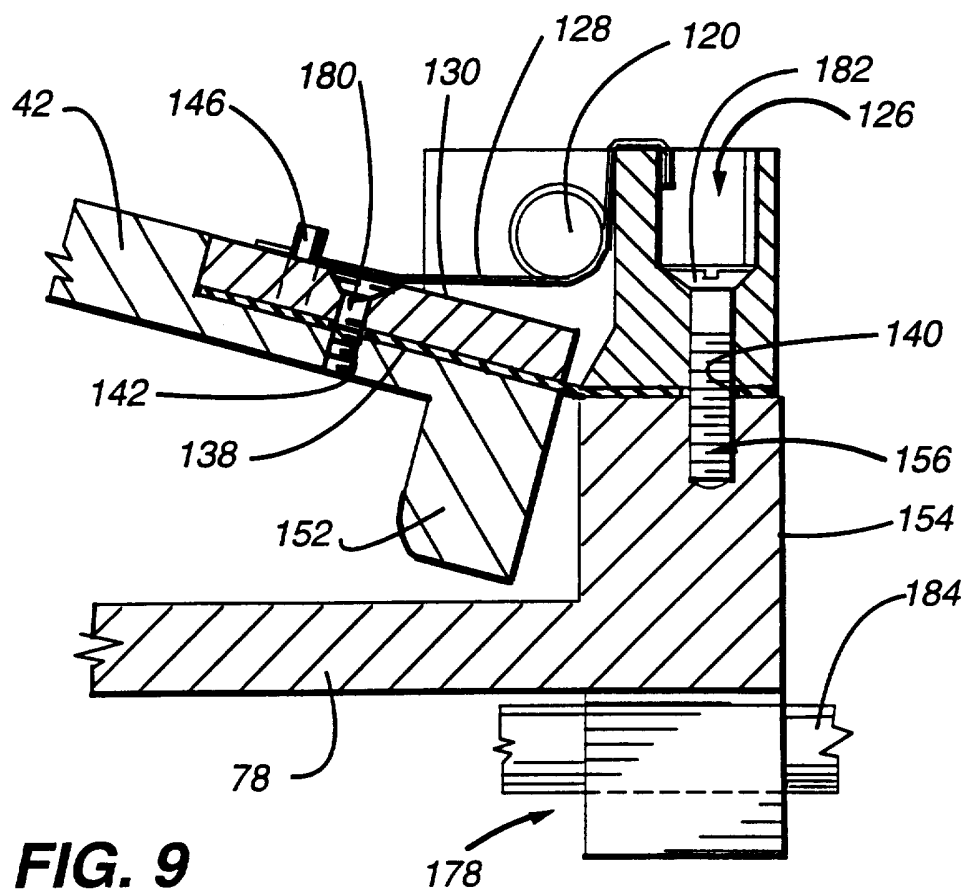
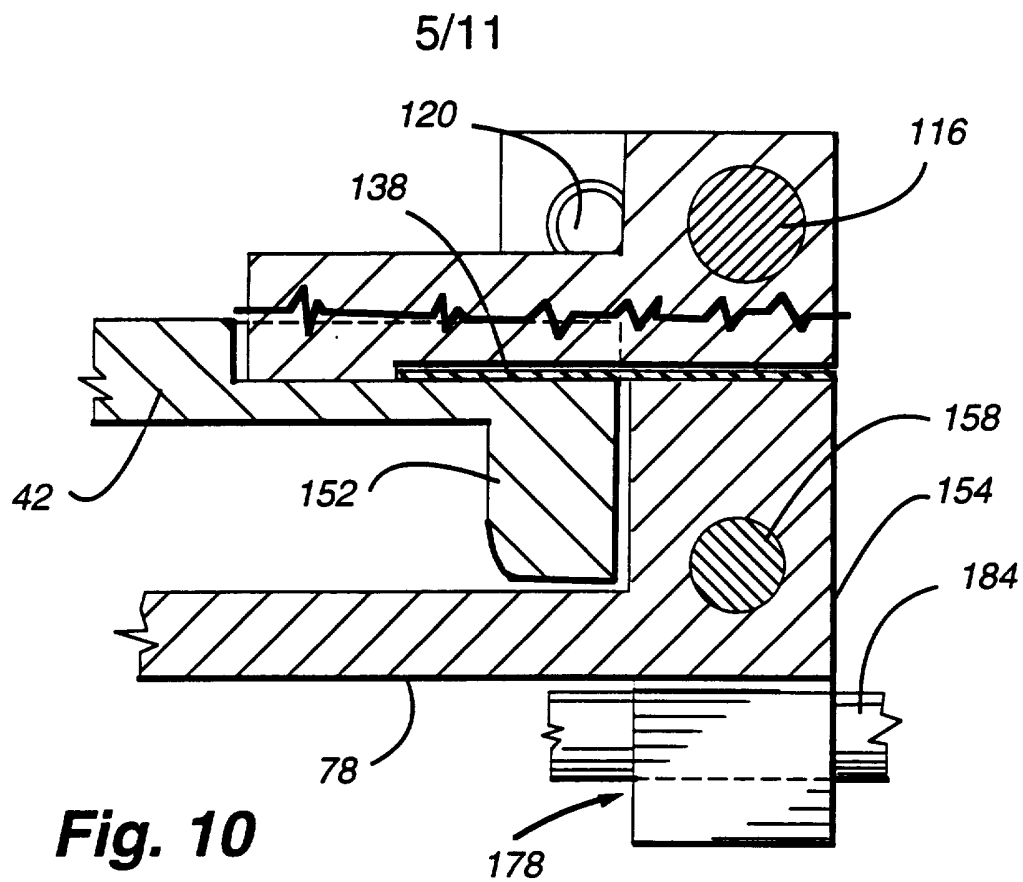
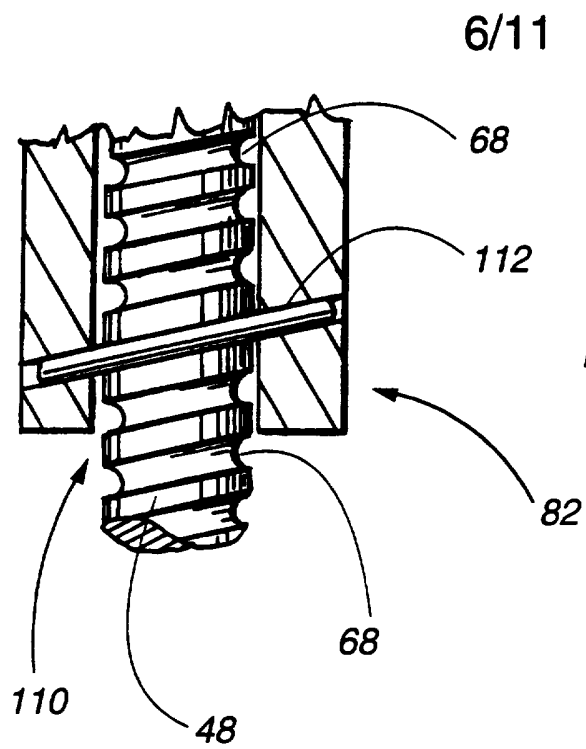


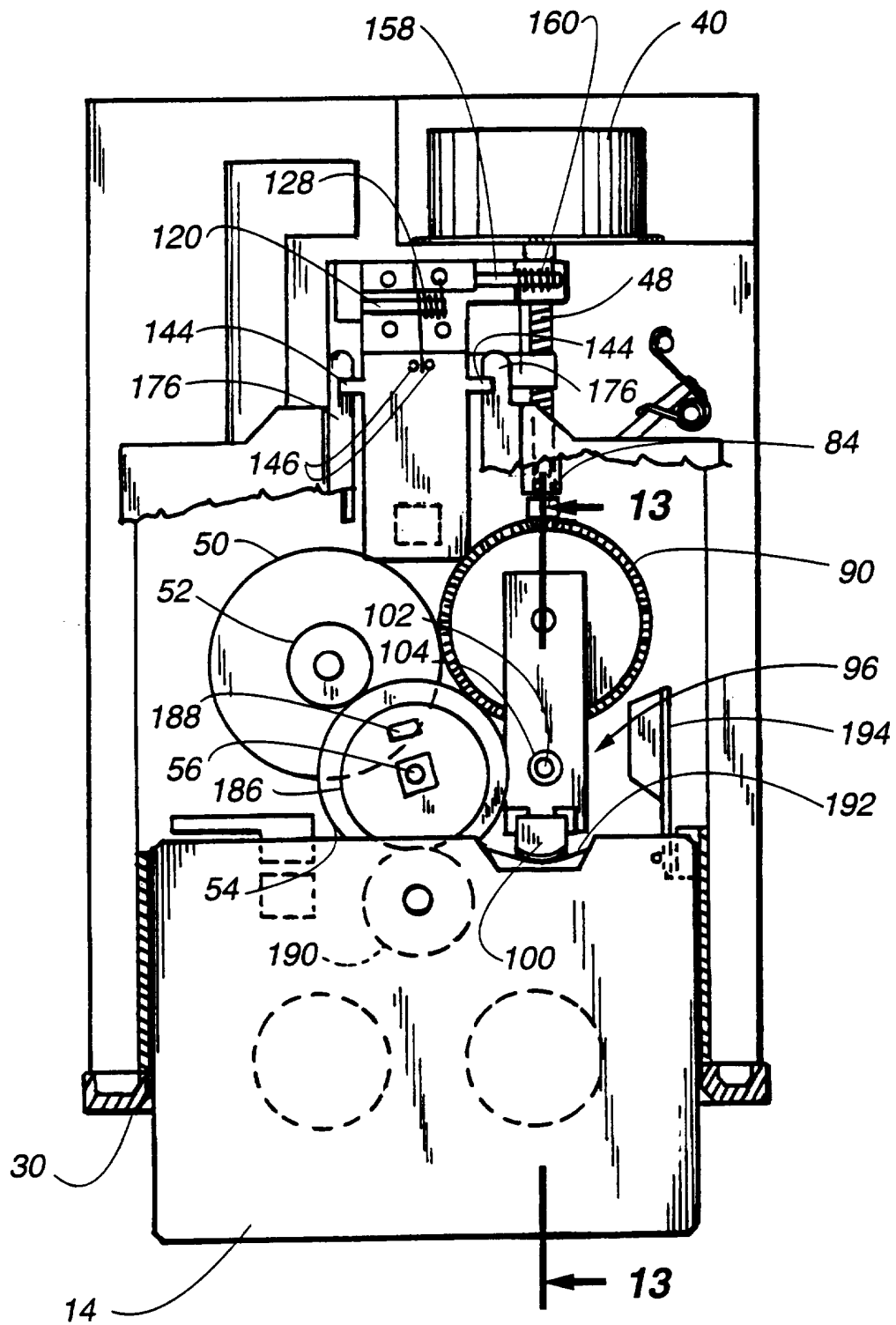
Fig. 7

Fig. 8





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**FIG. 12**

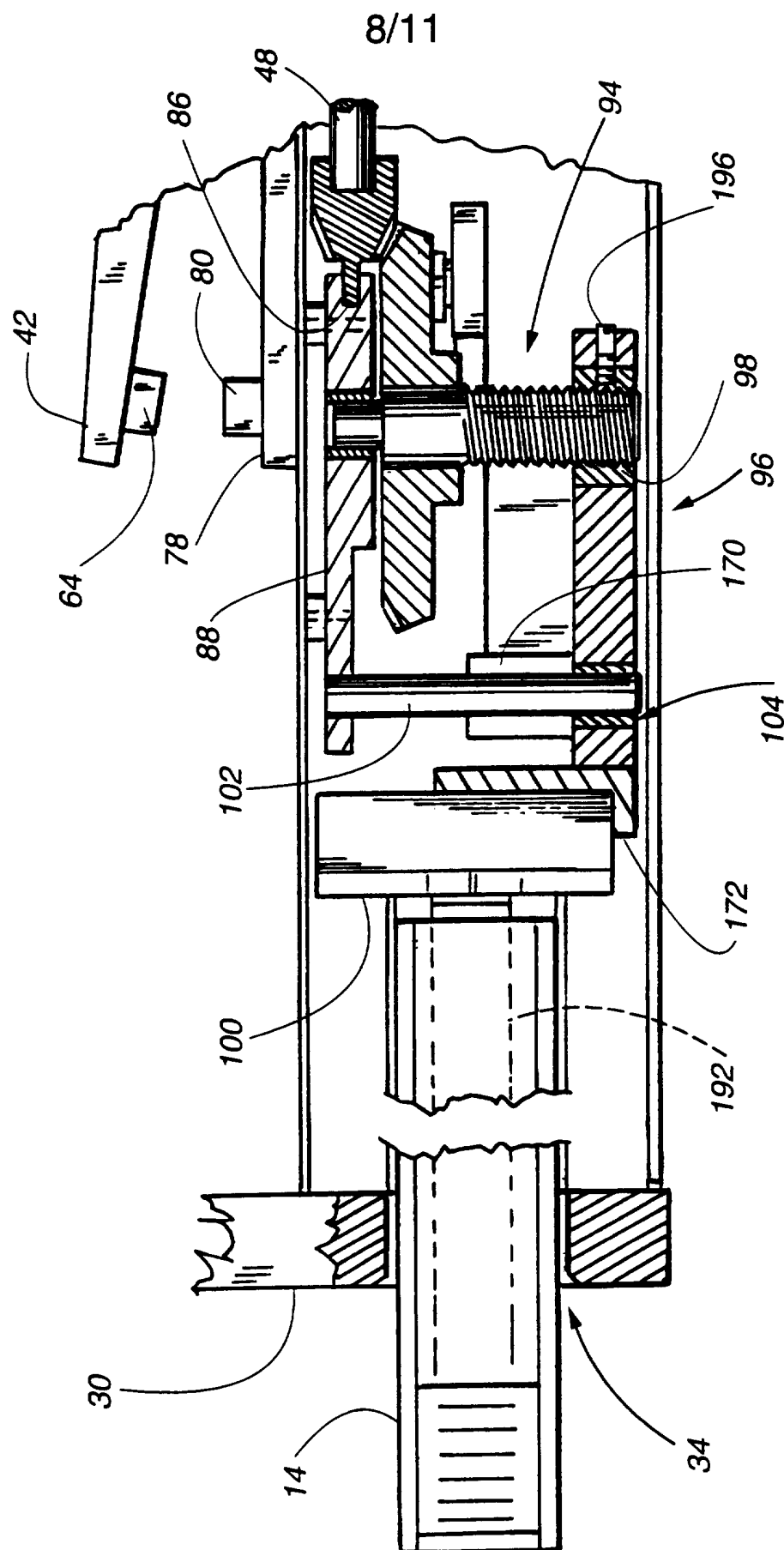
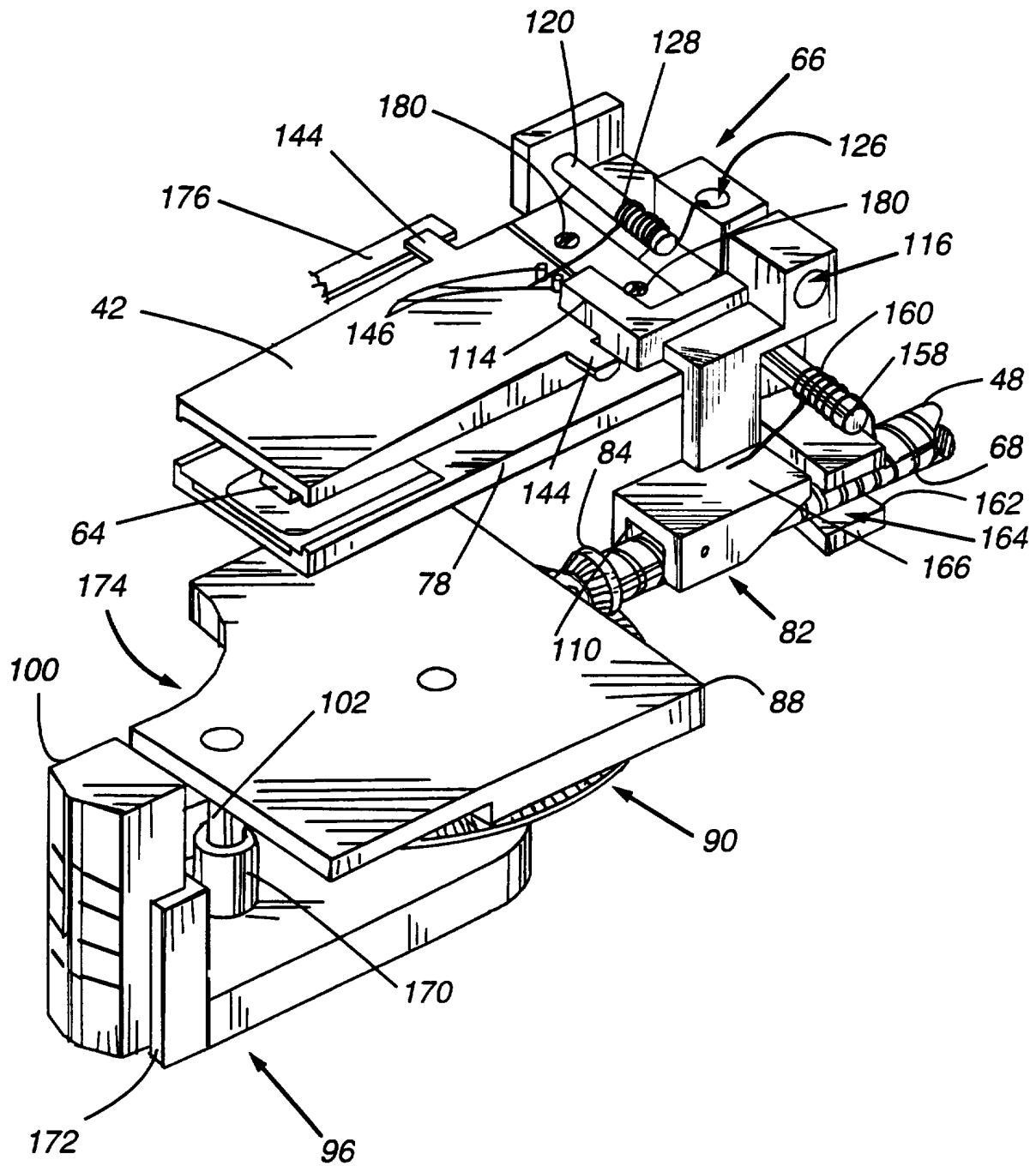
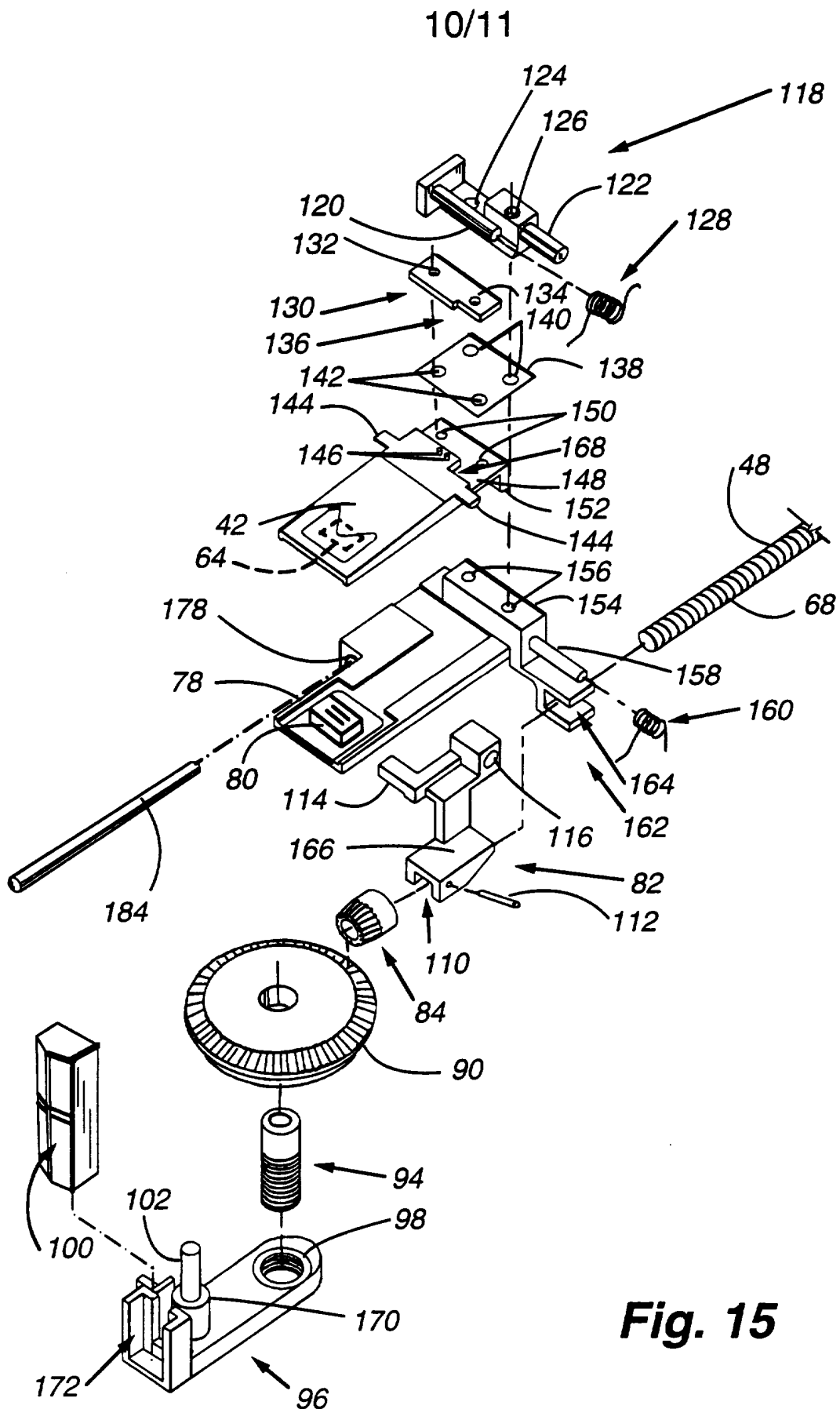


Fig. 13

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**Fig. 14**



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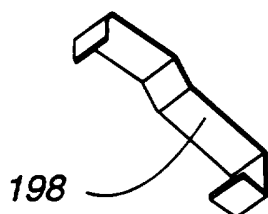


Fig. 16A

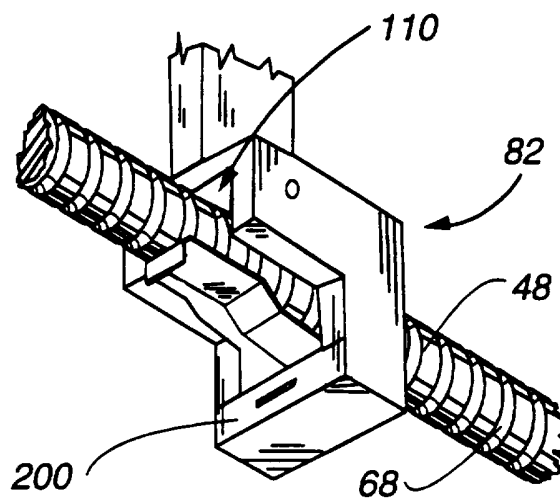


Fig. 16B

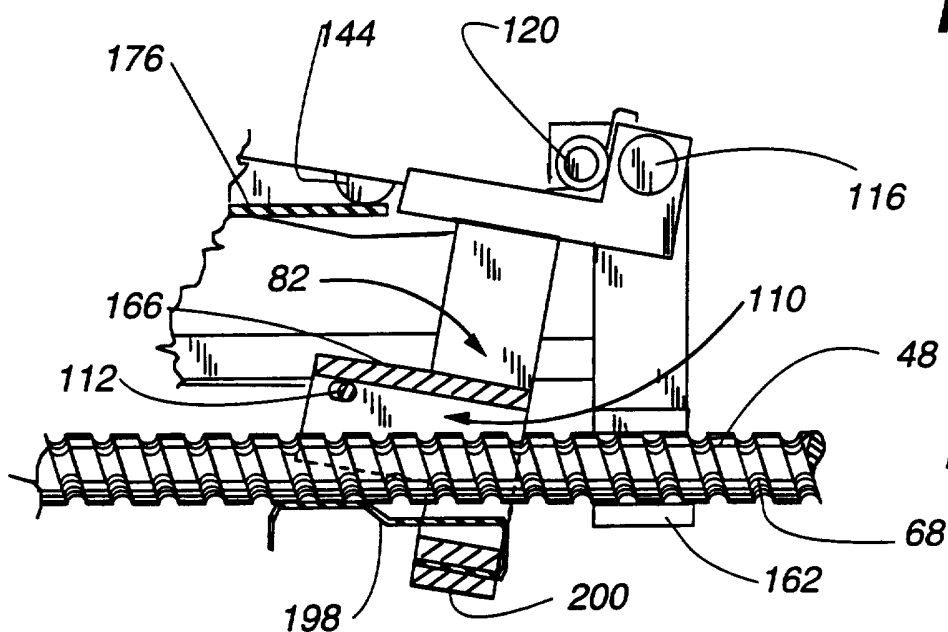


Fig. 17A

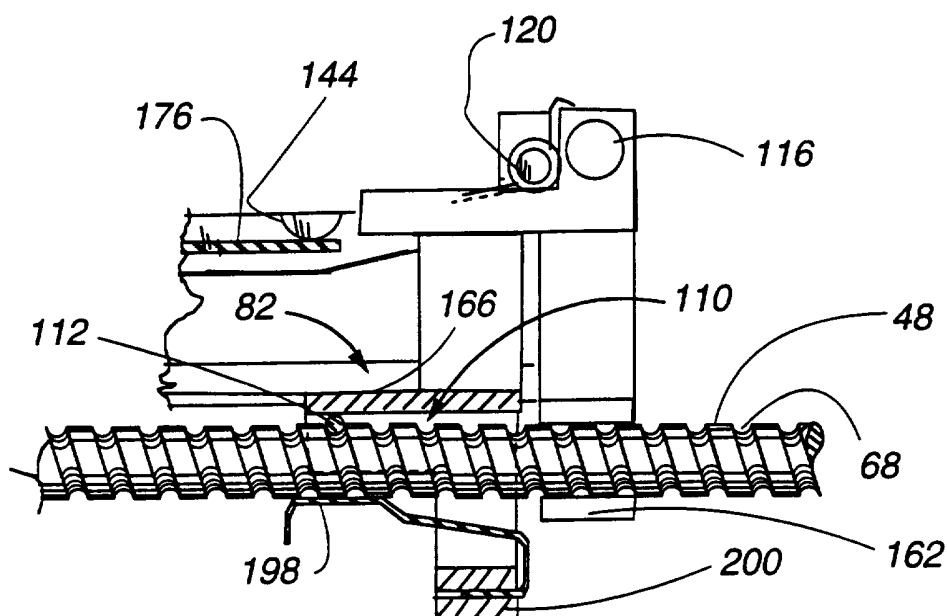


Fig. 17B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/13271

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G11B 17/00

US CL :360/97.01

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)

U.S. : 360/97.01, 105, 106, 107; 369/215, 220, 223, 244, 44.15, 44.16

Documentation 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)

APS

search terms: transducer, head, bi-directional motor, lead screw, orthogonal, cantilevered

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,825,309 (SHOJI ET AL) 25 April 1989, Figure 1, column 4, lines 10-57.	1-56
Y, P	US, A, 5,446,706 (NAITO) 29 August 1995, Figures 5-6.	1-56
A	US, A, 4,980,787 (IWANAGA) 25 December 1990, Figures 3 and 16	1-56
A	US, A, 4,484,241 (BRENDEN ET AL) 20 November 1984, Figures 1-3.	1-56

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier document published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 13 FEBRUARY 1996	Date of mailing of the international search report 16 FEB 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ALLEN CAO Telephone No. (703) 305-3796