PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
G11B 33/12, H05K 7/14	A1	WO 91/20083
		(43) International Publication Date: 26 December 1991 (26.12.91)

(21) International Application Number: PCT/GB91/00253

(22) International Filing Date: 19 February 1991 (19.02.91)

(30) Priority data:
9013403.2 15 June 1990 (15.06.90) GB

(71) Applicants *(for all designated States except US):* INTERNATIONAL BUSINESS MACHINES CORPORATION [US/US]; Armonk, NY 10504 (US). SOLENT & PRATT (ENGINEERING) LIMITED [GB/GB]; 202 St. Andrews Road, Bridport, Dorset DT6 3BS (GB).

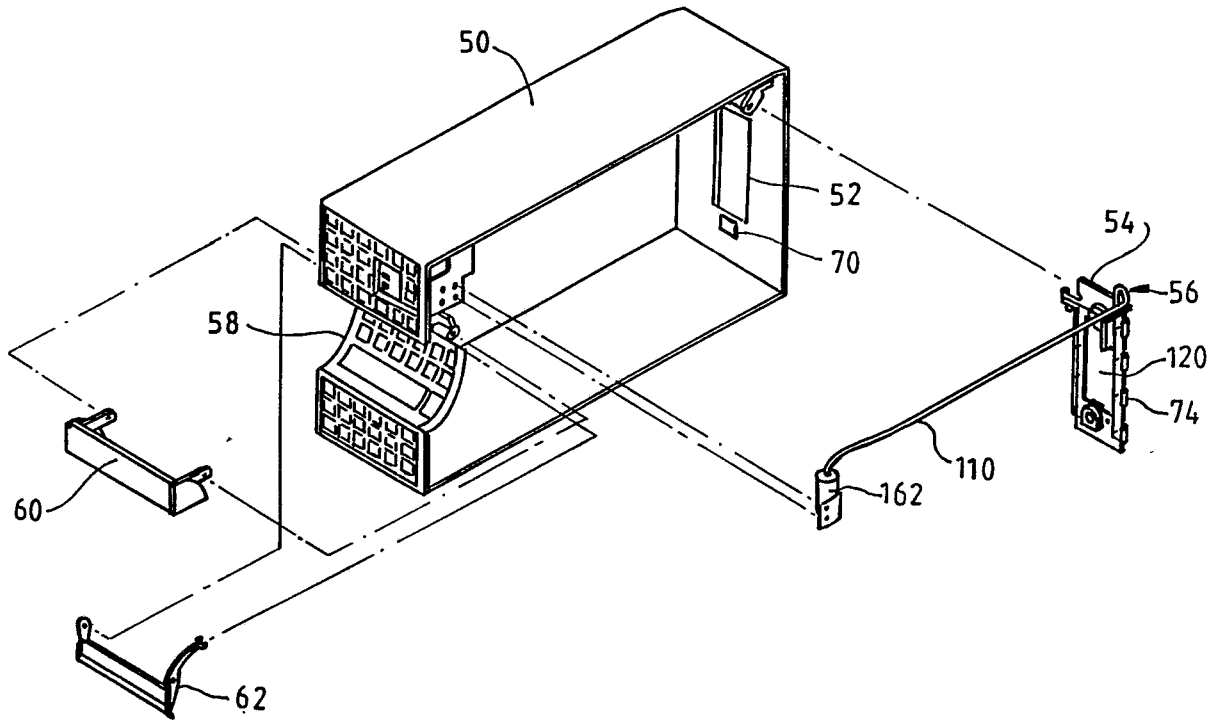
(72) Inventors; and
(75) Inventors/Applicants *(for US only) :* O'REGAN, Richard [GB/GB]; 70 Marls Road, Botley, Southampton, Hampshire SO3 2EY (GB). GOLLEDGE, Ian [GB/GB]; Buddy's Barn, Ampfield, Romsey, Hampshire SO51 9BU (GB). COLES, Richard, John [GB/GB]; Lothlorien, Knapp Lane, Ampfield, Hampshire SO5 9BT (GB). VEAL, John, Ernest [GB/GB]; 33 Redhill Close, Bassett, Southampton, Hampshire SO1 7BT (GB). GRAY, David, John [GB/GB]; 89 Queens Crescent, Stubbington, Nr Fareham, Hampshire PO1 4ZQ (GB). EDMUNDS, Andrew [GB/GB]; 25 Lapwing Drive, Totton, Southampton, Hampshire SO4 3UH (GB).

(74) Agent: MOSS, Robert, Douglas; Intellectual Property Department, IBM United Kingdom Limited, Hursley Park, Winchester, Hampshire SO21 2JN (GB).

(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.

(54) Title: REMOVABLE ELECTRICAL UNIT



(57) Abstract

A removable electrical unit is adapted for insertion into a receiving bay. An external connector at one end of the unit housing (50) mates with a complimentary connector at the end of the receiving bay. Adjacent the external connector is a latch mechanism (56) for receiving a latch member from the bay. Both the latching mechanism and the external connector are located on a floating mounting plate (54). The latch is remotely operated by a release mecanism at the other end of the housing. The latch is locked in the engaged position during operation to prevent withdrawal of the unit.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**ES**	Spain	**MG**	Madagascar
AU	Australia	**FI**	Finland	**ML**	Mali
BB	Barbados	**FR**	France	**MN**	Mongolia
BE	Belgium	**GA**	Gabon	**MR**	Mauritania
BF	Burkina Faso	**GB**	United Kingdom	**MW**	Malawi
BG	Bulgaria	**GN**	Guinea	**NL**	Netherlands
BJ	Benin	**GR**	Greece	**NO**	Norway
BR	Brazil	**HU**	Hungary	**PL**	Poland
CA	Canada	**IT**	Italy	**RO**	Romania
CF	Central African Republic	**JP**	Japan	**SD**	Sudan
CG	Congo	**KP**	Democratic People's Republic of Korea	**SE**	Sweden
CH	Switzerland			**SN**	Senegal
CI	Côte d'Ivoire	**KR**	Republic of Korea	**SU**	Soviet Union
CM	Cameroon	**LI**	Liechtenstein	**TD**	Chad
CS	Czechoslovakia	**LK**	Sri Lanka	**TG**	Togo
DE	Germany	**LU**	Luxembourg	**US**	United States of America
DK	Denmark	**MC**	Monaco		

REMOVABLE ELECTRICAL UNIT

Technical Field of the Invention

This invention relates to removable electrical units, such as hard disk drives for computers, and means for latching them into receiving apparatus.

Background of the Invention

Computer systems usually include data storage systems in which user data is retained, even after the computer system is powered down. Typically such storage systems comprise at least one of the following units: a tape drive, hard disk drive, floppy disk drive and CD ROM (optical disk drive). In recent years there has been a trend to try to develop user or customer removable units (CRU). In such a storage system, there is a chassis which is linked to the host computer system (PC, mini or whatever) and which has one or more bays into which a CRU can be inserted. Generally the CRU has a connector which plugs into a mating connector in the chassis bay. The use of CRUs has several advantages. For example, users can alter the configuration of the storage system, matching the combination of CRUs with their requirements at any particular time. Replacement in the case of device failure is also much simpler. A further advantage, which is especially applicable to hard disk drives, is to provide portability of data. This enables CRUs to be locked away inbetween use if security is an important consideration, or simply transported from one machine to another. Of course, tapes, floppy disks, and CDs are portable anyway, but none of these offers the combination of reliability, high storage capacity, fast access and write capability of hard disk drives. Rather, the range of available CRUs provides a complementary selection of devices.

When the CRU is inserted into the chassis, it is important that connector on the CRU is accurately aligned with the connector on the chassis. This applies both in a plane perpendicular to the direction of insertion, so that the connectors actually mate together properly, and also parallel to the insertion direction, in order to maintain wipe

length. Abrasion (wiping) between the contacts is important to keep them clean and so ensure good electrical conductivity. Typical prior art removable disk drives control the position of the CRU relative to the chassis using guide rails. However, in such an arrangement it is difficult to maintain ease of insertion and positional accuracy without undue cost. In many cases, an unacceptably large tolerance build-up ensues.

Another important consideration with CRUs is that they should not be removed whilst in the middle of operation. Doing so could have several undesirable consequences. One obvious result might be arcing as the connectors on the CRU and the chassis separate. With disk drives there is also the possibility of a head crash and consequential loss of data or damage to the head or disk if the head is not safely located in a landing or parking area on withdrawal. Some hard disk drives also have a high moment of inertia when the disks are rotating, which may prove awkward for the unwary user. In general for all CRUs it is preferable that power down proceeds in a controlled and orderly fashion.

EPA 0328260 discloses a removable disk drive which has a couple of first break/last make connector pins. Under normal removal rates, separation of the first break connector pins is used to trigger an orderly power down. However, there is no provision for preventing an unexpectedly fast withdrawal of the disk drive. This problem is addressed in GB 2153130-B in which a removable disk drive is automatically latched into position when it is inserted into the chassis. A latch member attached to the chassis engages a notch in the inserted disk drive to retain it there. The latch is released by manually energising a solenoid to raise the latch member, whereupon the disk drive may be withdrawn. Attempts to forcibly remove the disk drive however when the latch is engaged may result in damage to the solenoid.

Prior art latch mechanisms include cable release devices which are commonly used in remote operation of still camera shutters. The latch includes a release mechanism comprising a manually operated plunger attached to a cable which when depressed causes a flexible cable passing out of the release mechanism to move within a flexible cylindrical

sleeve, the remote end of the cable activating the camera shutter release to open the shutter. The advantage of this type of latch stems from the flexibility of the cable, allowing the user to remotely operate the shutter from a wide range of positions.

The plunger can be locked in the depressed position to keep the camera shutter open in order to achieve extended exposure times. The locking mechanism commonly used comprises a manually operated screw which passes perpendicularly through the housing of the release mechanism and when screwed inwards holds the plunger in a fixed position against the side wall of the housing.

EPA 0356769 discloses a locking device for use in motor cars to prevent shifting out of neutral unless, for example, the brake pedal is depressed. An in-line solenoid is used to control an armature, which on movement forces ball bearings into indentations where they act as a latch members. Deenergising the solenoid frees the ball bearings, and releases the latch. A somewhat similar device is disclosed in GB 1418606.

Thus the prior art recognises, but does not completely solve, the problems of ruggedly and accurately latching disk drives and other removable electrical equipment into apparatus, to provide accurate and secure mating of the connectors.

Disclosure of the Invention

Accordingly, the invention provides a removable electrical unit for location in a receiving bay of an electrical apparatus, the unit comprising a housing adapted for insertion into the receiving bay, an external electrical connector at one end of the housing, blind pluggable into a complementary connector in the apparatus, and a latch mechanism adjacent the external connector for receiving a latch member attached to the apparatus, said latch mechanism being linked to a latch release mechanism at the opposite end of the housing to the external connector to permit remote release of the latch member when the unit is fully inserted into the apparatus receiving bay.

In a preferred embodiment, the latch mechanism and external connector are mounted on a floating plate. The latch member is tapered for guiding into the receiving latch mechanism, thereby helping to align the floating plate and the complimentary connector to ensure correct mating of the two connectors. The receiving hole for the latch member on the mounting plate is also tapered. On insertion, the latch mechanism automatically engages the latch member to retain the unit in the bay. The latch release mechanism comprises a pivoted handle which is linked to the latch mechanism by an inner cable within a coaxial, cylindrical housing. When the unit is to be withdrawn, the handle is pulled, and this moves the inner cable through the housing to actuate the latch mechanism to release the unit. Thus the latch member is usually automatically released as one attempts to remove the unit.

In a further preferred embodiment the latch is locked when the inserted unit is powered up, to prevent release of the latch and removal of the unit until the unit is first properly powered down. The lock mechanism comprises a solenoid surrounding the inner cable and a housing containing a shuttle coaxial with the cable. Movement of the shuttle along the cable by the action of the solenoid causes gripping means arranged ahead of the shuttle to lock the cable in fixed position relative to the housing. Preferably the gripping means are ball bearings and the housing comprises two portions, a first portion having an internal diameter greater than that of the second portion. Actuation of the shuttle by the solenoid causes the ball bearings to move from the first portion, where there is sufficient clearance for them to move freely, towards the second portion, where they frictionally engage both the cable and the inner wall of the housing. This effectively locks the cable in position and so prevents release of the latch.

As a safeguard to prevent damage to the solenoid, it is preferred that a spring is included, such that attempts to release the latch when locked result initally in compression of the spring. Further force to release the latch by pulling on the handle results in the handle coming up against a fixed handle attached to the unit housing, so that additional stress is resisted by this fixed handle, and therefore the

latch itself, rather than the lock. Thus the solenoid is decoupled from the latch and the lock and protected from possible damage.

Other minor variations to the above embodiments spring readily to mind. For example, the latch mechanism and latch release mechanism may be connected electrically; and the distribution of the various parts of the latch and the lock between the unit and the apparatus may be easily varied. Equally, the exact number of latching or guide members is not important, providing that at least one latch member is received by a latch mechanism adjacent to the connector.

Brief Description of the Drawings

Figure 1 shows a data storage system having four CRU bays, with the top and near side panels removed;

Figure 2 shows the fan unit of Figure 1 in more detail;

Figure 3 illustrates an empty CRU frame (having the side panels removed) with a latching mechanism for insertion into a bay of the storage system of Figure 1;

Figure 4 shows the end of the CRU frame of Figure 3 in more detail, and in particular the latching mechanism with latch member in the engaged position (the fan unit to which the latch member would be attached is not shown);

Figure 5 shows the latch member and connector attached to the fan unit of Figure 2 in more detail, including EMI shielding around the connector and the first make/last break contact pins;

Figure 6 shows the mounting plate of Figure 4 with latch mechanism and connector including the EMI shielding and ESD protection;

Figure 7 is a simplified diagram of a CRU according to the invention with side panels removed illustrating the operation of the latch release mechanism and lock; and

Figure 8 is a sectional view of the solenoid lock mechanism of Figure 7 in the locked position.

Detailed Description of the Invention

Figure 1 illustrates a data storage device for housing CRUs, comprising essentially a chassis 10 with 4 bays 12 for CRUs, a power supply 16, a controller card 14, and a fan unit 18 for circulating cooling air. The data storage device is connected to a host computer system (not shown). The receiving bays are closed by a hinged front panel 20 on which are mounted various diagnostic LEDs indicating operational status, as well as on/off switches to control power to the CRUs. The front panel 20 is shown in the open position in Figure 1 to allow insertion or removal of a CRU.

The fan unit 18 is shown in more detail in Figure 2, and contains two fans 30 (only one shown) and wires 32, 34 for connecting the CRUs to the controller card and power supply. The wires terminate at female connectors 36 attached to a bulkhead 38. In the assembled storage device, one connector is located at the end of each bay for mating with a CRU. All the power and instructions for an individual CRU come through this one connector. Attached to the bulkhead 38 above and below each female connector, and in fixed relation thereto, are two pins, 40, 42, the top one of which is a latching member 40. Both pins serve as guides for aligning the CRU during insertion. A channel 41 passes underneath the bays for the power supply to the front panel 20.

The frame 50 of a CRU is shown in Figure 3 with the side panels removed and houses for example a hard disk drive (not shown). At one end of the frame is an aperture 52, covering which is a floating mounting plate 54. Attached onto the plate are a latch mechanism 56 and male connector (not shown), to engage the latch member 42 and female

connector 36 respectively from the fan unit 18. At the opposite end of the frame to the aperture is an inwardly facing depression 58. Partially extending over this is a fixed handle 60. A second pivoted handle 62 is also provided, which is used to release the latch mechanism 56.

Figure 4 shows the end of the frame where the male connector 37 and latch mechanism 56 are located in more detail. The floating mounting plate 54 is inserted by sliding under lugs 70 on the frame. Plastic clips 72 are then placed between the lugs and the mounting plate to force the plate against the frame wall, although it is still able to slide over the frame wall surface. The mounting plate has slight ribs (not visible in Figure 4) which project into the frame wall aperture (in order to be able to insert the plate under the lugs, the height of these ribs must be less than the thickness of the plastic clips). The ribs limit further motion of the plate when they come up hard against the edge of the aperture. The amount of float is determined by the location of these ribs, and by the size of the lugs. Curled fingers 74 of beryllium-copper extend from the mounting plate to brush against the frame wall. These do not affect the float capability, but rather ensure good electrical contact between the frame and the plate to provide electromagnetic interference (EMI) shielding between them.

The mounting plate 54 has holes 76, 77 at either end of the connector 37 to receive the latch/guide members 40, 42 from the fan unit 18. The latch/guide members are round pins with conical ends 100, essentially the shape of short pencils, and have a circumferential slot cut 102 into them (see also Figure 5). Although only the top pin of these two members 40 is actually latched in position, both pins are important to ensure correct alignment during mating of the connectors. The latch mechanism 56 has a cross-wire 80, fastened at one end to the mounting plate (essentially it is clipped into a receiving groove), which lies across aperture 76, partially obstructing it. At the other end the cross-wire is wound around a cable 110 linked to the release mechanism (see Figure 3). The cross-wire is free to slide along the cable, but a stop at the end of the cable lifts the cross-wire clear of the mounting plate hole 76 when the cable is withdrawn. When the CRU is inserted into the bay, the latch member 40 passes through the hole in

the mounting plate, the conical surface 100 automatically lifting the cross-wire 80 out of the way. The position of the slot 102 is arranged such that when the connectors have fully mated, the latch member protrudes through the mounting plate hole to such an extent that the cross-wire falls into the slot therein. The latch is now in the engaged position shown in Figure 4. The crosswire lying in the slot prevents removal of the latch member, thereby retaining the CRU in the bay. The CRU can only be withdrawn if the latch release mechanism is operated to raise the crosswire and so allow removal of the latch member. The coil in the cross-wire gives it more elasticity.

Figures 5 and 6 show the female 36 and male 37 connectors respectively, together with the latch. The mounting plate 54 has an aperture 120 substantially aligned with the aperture 52 of the frame through which the male connector 37 receives the female connector 36. It is essential for correct mating that the connector 37 on the CRU is correctly aligned with connector 36 at the rear of the CRU bay. To this end, the latch member 40 and receiving hole 76 double as a guide mechanism, together with the matching hole 77 and guide member 42 situated below the connectors. Initial correction of an inaccurate insertion position or angle is achieved by the tapered ends 100 of the guide members 40, 42. This is supplemented by an extension of the receiving hole walls along the line of insertion to provide a conical entrance 120 with the inner surface of each receiving hole 76, 77 having an essentially funnel shape. Therefore, when the latch members are pushed through the receiving holes, the connectors are guided into alignment by the tapering of both the latch members and the inside walls of the holes themselves. Tolerance levels are such that this achieves a sufficient degree of alignment for the connectors to be able to mate properly (the connectors have some self-alignment capability).

Note that in the insertion process, the connectors can be aligned by movement of the float plate 54 relative to the CRU itself. This is possible because the latch mechanism 56 is also located on the floating mounting plate, directly adjacent to the connector. Such an arrangement allows very accurate mating without the need to manufacture guide rails of great accuracy, and is a highly effective way of coping with

tolerance build-up. Note also that the latch, and in particular the slot in the latch member, helps to control the position of the CRU not only perpendicular to the direction of insertion, but also parallel to it.

A major danger with removable electrical apparatus is that one component may pick up a static charge with respect to the other. This produces an electrostatic discharge (ESD) when the two pieces of apparatus are connected together, which can be very damaging to sensitive electronic components. To protect against this, the latch members and receiving holes are made of metal, so that any static charges on the CRU frame are discharged through the latch and then the storage subsystem chassis before the two connectors come into contact with each other. As a backup to this, the female connector 36 has first make/last break contacts 130, which are located slightly further forward than the other contacts 132. These first make/last break contacts are connected to ground (not logic ground), and so again, lead to safe discharge of any static. One first make/last break contact is located at each end of the conector, so that at least one such contact discharges properly before the main set of contact pins engage, whatever the angle with which the two connectors are mated.

Another important consideration with connectors is to prevent EMI leakage from them. This requires electrical continuity around the connectors, and is provided by metal coverings on the exterior surface 144 of the female connector, and the interior surface 146 of the male connector. These two metal coverings are connected to the chassis and CRU frame respectively.

One further ESD danger with CRUs is that when they are removed, a statically charged person touching the connectors can lead to a damaging discharge. To counter this, a metal covering is placed across the central bridge 142 of the male connector. Any stray fingers will connect this central covering to the covering on the internal surface 140, thereby providing safe discharge through the frame rather than through the contact pins 131. The covering on the central bridge is electrically connected to the two outermost pins (ie the first make/last break pins) which are already connected to ground.

A CRU including a disk drive is shown somewhat schematically in Figure 7, which also illustrates latch release mechanism 160. A cable 110 comprising a cylindrical housing 172 with an inner cable 170 is attached at one end to the latch release mechanism, and in particular to the latch operating lever 62, which is the second pivoted handle of Figure 3. The inner cable along with the coaxial outer sleeve extends from the latch operating lever 62 to the latch mechanism 56. The latch is released by operation of the lever causing the inner cable to be pulled through the outer cable, as in a conventional camera cable release system, for example. As the inner cable is withdrawn, it raises the cross-wire of Figure 3, and so allows the latch member to be removed.

Surrounding the cable near the lever end is a solenoid 162, shown in detail in Figure 8, which essentially acts as a lock to prevent release of the latch when the CRU is in use. The solenoid forms an enclosure surrounding a portion of the inner cable 170, the outer cylindrical cable housing 172 having been removed from this portion of the cable. The solenoid contains a coil 180 plus coil former 182, and a soft iron slug 184, coaxial with the cable, which is free to slide along the inner cable. Also freely sliding along the cable between the end of the slug and the lever end of the enclosure is a shuttle 186 which carries a compression spring 188. Located between the end of the slug and the shuttle are a number of ball bearings 190 which are equally spaced radially within the enclosure. The spring must be of adequate strength to move the slug and shuttle together with the ball bearings back to their original position when the locking action described below is released. The slug, ball bearings and shuttle are all housed between the coil former and the inner cable. Towards the lever end of this solenoid, the wall of this housing tapers inwards 202.

When the coil is energised, the slug is moved towards the lever end of the solenoid (ie towards the ball bearings). The slug pushes the ball bearings into the tapered section 202 of the housing. As the clearance between the cable sleeve and the inner wall of the housing decreases, the ball bearings grip both inner cable 170 and the tapering wall with increasing force, and end up jammed between them. This locks the cable in fixed position relative to the housing. Thus with the solenoid coil

in energised state, the lever 62 cannot be operated to move the cable and thus the latching unit cannot be opened. In fact any attempt to unlatch the mechanism by use of the lever urges the ball bearings into a yet narrower part of the housing, and so further increases the grip on the cable, effectively isolating the lever.

When the coil is de-energised,the force on the slug is removed and the slug, ball bearings and shuttle are returned by the action of the spring in the direction indicated by arrow A to their unlocked position. The ball bearings are now located in a part of the housing where they may freely rotate, and the inner cable allowed to pass through. Thus the lock is switched off and the latch may now be released by operation of the lever.

The solenoid enclosure 204 of Figure 8 forms a flux concentrating cage such as that commonly found in solenoid operated mechanisms. The flux cage enables a greater motive force to be applied to the slug. This has the effect of increasing the strength of the locking mechanism. The cage and slug may be made of iron or similar flux conducting material while the coil former may again be made of plastic material.

By placing the solenoid coaxially with the cable, the solenoid is decoupled from the motion of the cable, and so difficult to damage if an attempt is made to forcibly release the latch when locked. An additional overload safeguard is included as shown Figure 7. The latch release mechanism 160 includes a first spring 166 wound around the cable 170 having a spring force F at the lever end of the latch. This spring is positioned so that any attempt to forcibly remove the CRU when the solenoid is locked by applying load to the lever is accommodated simply by compression of the spring. In particular, the spring accommodates all the travel on the lever until it reaches the fixed handle 60 (the dashed position in Figure 7). At this point any further force to remove the CRU is resisted not by the lock mechanism but by the much stronger latch, since the spring cannot be compressed any further. This arrangement further decouples the solenoid from the latch, and reduces the likelihood that the lock can be overcome or damaged by application of brute force to the lever.

A second spring 164 having a spring force F1 is included in the latch mechanism 56, located between a stop 192 at the end of the cable 170, and a tab 190 on the mounting plate through which the cable 170 passes. This spring returns the inner cable to its original position after the latch has been released, lowering the cross-wire 80 into a receiving notch in a projection from the mounting plate.

To ensure correct release of the latch, spring force F must be greater than spring force F1, and there must be some clearance for spring F in the unlocked condition. In other words, in normal operation to release the latch using the lever, the first spring 166 remains essentially uncompressed, and it is the second spring 164 which is compressed between the stop 190 at the end of the cable and the tab 192 on the mounting plate so as to raise the cross-wire 80. Equally, when the latch member 40 is originally inserted into the hole 76 in the mounting plate, the cross-wire 80 is raised against the force of the second spring without undue effort.

The operation of the latch and lock can therefore be summarised as follows. To prevent damage to the CRU or receiving system, a lock mechanism is employed to ensure that the unit cannot be removed whilst in operation. On insertion of the CRU into the chassis, the connectors of the CRU and the receiving bay mate together, and the latch is engaged. If power is not switched on to the CRU, then the CRU can be removed at any time simply by releasing the latch. In practice this will be done automatically, as the pivoted handle will naturally be pulled up against the fixed handle in the normal withdrawal procedure. However, the solenoid is arranged so that powering up the CRU (by means of a power-on switch on the front panel) automatically supplies current to energise the solenoid, and so activates the lock. This prevents the latch from being released, thereby stopping anyone from removing the CRU. When power to the CRU is switched off, there is a slight delay before the solenoid is deenergised to allow an orderly power down procedure to be followed. This delay can be controlled by logic associated with the power supply, or alternatively by using the back emf of the disk drive spindle motor to power the solenoid. After the solenoid is de-energised and the latch unlocked, the latch can be released and the CRU removed in the normal manner.

Claims

1. A removable electrical unit for location in a receiving bay (12) of an electrical apparatus, the unit comprising

a housing (50) adapted for insertion into the receiving bay,

an external electrical connector (37) at one end of the housing, blind pluggable into a complementary connector (36) in the apparatus,

and a latch mechanism (56) adjacent the external connector (37) for receiving a latch member (40) attached to the apparatus, said latch mechanism being linked to a latch release mechanism (160) at the opposite end of the housing to the external connector to permit remote release of the latch member when the unit is fully inserted into the apparatus receiving bay.

2. An electrical unit according to claim 1, wherein said latch mechanism (56) and said external connector (37) are attached to a mounting plate (54) which can float within specified limits relative to said housing.

3. An electrical unit according to claim 2, including conductive material (74) extending from the mounting plate to the housing to provide electromagnetic interference shielding.

4. An electrical unit according to any preceding claim, wherein said latch mechanism (56) includes a conically tapered hole (76) in the mounting plate (54) for receiving the latch member (40).

5. An electrical unit according to claim 4, further including a second conically tapered hole (77) in said mounting plate for receiving a guide member (42) attached to the apparatus, whereby the two holes (76, 77) are disposed on opposite sides of said external conector (37), and are adapted for guiding the two connectors (36, 37) into correct mating with one another.

6. An electrical unit according to any preceding claim, wherein said latch release mechanism (160) and said latch mechanism (56) are linked by a cable (110) having an inner cable (170) within a coaxial cylindrical housing (172), and the latch member is released by movement of the inner cable within the housing.

7. An electrical unit according to claim 6, wherein said latch mechanism (56) includes retaining means (80) attached to the inner cable to engage the latch member (40), said retaining means being moved to release the latch member by withdrawal of the cable into the housing.

8. An electrical unit according to any preceding claim, wherein said latch release mechanism is actuated by the handle (62) used for withdrawing the unit from the bay.

9. An electrical unit according to any preceding claim, further including a lock mechanism (62) to lock the latch release mechanism when the unit is operating in the receiving bay, thereby preventing release of the latch member and withdrawal of the unit from the bay.

10. An electrical unit according to claim 9, including spring means (166) and hard stop means (60), whereby attempted removal of the unit from the bay when the latch release mechanism is locked compresses said spring means until said hard stop is reached, whereupon any additional force on the unit is resisted by the latch member and not by the lock mechanism.

11. An electrical unit according to claim 9 or 10 as dependent on claim 6, wherein the lock mechanism comprises a solenoid surrounding said inner cable (170) for releasing the latch mechanism, and a housing (182) containing a shuttle (186) coaxial with the cable which when moved by the action of the solenoid along the cable causes gripping means (190) arranged ahead of the shuttle to lock the cable in fixed position relative to the housing.

12. An electrical unit according to claim 11, wherein the housing and shuttle are substantially cylindrical, the housing (182) comprising two

portions, a first portion having an internal diameter greater than that of a second portion (202), whereby actuation of the shuttle by the solenoid causes the gripping means (190) to move from the first portion towards the second portion causing the gripping means to frictionally engage both the cable (170) and the inner wall of the housing.

13. An electrical unit according to claim 11 or 12, wherein the gripping means comprises a plurality of ball bearings having a diameter less than the clearance between the cable and the inner wall of the first housing portion, and greater than the clearance between the cable and the inner wall of the second housing portion.

14. An electrical unit according to claim 11, 12 or 13, further including spring means (188) located between the end of the housing and the gripping means which moves the gripping means out of frictional engagement with the housing and cable when the solenoid is de-energised.

15. An electrical unit according to any preceding claim, wherein said latch mechanism (56) and said latch member (40) are adapted to make electrical contact when the unit is inserted into the bay before the respective connectors do.

16. An electrical unit according to any preceding claim, wherein one or more of the contacts (130) in said connectors is located further forward than the remainder, (132) so as to form a first make/last break contact.

17. An electrical unit according to claim 16, wherein there are two of said first make/last break contacts, one located at each end of the set of contacts in at least one of the connectors.

18. A data storage apparatus including one or more receiving bays (12) with a connector (36) at the end of each bay, with a latch member (40) adjacent thereto, and a removable electrical unit as claimed in any preceding claim.

FIG. 1

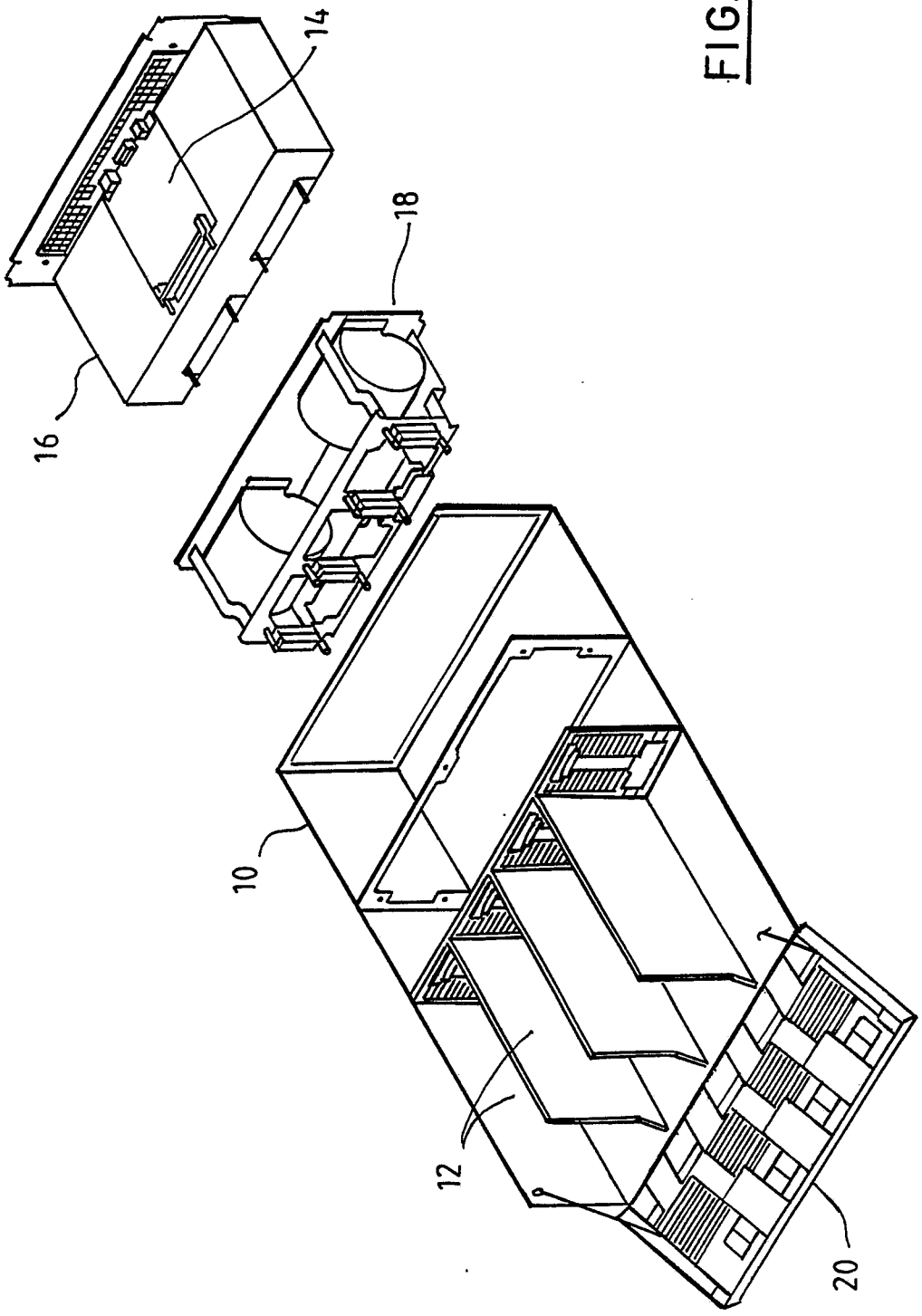
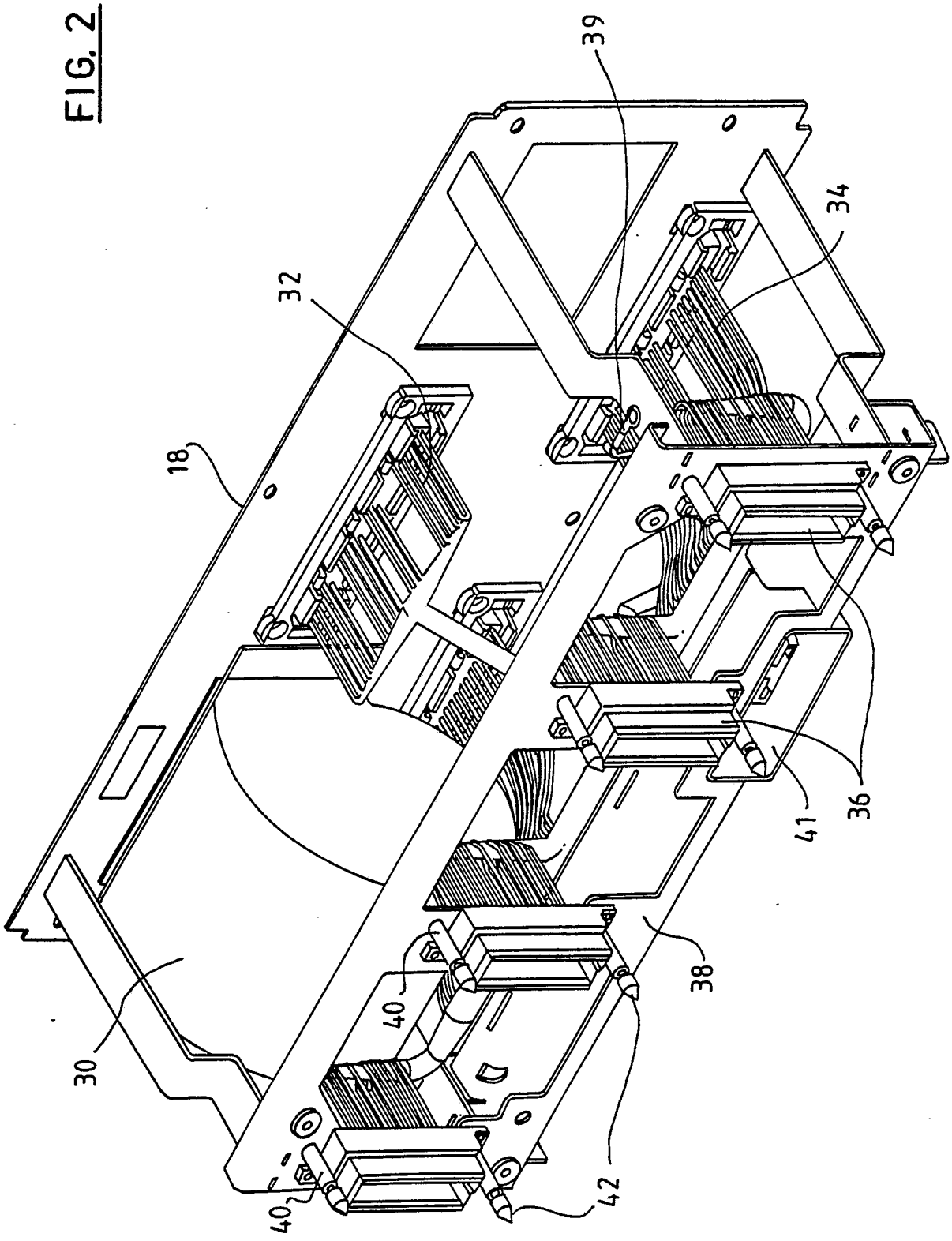


FIG. 2



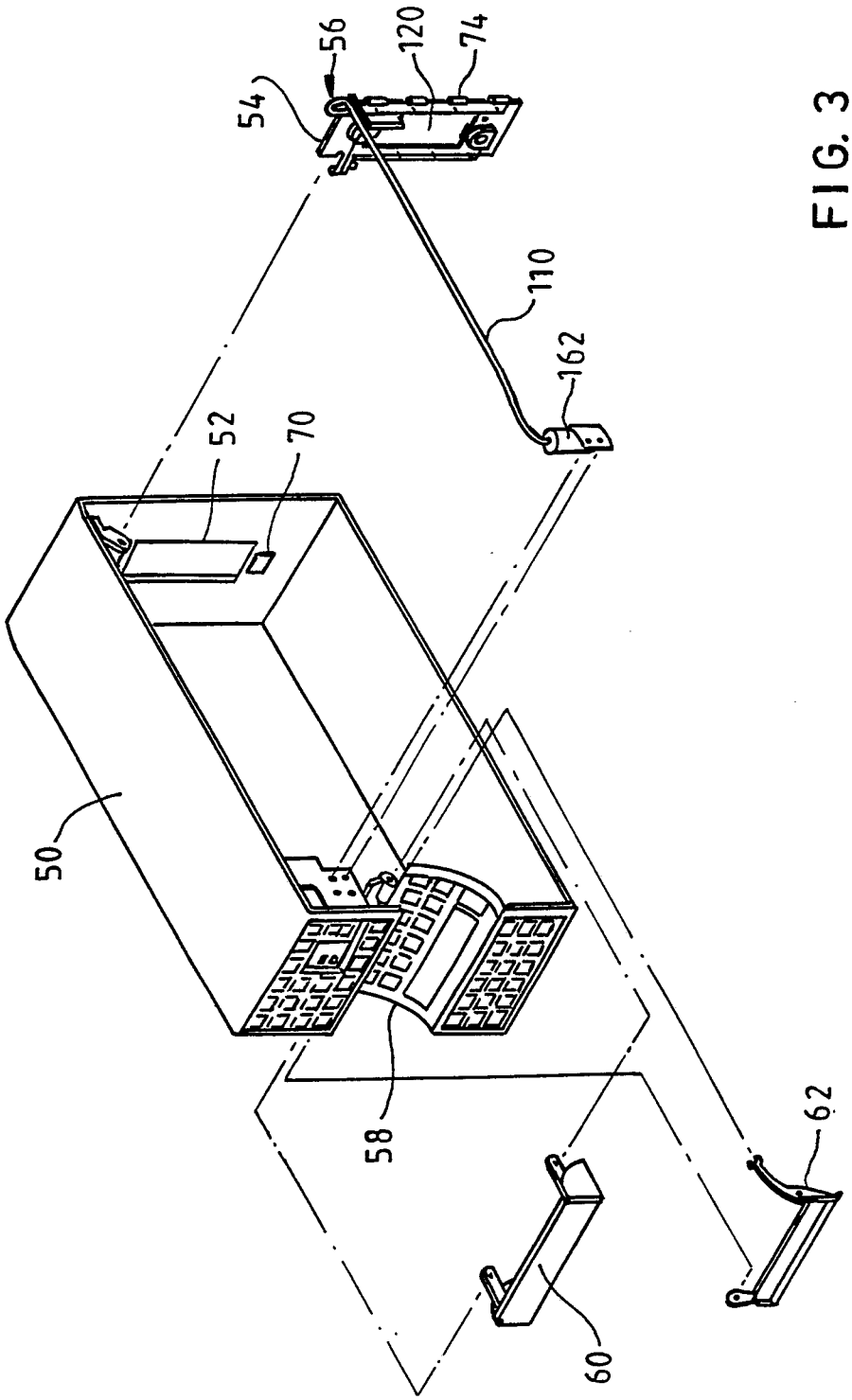


FIG. 3

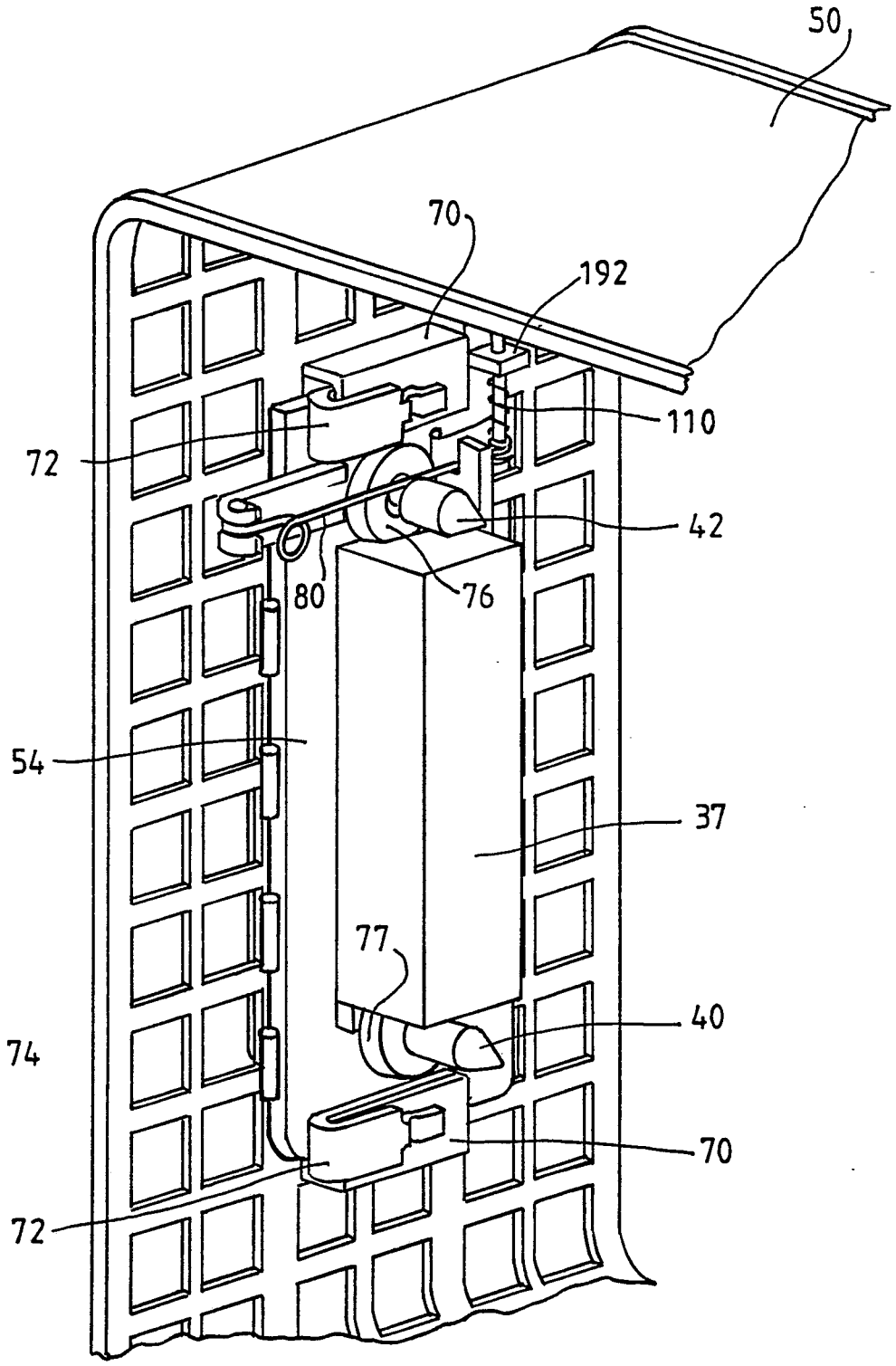


FIG 4

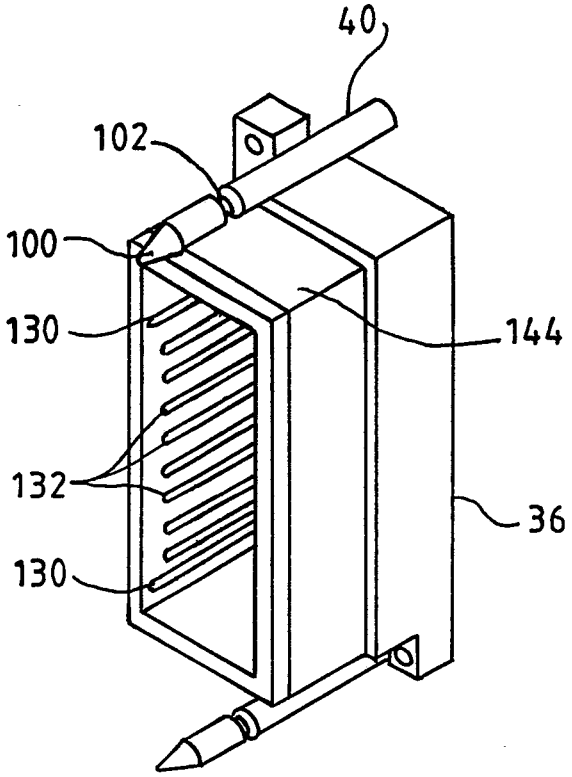


FIG. 5

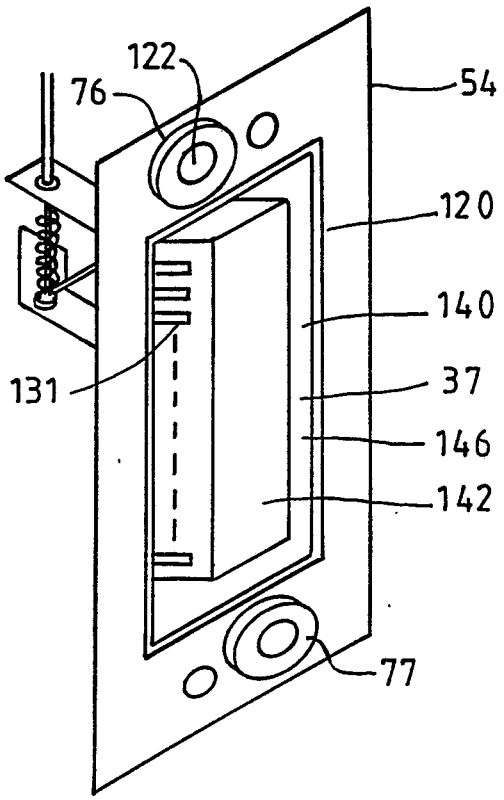


FIG. 6

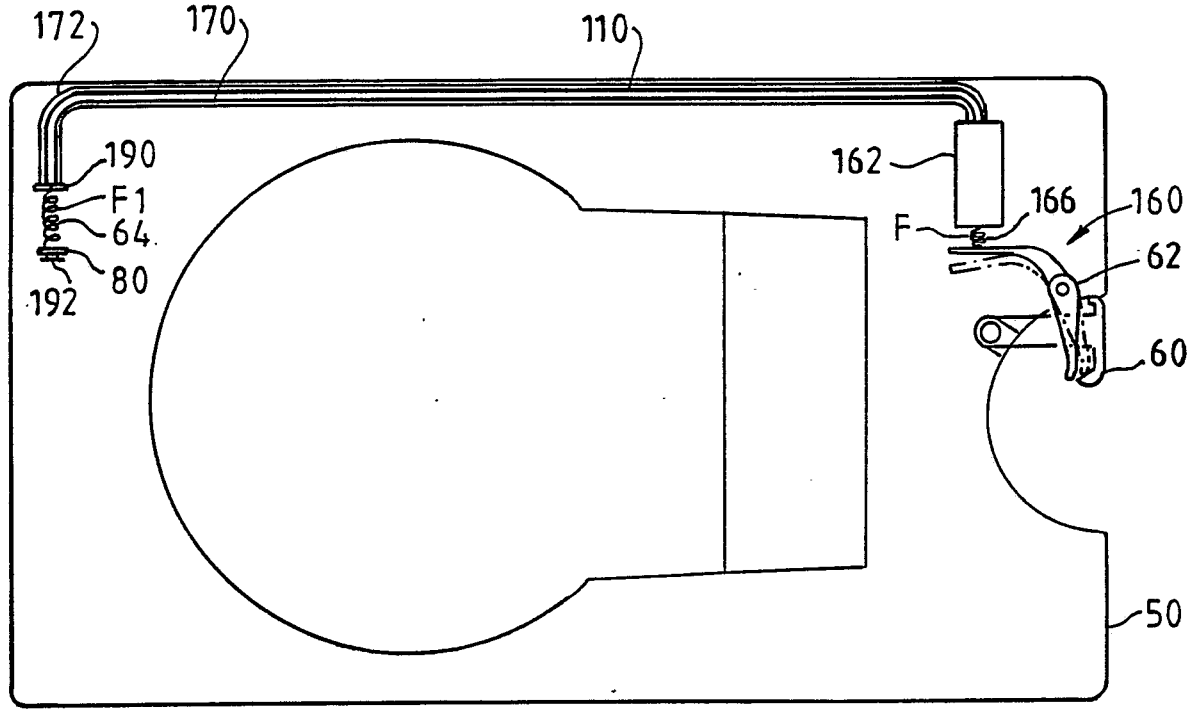


FIG. 7

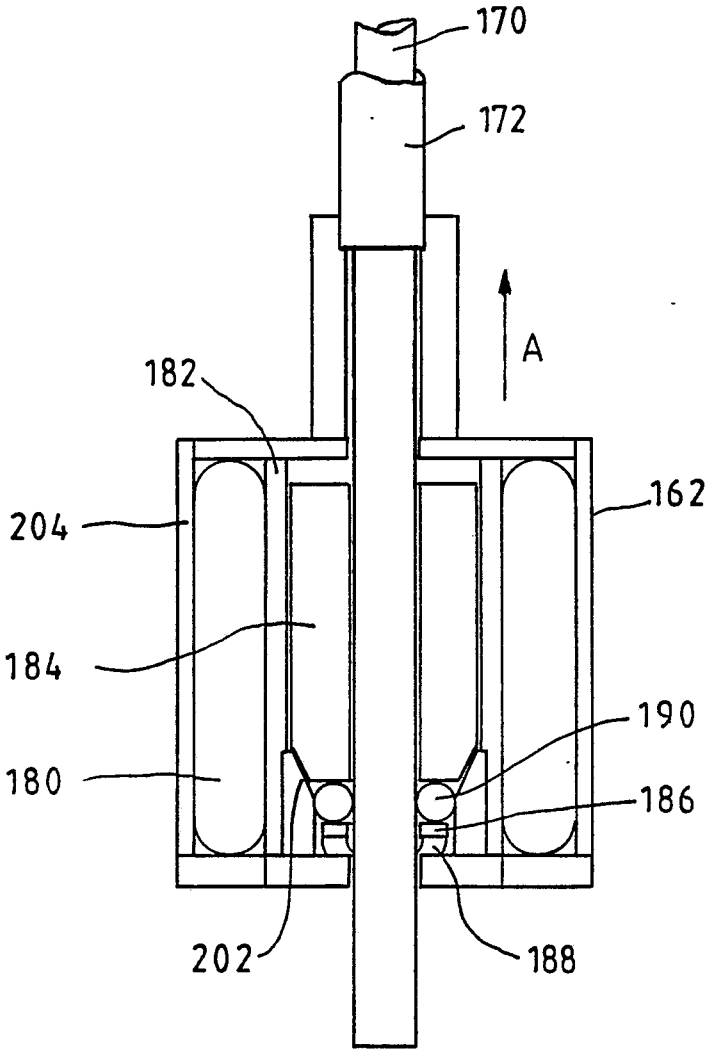


FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00253

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: G 11 B 33/12, H 05 K 7/14

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	G 11 B, H 05 K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 2855454 (MILTON ALDEN) 7 October 1958 see column 3, lines 6-62; figures --	1
X	DE, A, 2047134 (SIEMENS) 30 March 1972 see page 2, line 26; figures --	1,8
X	EP, A, 0195722 (THOMSON CSF) 24 September 1986 see column 4, lines 11-26; figures --	1
A	CH, A, 600738 (CONTRAVES AG) 30 June 1978 see column 2, lines 11-65; figures --	1,4,5
A	IBM Technical Disclosure Bulletin, vol. 27, no. 7b, December 1984, (New York, US), M.A. Cook: "Customer set-up and replaceable DASD assemblies", pages 4206-4209, see the whole article -- ./.	1,8,18

* Special categories of cited documents: [10]

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

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

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

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

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

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

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

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

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
31st May 1991	01. 10. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Mme Dagmar FRANK

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, ** with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	WO, A, 8806780 (TANDON CORP.) 7 September 1988 see page 3, lines 28-34; claims; figures	1,9,18
A	GB, A, 2153130 (NORAND CORP.) 14 August 1985 see page 4, line 113 - page 6, line 96; figures cited in the application	1,8,9,18
A	IBM Technical Disclosure Bulletin, vol. 32, no. 7, December 1989, (New York, US), "Adjustment and alignement interconnect technique for DASDs", pages 32-34 see the whole document	1,2,18
A	EP, A, 0317469 (IBM) 24 May 1989 see abstract; figures	1,2,3,15
A	EP, A, 0356769 (LECRON PRODUCTS INC.) 7 March 1990 see the whole document cited in the application	1,6,10-14

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATION WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

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

1. ☐ Claim numbers because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers because they relate to parts of the International application that do not comply with the prescribed requirements to such an extent that no meaningful International search can be carried out, specifically:

3. ☐ Claim numbers because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

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

1. Claims 1-15; 18
2. Claims 16;17

For further information please see form PCT/ISA/206 dated 17-07-1991.

1. ☐ As all required additional search fees were timely paid by the applicant, this International search report covers all searchable claims of the International application

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this International search report covers only those claims of the International application for which fees were paid, specifically claims:

3. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9100253

SA 44764

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 20/09/91
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2855454		None	
DE-A- 2047134	30-03-72	None	
EP-A- 0195722	24-09-86	FR-A- 2579402	26-09-86
CH-A- 600738	30-06-78	None	
WO-A- 8806780	07-09-88	US-A- 4833554	23-05-89
		AU-B- 596282	26-04-90
		AU-A- 1368788	26-09-88
		EP-A- 0303670	22-02-89
		EP-A- 0378282	18-07-90
		GB-A- 2237436	01-05-91
		JP-T- 2500623	01-03-90
GB-A- 2153130	14-08-85	US-A- 4633350	30-12-86
		AU-B- 587965	07-09-89
		AU-A- 3770185	20-03-86
		US-A- 4912580	27-03-90
EP-A- 0317469	24-05-89	US-A- 4791524	13-12-88
		JP-A- 1143398	05-06-89
EP-A- 0356769	07-03-90	US-A- 4987968	29-01-91