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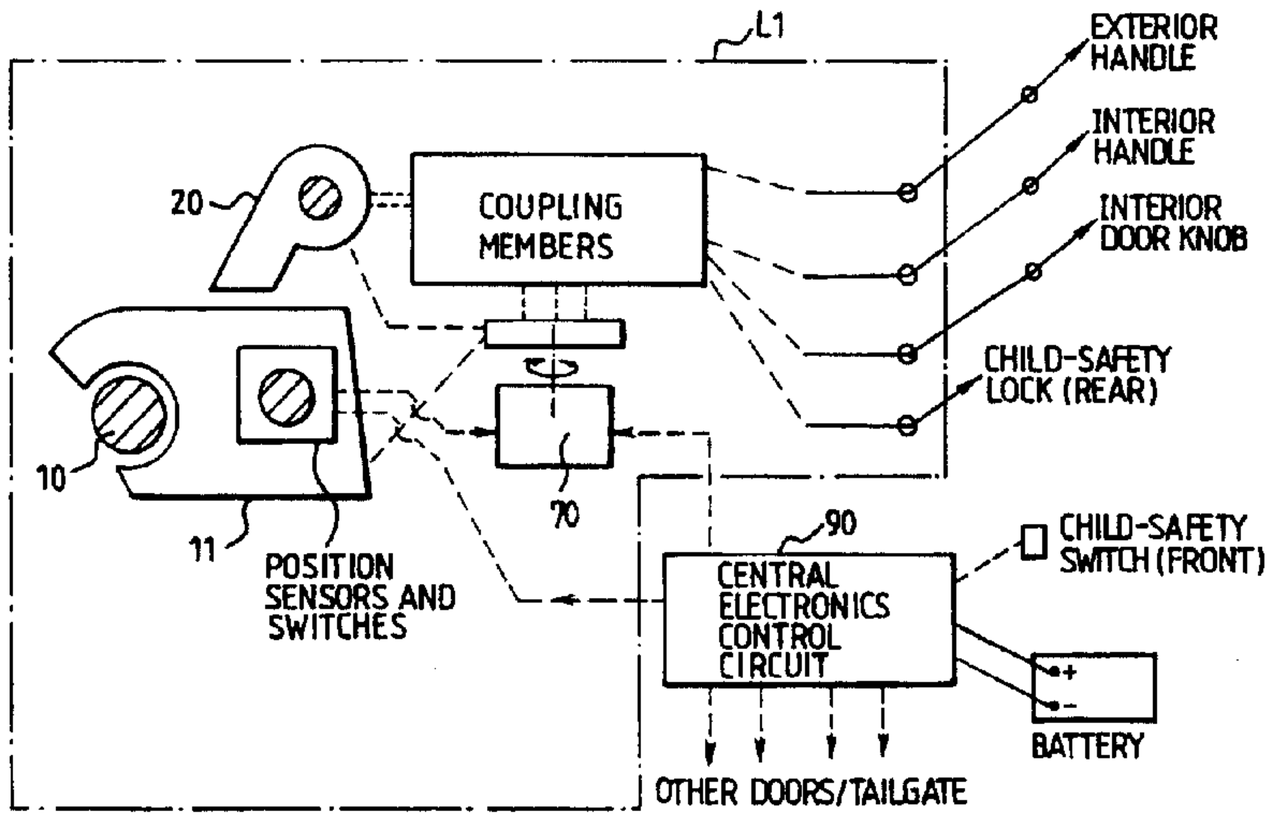
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(54) **MONTAGES DE VERROU DESTINES A DES PORTIERES D'AUTOMOBILES OU A D'AUTRES DISPOSITIFS DE FERMETURE**

(54) **LATCH ARRANGEMENTS FOR AUTOMOTIVE DOORS OR OTHER CLOSURES**



(57) L'invention concerne un montage de verrou permettant de retenir de façon libérable une gâche et comprenant: un pêne demi-tour formé de manière à retenir la gâche dans une position de verrouillage, et de libérer la gâche dans une position de déverrouillage du pêne demi-tour; un mécanisme de verrouillage amovible entre une position de verrouillage, dans laquelle il retient le pêne demi-tour dans sa position de verrouillage, et une position de déverrouillage, dans laquelle le pêne demi-tour peut retrouver sa position de déverrouillage; un dispositif permettant de relier le mécanisme de verrouillage à une commande manuelle extérieure

(57) A latch arrangement for releasably retaining a striker (10), comprising a latch bolt (11) shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a locking mechanism (20) moveable between a locking position, at which it retains the latch bolt (11) at its latching position, and an unlocking position, at which it allows the latch bolt (11) to move to its unlatching position; means for linking the locking mechanism (20) to a latch-opening external manual control such as a door handle; drive means (50, 60) coupled to the locking mechanism (20) and/or the latch bolt (11) for powered actuation thereof

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d'ouverture de verrou, telle qu'une poignée de porte; un dispositif d'entraînement couplé au mécanisme de verrouillage et/ou au pêne demi-tour pour un actionnement mécanique de ce dernier afin de verrouiller ou de déverrouiller le mécanisme de verrouillage et/ou pour entraîner le pêne demi-tour dans sa position de verrouillage ou de déverrouillage; un embrayage rotatif permettant de coupler le dispositif d'entraînement à un moteur d'entraînement électrique; et un mécanisme de débrayage couplé par entraînement à la commande manuelle extérieure de sorte que l'actionnement de la commande manuelle extérieure d'ouverture de verrou isole le pêne demi-tour et le mécanisme de verrouillage du dispositif d'entraînement.

to latch or unlatch the locking mechanism and/or to drive the latch bolt to its latching position or to its unlatching position; a rotary clutch coupling the drive means to an electrical drive motor; and a clutch release mechanism drivingly coupled to the said external manual control such that operation of the latch-opening external manual control isolates the latch bolt and locking mechanism from the drive means (50, 60).

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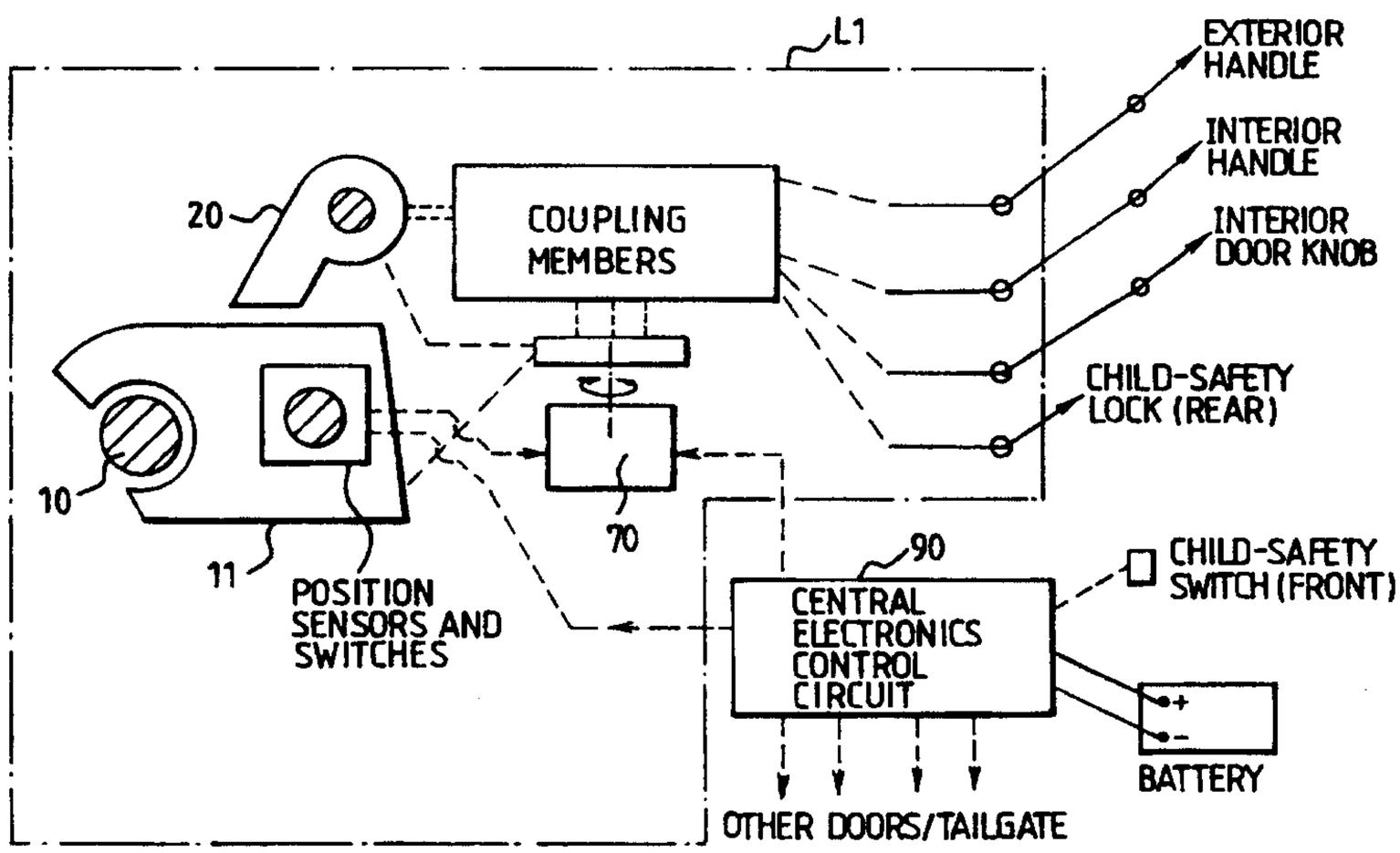
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(54) Title: LATCH ARRANGEMENTS FOR AUTOMOTIVE DOORS OR OTHER CLOSURES



(57) Abstract

A latch arrangement for releasably retaining a striker (10), comprising a latch bolt (11) shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a locking mechanism (20) moveable between a locking position, at which it retains the latch bolt (11) at its latching position, and an unlocking position, at which it allows the latch bolt (11) to move to its unlatching position; means for linking the locking mechanism (20) to a latch-opening external manual control such as a door handle; drive means (50, 60) coupled to the locking mechanism (20) and/or the latch bolt (11) for powered actuation thereof to latch or unlatch the locking mechanism and/or to drive the latch bolt to its latching position or to its unlatching position; a rotary clutch coupling the drive means to an electrical drive motor; and a clutch release mechanism drivingly coupled to the said external manual control such that operation of the latch-opening external manual control isolates the latch bolt and locking mechanism from the drive means (50, 60).

Latch Arrangements for Automotive Doors or other Closures

This invention relates to latch arrangements for closures such as automotive doors and tailgate locks, and is particularly, although not exclusively, useful with electronic central locking systems for vehicles. The inventions disclosed in this application concern components of the latches, systems incorporating such components, and methods of manufacture of latch arrangements. Generally, the purpose of each invention is to simplify and render more compact such latch arrangements, in order to reduce their cost and to reduce vehicle weight.

Electronic central locking systems are well known, and a typical such system is disclosed for example in GB-A-2167482; an improvement is disclosed in our PCT publication WO97/28338. These systems provide central control of the locking and unlocking of vehicle doors and other closures such as tailgates, bonnets and petrol caps, amongst other vehicle functions such as lights. They interact mechanically with the conventional locking mechanisms which usually comprise, for each door, an external key mechanism and an internal door locking knob. Interior and exterior door handles are rendered inoperable or neutral by such locking mechanisms.

Vehicle door latches are disclosed for example in our own applications WO97/19242 entitled "Latch and Latch Actuator Arrangements", WO97/19243 entitled "Latch Arrangement suitable for an Automobile Door" and WO97/28337 entitled "Latch Actuator Arrangement". An electric motor incorporated within the latch, and usually controlled by the central locking arrangement, drives a mechanism for unlocking and locking the latch. A problem with door latches manufactured in accordance with other patent publications, such as EP-A-397966 (Roltra-Morese Spa) and GB-A-2221719 (Kiekert GmbH & Co Kommanditgesellschaft) has been size, weight and complexity.

Further, whilst mechanisms for using an electric motor to complete the closure of a partially-closed door are known as such, for example from US-A-5423582 (Kiekert GmbH & Co Kommanditgesellschaft), and systems for using an electric motor to release the latch and allow the door to open are also known, for example from EP-A-625625 (General Motors Corporation) which discloses power-assisted door opening and closing, none of these prior systems has been hitherto capable of integration with electronic central locking. Some of the present inventions disclosed in this application provide integrated electric central locking and electric door opening and/or closing, and even the possibility of using a common electric motor for all these functions. This represents a substantial improvement to the state of the art.

To illustrate the possible saving in the number of latch components required to be assembled in manufacture, it can be seen for example from EP-A-743413 (Rockwell Light Vehicle Systems (UK) Limited) entitled "Vehicle Door Latch Assembly" that a very large number of components is typically required in a vehicle door latch. The present inventions reduce significantly the number of components, by simplifying the mechanical operation of the latch and its interaction with electric motor drive.

It is an important security feature that all electrically-operated drive systems, such as locking and door opening or closing, can be overridden by corresponding manual mechanical drive, as appropriate, in case of electrical malfunction or jamming. Each separate invention is capable of being used in a latch with full mechanical override.

In order to provide a clutch for door opening and closing drive mechanisms, enabling the door handles to operate the latch even in the event of power failure or

the jamming of the electric drive mechanism, an invention provides a latch arrangement as defined in Section C.1, Claim 1, referred to as Claim C.1.1.

Double locking or so-called deadlocking or "super locking" mechanisms for vehicle doors are known as such. If the door has been locked by the key mechanism or electronic central locking, then it cannot be unlocked by the interior door knob. It can be unlocked by the interior door knob only if it has previously been locked by the door knob. To achieve this efficiently and simply, an invention provides an automobile door latch having a deadlocking arrangement, as defined in Claim C.2.1.

Child-safety locks on the rear doors of a car are of course well known. They generally comprise a small lever within the latch but accessible only when the door is open or by means of a special tool, for decoupling the interior door handle from the door latch. An invention of this application enables such a mechanism to be controlled remotely of the latch, for example from the driver's console at the front of the vehicle, or by a remote hand-held transmitter, by providing a latch arrangement as defined in Claim C.3.1.

In order to minimise the cost and weight of a vehicle, an invention enables the number of key mechanisms to be reduced, by coupling plural latches to one key mechanism in accordance with the invention of Claim C.4.1.

Existing door latches for vehicles generally include components within a housing, and components extending outside the housing which make the arrangement bulky. As shown for example in Kiekert US Patent No. 5419597, the levers which cause the latch to release and the door to open, and which are connected to door handles by cables, generally project from the latch housing. We have discovered that it is possible to simplify the latch arrangement and to

accommodate door handle-operated levers inside the latch housing, by providing a common axis of rotation for the latching pawl (sometimes denoted by the general term "locking member"), the pawl release lever connected to the door handle, and preferably also a rotary coupling member for selectively coupling the pawl release lever to the pawl. This invention is claimed in Claim C.5.1.

Door latches typically comprise housings to which components are permanently riveted, so that the door latch cannot be disassembled non-destructively. An invention overcomes this problem, and also simplifies the process of assembly, by providing a latch assembly whose housing has a retaining means for retaining parallel plates releasably, in accordance with Claim C.6.1.

In some door latch arrangements incorporating electrically-powered actuation members for locking and unlocking, locking and unlocking is temporarily blocked if one of the door handles is pulled, but is unblocked once the handle is released. It then becomes necessary to repeat the actuation for locking or unlocking. In order to overcome this problem, an invention enables such actuation to be continued fully to completion once the handle has been released, without the need to repeat the actuation. To achieve this, the invention provides a latch arrangement as defined in Claim C.7.1.

Automotive key mechanisms typically provide a rotational output drive, for example through a spindle on the axis of rotation, or a radial arm connected to the spindle. In order to make latch assemblies more compact and simple, we have found that it is desirable to convert such rotary motion to a linear motion for the driving of the appropriate linear actuator within the latch arrangement, for locking and unlocking. Accordingly, an invention comprises a latch assembly as defined in Claim C.8.1.

In order to couple electric motor drive to various appropriate actuation members within the latch assembly, for door opening and/or closing and/or for locking and unlocking or other functions such as child-safety locking, we have discovered that a rotary indexing mechanism is particularly useful, in which there is resilient coupling between formations in the driving actuators and formations on the rotary indexing mechanism. The resilience of this coupling allows the continued rotation of the indexing mechanism past the actuator once actuation has been completed over a phase of rotation of the indexing mechanism, and prevents jamming. It also simplifies the mechanical arrangement, by allowing positional tolerance. Accordingly, an invention provides a latch assembly as defined in Claim C.9.1.

As mentioned above, some of the inventions herein concern electric door opening, i.e. electrically-driven release of the latching mechanism to enable the door to open. An invention, as defined in Claim C.10.1, provides for the selective coupling of interior or exterior door handles, for example, to the door opening mechanism of the latch arrangement, under the control of a common electric motor. This is particularly advantageous as it provides electric control independently of each door handle, and thereby avoids the need to use a mechanical control for child-safety locking. Accordingly, an invention provides a latch arrangement as defined in Claim C.10.1.

Some existing door latch arrangements provide for so-called panic door opening, by which the door can be unlocked by the operation of the interior door handle without the need to lift the interior door knob. The door then remains unlocked to ensure that the door can be opened by the exterior door handle. This prevents inadvertent locking out of the vehicle by the occupant. Usually, the door

latch will be unlocked when the vehicle is in motion, but there may be circumstances in which it is locked with the vehicle stationary or even moving. The invention of Claim C.11.1 enables panic door opening to be provided in a latch arrangement of compact and simple design.

A particularly important invention is the combination of electric locking and electric door latch release (door opening) using a common electric motor, and this is provided by the invention of Claim C.12.1. The invention of Claim C.13.1 also provides electrically-powered door closing, using the same electric motor. Preferably also such latch arrangements provide selective electrical control of interior or exterior door handles, for example, for door opening, and preferably they also provide electrically-operable child-safety.

Latch arrangements typically comprise a latch bolt, for engaging a fixed striker in the door frame, and a latching pawl for releasably holding the latch bolt so as to latch the bolt. Electric door opening can then be achieved by actuating the latching pawl. We have discovered a particularly beneficial arrangement for electrical door latch release and door opening, using a linear actuator acting directly on the latch pawl, this arrangement allowing independent door opening by external mechanical means such as the door handle. This invention is defined in Claim C.16.1.

An alternative beneficial arrangement for electrical door latch release on manual door opening, using a rotary actuator acting directly on the latch pawl, is defined in Claim C.17.1.

Electrically-powered door closing requires application of the drive to the latch bolt which then pulls on the fixed striker to draw the door to its fully closed position. We have found that a particularly beneficial arrangement is to have a rotary

actuator, under electric power, acting on the latch bolt. This is defined in Claim C.18.1. Preferably, the arrangement also provides door opening, i.e. the same electrical drive, and preferably the same rotary actuator, is used to release the latch pawl to allow the door to open.

As a beneficial alternative to the arrangement of Claim C.18.1 using a rotary actuator, an invention also provides a linear actuator acting directly on the latch bolt, again with optional door opening. This is defined in Claim C.19.1.

With all of these arrangements, there is preferably a full mechanical override of any electrical function, i.e. mechanical actuation is independent.

With door latching arrangements there is a danger of inadvertent door locking when the door is slammed shut. This is particularly disadvantageous in electric central locking arrangements in which the locking of one door is linked to the locking of all doors. Existing anti-slam locking arrangements are generally quite complex, and the purpose of the invention of Claim C.20.1 is to provide an anti-slam latching arrangement with all the advantages of compactness and simplicity of the other inventions. This is achieved by appropriately orientating a reciprocating sliding coupling member within the latch arrangement. According to the invention of C.21.1, anti-slam latching is achieved differently, by ensuring that an actuator is prevented from moving within the latching arrangement whenever the arrangement is unlatched and the door open. The latching arrangement has a fixed formation which co-operates with the coupling actuator only at its unlocking configuration.

As mentioned above, cables, typically Bowden cables, are used to link the latching arrangement with door handles and key mechanisms and the like. Conventional means for coupling cable ends to actuator arms comprise special

formations on the arms for engaging a cylindrical nipple at the end of the cable. We have found that it is not necessary to provide specially-moulded actuator arms for retaining cable nipples, and the invention of Claim C.22.1 enables the use of a simple planar blank to form the appropriate actuator arm. A flange at the end of the blank is folded over to define an appropriate formation for receiving and retaining the nipple whilst still allowing it to rotate freely.

In order that the inventions may be better understood, the preferred embodiments thereof will now be described, by way of example only, with reference to the accompanying drawings, in which common reference numerals are intended to denote identical or equivalent parts throughout:

Figure 1 is a schematic diagram of a car with central locking;

Figure 2 is a schematic diagram of a car door and part of the frame;

Figure 3 is a schematic block diagram of a central locking system and of one of the latch arrangements;

Figure 4 corresponds to Figure 1 of our PCT Application No. WO97/28338 mentioned above, and is a schematic wiring diagram of an electronic central locking system for a motor vehicle;

Figure 5 is a view from one side of a mechanically-driven switch arrangement forming part of a latch arrangement for a car door;

Figure 6 is a schematic plan view of a cam assembly forming part of the arrangement of Figure 5;

Figure 7 is a schematic circuit diagram of the motor control circuit including the switches shown in Figure 5;

Figure 8 is a schematic circuit diagram corresponding to Figure 7, but additionally including a relay switch for door opening control;

Figure 9 shows an electric door opening mechanism;

Figure 10 shows an alternative electrical door opening mechanism;

Figure 11 shows an electrical door opening and closing mechanism;

Figure 12 shows an electrical door opening and closing mechanism;

Figure 13 shows a further electrical door opening and closing mechanism;

Figure 14 shows a variant of the electrical door opening and closing mechanism of Figure 13;

Figure 15 shows an electrical door opening mechanism, as a variant of Figure 10;

Figure 16 shows an electrical door opening and closing arrangement as a variant of Figure 13;

Figure 17 shows a further electrical door opening and closing mechanism;

Figure 18 shows a further electrical door opening and closing mechanism, using a rotary indexing and driving mechanism;

Figure 18a shows a door opening arrangement integrated with electrical locking;

Figure 18b shows an electrical door opening and closing mechanism, using a bi-directional rotary driving and indexing arrangement;

Figure 19 shows a latch arrangement with a rotary driving and indexing mechanism for electrical door opening and closing, also enabling powered door opening;

Figure 20 is a partial view of two of the components of Figure 19;

Figure 21 is a simplified view of two of the components of Figure 19, but in which the motor gearing is modified;

Figure 22 shows an electrical door opening and closing mechanism, as a variant of Figure 16;

Figure 23 shows a further door opening arrangement;

Figure 24 shows a compact latch arrangement within a housing suitable for vehicle doors, with electric locking;

Figure 25 shows a latch arrangement for the selective electrical locking of a door with two door handle mechanisms and an interior door knob;

Figure 26 shows a variation of the latch arrangement of Figure 25;

Figure 26A is a schematic partial enlarged end view from the right of the arrangement of Figure 26;

Figure 27 shows a door handle lever of the type shown in Figures 25 and 26 and illustrates how the actuation of the mechanism towards its unlocked, handling-coupling position is continued automatically even after it has been blocked temporarily by the door handle being actuated;

Figure 28 illustrates an alternative form of rotary coupling member for the arrangements shown in Figures 25 and 26;

Figure 29 illustrates the use of an electric motor for actuating a child-safety arrangement, in a latch arrangement of the type shown in Figures 25 and 26;

Figure 30 shows an integrated electrical door opening and closing, and central locking arrangement, using a common electrical motor;

Figure 31 shows the use of a rotary indexing and driving mechanism for three separate actuation functions in a latching arrangement;

Figure 32 shows a variation of the arrangement of Figure 31, for four independent actuation mechanisms;

Figure 33 shows the use of a rotary indexing and driving mechanism for the independent actuation of locking and door opening, suitable specially for use with a tailgate or boot latch;

Figure 34 shows the use of a rotary indexing and driving mechanism for driving two linear actuators selectively, for example those shown in Figures 25 and 26;

Figure 35 illustrates a possible form of resilient coupling between an actuation member and a rotary drive member, useful for example in the arrangement of Figure 25;

Figure 36 shows an alternative form of resilient coupling between a rotary drive member and an actuation member;

Figure 37 shows an alternative resilient coupling arrangement suitable for use in the arrangement of Figure 36;

Figure 38 shows an alternative form of selective coupling between two actuators and a rotary indexing and driving mechanism;

Figure 39 shows schematically a disc for converting the rotary movement of a key mechanism into the linear movement of two independent actuators so that the actuators move in opposite directions and reciprocate;

Figure 40 shows an alternative to the disc of Figure 39, in which the actuators are made to reciprocate together in the same direction;

Figure 41 is a side view of the disc of Figure 39 also showing the ends of the actuators; and

Figure 42 is a view corresponding to Figure 41 for the disc of Figure 40;

Figure 43 shows part of a key mechanism having a rotary output drive disc of the type shown in Figures 39-42;

Figure 44 shows schematically a rotary output spindle of a cylinder key mechanism, with a radial arm;

Figure 44a shows one form of coupling between the rotary output of the key mechanism of Figure 44 to a pair of linear actuators, for reciprocating motion in the same direction;

Figure 44b shows an arrangement corresponding to Figure 44a, but in which the linear actuators move in opposite directions;

Figure 44c shows an alternative form of rotary output drive of a key mechanism and a rotary to linear converter arrangement for driving a linear actuator;

Figure 45 shows a double locking arrangement for a key mechanism and an interior door knob, suitable for use with any of the latch arrangements described in relation to the other drawings, for example Figures 25 and 26;

Figure 46 illustrates an actuation plate formed from a planar blank with an end arrangement for connecting to a cable, and a method of formation of such an arrangement;

Figure 47 shows part of a latch arrangement of the type shown in the other drawings, with a single housing which is disassemblable non-destructively;

Figure 48 shows how a single key mechanism can be arranged to operate two separate locks in different parts of a vehicle;

Figure 49 illustrates a clutch mechanism for the electrical drive for example to a door opening and closing mechanism;

and Figure 50 is a perspective view of a clutch-actuating lever of the clutch mechanism shown in Figure 49.

Motor Vehicle with Central Locking

Figures 1 and 2 illustrate a conventional arrangement for locking vehicle doors and other closures. Latches L1 to L4 are bolted on to each of the four passenger doors, latch L5 on to the tailgate (boot) and latch L6 to the petrol locking cap. The vehicle battery is connected to a central electronic control system 90 which in turn is connected by electric cabling (not shown) to the latches.

As shown in Figure 2, each door has interior and exterior handles, a key mechanism, usually in the form of a cylindrical key mechanism, and an interior door knob which is constrained to move linearly between an unlocked position, at which the knob projects from the door frame, and a locked position, at which it projects only slightly from the door frame. A striker, in the form of a cylindrical bar, is fixed vertically in the door frame. The door latch arrangement L1 is bolted to the door such that a latch bolt, described in more detail below, engages the striker to hold the door in its closed position. A door has a resiliently-deformable seal (not shown) which is deformed as the door closes against the frame, and which causes the door to open as soon as the striker is released by the latch bolt. However, even in the absence of such a seal, the latch bolt is normally spring biased to the open position so that it opens the door.

The function of the latch L1 is described in greater detail with reference to Figure 3, which also shows the central electronic control unit 90 and car battery to which it is connected by an electric cable. The striker 10 is also shown, partially surrounded by the jaw of the latch bolt 11. A latching pawl 20 engages an edge of the latch bolt in order selectively to latch it fully or to half-latch it, in a conventional manner. The pawl is rotated under the control of various coupling members which are linked respectively to the exterior and interior handles, interior door knob (where provided) and mechanical child-safety lock control (where provided). An electric

motor 70 is controlled by the central electronic control unit 90 in accordance with the rotary position of the latch bolt 11, which is sensed, as described below with reference to Figures 5 to 8, by position sensors and switches within the latch L1.

This position sensing provides the necessary information for the control of most electrical functions connected with door locking, closing and opening, and, although not always specified in the following description, it is included in most latch arrangements.

The electric motor is controlled to operate the pawl to release the latch bolt, for electrical door opening. It is also controlled to selectively couple the exterior handles and knobs to operate the pawl appropriately. However, in some arrangements, separate electric motors may be provided for this purpose, depending on design requirements and space availability.

The central electronic control circuit 90 is shown in Figure 4, together with the electric motors shown as A for the four doors and the tailgate and filler (petrol) cap catch; also for the engine compartment catch (bonnet catch). In this example, the interior lock is operated simply by an electric switch R6, avoiding the need for an interior door knob, although such a knob could also be provided. The function of this circuit need not be described in detail here, but is described more fully in WO97/28338, referred to above.

The electrical control system will now be described with reference to Figures 5 to 8. In accordance with the invention, there is mechanical position-sensing using microswitches, which alternates the polarity of the electricity supply to the motor, corresponding to the reciprocating motion of the body being driven by the motor, in this case the latch bolt 11. This mechanically-responsive power supply

can also be operated together with electronic control through a relay switch, for initiating door opening, as will be described below with reference to Figure 8.

As shown in Figure 5, a camming member 101 is arranged for pivotal motion about the same axis 15 as the latch bolt 11, and it is driven by means of a projection 140 engaging in a recess 141 in the latch bolt 11. As also shown in Figure 5, the latch housing 100 has three parallel layers, and these three layers are rigidly interconnected by means of a hinge on the axis 15, serving both the camming member 101 and the latch bolt 11. The camming member 101 is capable of sliding upwards and downwards on its pivot axis, to allow cam-following microswitch actuators 111,121 and 131 to follow rectangular cam tracks C, B, A respectively shown in Figure 6. The camming member 101 is biased by a spiral spring 19, upwards in Figure 5, and downwards, shown by arrow 191, in Figure 6. A bank of three microswitches 110, 120, 130 is connected rigidly to the latch housing 100, so that the corresponding microswitch actuators ride along their respective rectangular cam tracks.

The face of the camming member 101 which faces the bank of microswitches is shown, to an enlarged scale, in Figure 6. Unshaded portions of each cam track are the deepest, as represented by line 102 in Figure 4; heavily shaded areas in Figure 6 represent a shallow floor to the cam track, as represented by line 103 in Figure 5. Ramps from the deeper to the shallower areas are shown by shading of an intermediate density in Figure 6. The respective rectangular cam tracks are defined by rectangular walls as shown, and by central walls 104, 105 and 106. The pin-shaped microswitch actuators 111,121, and 131 are represented as circles in Figure 6, at position indicative of their motion along the respective cam tracks. When the door is open, the microswitch actuators are at the top right hand

corners of the cam tracks shown in Figure 6. As the door begins to close, their relative positions move in the direction shown by Letter L, to the positions shown as A, B, C in Figure 6. At this point, the door is fully closed.

A formation H, extending diagonally across the middle cam track B, and continuous with the end face of the middle wall 105, cams the entire cam assembly 101 upwards in Figure 6, against the spring bias, in the direction M, as the latch bolt 11 moves towards the door open position. This is because of the sliding camming action of pin 121 on step H. Continued motion in the direction K brings the microswitch actuators back to position F, at which point the spring force 191 returns them to the top right hand corner as shown in Figure 6, with the cam assembly moving in direction N. The ramps E cause the cam actuators to be depressed into the respective microswitches, to change the microswitches from "off" to "on". Abrupt steps H allow the microswitch actuators to spring out again, turning the microswitches off.

The motor control will now be described with reference to Figures 7 and 8, which show alternative arrangements of the circuitry. In a motor vehicle, each door is controlled by its own motor 70, and each door has a red hazard light 80 to warn motorists that the door is open. The vehicle has a central electronic control circuit 90, with integrated stall current sensor circuitry 91, of a conventional type. First microswitch 110 controls the switching of the door hazard light 80. Second microswitch 120 provides power of one polarity to the motor, appropriate for door closing control. Third microswitch 130 supplies power at the opposite polarity to the motor, appropriate for door opening control. The mechanical arrangement of Figures 5 and 6 ensures correct sequencing of these microswitches. Using conventional notation, NO represents the normally open terminal, NC represents

the normally closed terminal, and C represents the common terminal. With the door closed, the microswitch actuators are at positions A, B and C in Figure 6, and all microswitches are off. Movement towards the opening position causes motion of the microswitch actuators in the arrow K of Figure 6, and after a small neutral movement, microswitch 130 is switched on, as actuator 131 rides up the ramp E. This provides power assisted door opening. Whilst the door is being opened, the door hazard light control microswitch comes on, as actuator 111 rides up its own ramp. When the door has reached the end of the power assisted motion, the door opening microswitch 130 is switched off, and only the door hazard light remains on. As the door is reclosed, the door closing control microswitch is immediately switched on, as the actuator 121 rides up its ramp from line F of Figure 6. During door closure, the hazard light is switched off.

When fully closed, the door closing control microswitch 120 switches off, as actuator 121 drops down the step at line G in Figure 6.

It is preferred that door opening be initiated under central electronic control, and this is provided by the relay switch 140 of Figure 8. A signal from the central electronic control circuitry 90, along lines 150, switches on the relay 140 to power the motor, and remains on for a sufficient period to move the mechanical arrangement to the point at which the third microswitch 130 switches on. The relay switch will then switch off, or time out.

The stall current sensor circuitry 91 need not be described in detail. In this example, it is a circuit breaker which provides over current protection, and is manually re-settable when tripped. current sensing of the drive motor current takes place in its ground return path, and current sensing is effected by means of a resistor, whose voltage is amplified by an appropriate integrated differential

amplifier. A second amplifier determines the voltage difference between the resistance value and the value of a reference voltage, provided by a temperature stable diode. The second differential amplifier acts as a comparator, providing logic level conversion, and outputting a stall signal.

Remote control transmitters are conventionally provided to control the central locking system, for example to unlock or lock the car from outside. The same command can be used by the central control system to open the doors, or specific doors, by remote control. However, the same type of remote control may be adapted, in accordance with one of the inventions, to operate electrical child-safety locking.

The central electronic control circuitry preferably received inputs from sensors, some of which are placed inside the latch to determine the positions of pawl, the latch bolt, and pawl actuator, or any other part of the latch mechanism. Some other sensors are preferably placed elsewhere in the vehicle, for example to monitor the state of the car engine. For example, the current energising the drive motor can be cut off, by the central electronic control circuitry 90, when the engine has been started and the car is in motion. This safe guards against accidental electrical door opening. As a further example, if the door is jammed and the motor drive is stalled, the current sensor circuitry 91 sends a message to the central electronic control circuitry 90 which cuts the current energising the motor until it detects certain predetermined favourable conditions, for example the release of the door handle and the moving of the door to a certain position manually.

The specific arrangements described above in the context of a motor vehicle provide significant cost benefits. By incorporating the switches in the latch housing, this minimises the length of wiring, and in fact it is possible to reduce the necessary

wiring to just the two wires shown in Figure 7, or the four wires 150, 151 and 152 shown in Figure 8, linking the door latch with the central control. By integrating the door hazard light with the door latch, for example by having a simple plug-in lamp, this minimises wiring and assembly costs. The integrated arrangement of the door opening and door closing microswitches, arranged in the same bank, is the most efficient arrangement, and minimises wiring.

Electrical Door Opening and/or Closing

The operation of the latch bolt and pawl in relation to the movement of the door is described below with reference to Figures 19 to 21, and also in the published patent specifications referred to above.

As shown in Figure 9, a latch bolt 11, closable around a striker 10, has notches 13 and 14 respectively for full-latch and half-latch detention of the pawl 20. The latch bolt 11 is spring biased clockwise to the open position, and the pawl 20 is spring biased anti-clockwise (B5) to the latching position at which the latch bolt is latched. An electric motor 70 has a rotary output with crown and bevel gearing to a rotary output drive 50 which is arranged to rotate in the direction D1 so that its eccentrically-located projecting pin 30 abuts against the pawl 20 to move it in direction D2 to its unlatching position. Upon continued rotation in direction D1, the pin 30 allows the pawl 20 to spring back in direction D5, to latch the latch bolt once again after the door has been closed.

The pin 30 is returned to its original neutral position Np, as shown in Figure 9, either by the force of the pawl 20 returning to its latching position, or else under the reverse drive of the electric motor 70. It is then ready, in its neutral position, for a further door-opening actuation.

Obviously alternative output drive couplings are possible, for example screw gears or spur gears. Further, the pin 30 could be replaced with any form of cam arrangement for abutting against a pawl.

In this arrangement, the door is opened, once the pawl has moved to its unlatching position, under the force of the resiliently-deformed door seal. The spring bias of the latch bolt 11 also contributes to the opening of the door.

An alternative form of door opening arrangement is shown in Figure 10. The electric motor 70 output drive takes the form of a rack and pinion arrangement 31 producing linear drive in the direction D1, with part of the rack abutting against the pawl 20. Once the latch bolt has been electrically sensed to have moved to its fully unlatched position, the electric motor is either switched off, or else powered in the reverse direction, to bring the rack 31 back to its neutral position as shown in Figure 10. When it is switched off, the rack remains in its door-opening position until the door is shut. Shutting the door causes the pawl to rotate to its latch engaging position, simultaneously driving the rack back to its neutral position. This is assisted by the spring biasing of the pawl 20.

The sensing of the position of the latch bolt also of course applies to the arrangement of Figure 9, for either switching off or reverse powering of the electric motor.

The arrangements of Figures 9 and 10 are suitable for vehicle side doors. Tailgate and boot latch bolts differ from that illustrated, in that they normally only one notch 13, for fully latching the bolt. Again, various alternative gearing arrangements would of course be possible.

The latch arrangement shown in Figure 11 provides for powered door closing as well as electric door opening. Thus it is an opening and closing

mechanism, powered by the same electric motor 70. The electric motor drives a rotary indexing and driving member 50 selectively in either direction, D1 or D4. Its neutral position Np, shown in Figure 11, corresponds to the position at which its pin 34 is free of the door latch 11. The indexing and driving member 50 is rotationally biased towards its neutral position by a torsion spring 36 mounted co-axially with the member 50, and constrained by a bar 35 fixed to the latch housing. The torsion spring 36 has two limbs 33a and 33b which engage opposite side surfaces of the projecting pin 34. Thus as the member 50 is driven clockwise in direction D1, pin 34 drives limb 33a of the spring which then causes the member 50 to return in the opposite direction to the neutral position. Correspondingly, anti-clockwise movement D4 causes pin 34 to displace limb 33b of the spring, which again returns the member 50.

In this example, the unlatching or release of the pawl 20 is achieved indirectly through an actuation plate 38 pivotally connected at 40 to the pawl 20, and coupled to the rotary indexing and driving mechanism 50 by means of an arcuate slot 39 and a projecting pin 32 of the member 50. The arcuate slot 39 of the actuation plate 38 is cocentric with the rotary member 50, and its function is to allow relative rotation of the rotary member 50 for approximately 70° in the clockwise direction D1, for door closing, without interference.

An extension arm 37 of the latch bolt 11 projects over the rotary indexing and driving member 50 for selective engagement with the pin 34. To close the door, the pin 34 is driven clockwise in direction D1 to the position A which the latch bolt 11 will have reached as a result of partial closure of the door manually. Completion of door closing is achieved by pin 34 abutting against extension 37 and driving it in the direction D3 to its fully latched position B. Once the latch bolt is

electrically sensed to be fully latched, the motor is switched off and the rotary member 50 is returned by the spring 36 to its neutral position Np.

To open the door electrically, the motor drives the pin 34 anti-clockwise in direction D4, causing the pin 32 immediately to pull the end of the slot 39, thus to pull the pawl 20 in the direction D5 to unlatch it in direction D6. The latch bolt then springs open in the direction D7 as the door moves away from the frame in direction D8. Once the latch bolt has electrically been sensed to have reached its fully unlatched position, the motor is switched off, and rotary member 50 springs back to its neutral position Np.

The electrical position sensors are placed suitably in the latch so that, for example, when the pawl 20 is actuated to its unlatching position, it is prevented from falling into its half-latched position in notch 14.

This arrangement is capable of being accommodated in a single housing which is compact and simple to produce, improving on sound proofing and reducing manufacturing costs.

The latch arrangement of Figure 12 is a variant of that of Figure 11, for door opening and closing. In this example, the actuator plate 41, which replaces plate 38, is arranged to slide over the pivot axis 43 of the rotary indexing and driving member 50; it has a slot 45 which guides it over the pivot 43. The actuation plate 41 has an end flange 44A depending downwardly for abutting engagement with the pin 34 of the rotary member 50. The actuator plate 41 is capable of sliding between positions C and C1, corresponding to the latched and unlatched positions respectively of the pawl 20.

Door closing is caused by rotating the pin 34 clockwise in direction D3 to abut against the latch bolt extension 37 at A and drive it to position A1. After a

slight overtravel beyond point A1, the cam pin 34 becomes free from the latch bolt whilst rotating in the direction D3 towards a second neutral position Np2. Thus the first neutral position Np1 is located just before the cam pin 34 engages the latch bolt extension 37. The second neutral position Np2 is located at a point just past A1 but before it can engage the flange 44A. Once freed from the latch bolt, the cam pin 34 stops at its second neutral position Np2, by a resiliently deformable means such as a spring (not shown), after the motor has been switched off under the control of a suitable electrical position sensor (not shown). The motor may also be stopped at the second neutral position by means of a controlled powering of the motor in the reverse direction.

To open the door electrically the motor is powered to drive the cam pin from its neutral position 34B in direction D3 to the point 34C at which it abuts the actuator plate 41 to the point C1 at which the flange reaches the position 44B in direction D7. This causes the pawl to rotate in direction D4 to its fully unlatched position which allows the latch bolt to rotate in direction D5 whilst simultaneously moving away from the striker in direction D6. The cam pin 34 continues in the same direction to its first neutral point Np1.

At either neutral position, the latch bolt and pawl are completely free to be actuated manually, in a conventional manner, between their latched and unlatched positions. Thus conventional mechanical operation is interrupted only during electrical door opening and closing. This provides complete mechanical override as a safety measure against electrical dysfunction.

In contrast to the arrangement of Figure 11, the rotary indexing and driving member 50 rotates uni-directionally, although its motion may be braked or partially reversed by reversed electrical drive.

The arrangement of Figure 12 has the advantages of compactness and sound proofing associated with the arrangement of Figure 11.

A variant is shown in Figure 13, providing electrical door opening and closing using the same electrical drive motor 70. In this example, the rotary output drive at 50 is converted to linear motion by a rack and pinion gear. The rack 56 is formed integrally with a shuttle which has an end abutment surface 55 for engaging the latch bolt extension 37. At the other end, the rack is connected at 57 to a coil spring 58 mounted on the frame 59 of the latch housing, for compression and tension. The spring serves to return the shuttle to a neutral position Np and also to absorb shock and reduce noise.

The shuttle 56 is connected drivingly to an actuator plate 52 by a pin 54 riding in a slot 53, such that the shuttle is capable of driving the latch bolt for door closing without interference. The actuator plate 52 is pivotally connected at 51 to the pawl 20.

As with the arrangements of Figures 11 and 12, the electric drive mechanism is isolated from the conventional mechanical latch operation, by which a door handle operates the pawl, when it is at its neutral position Np.

Thus to open the door the shuttle 56 is driven from its neutral position to its extreme position P1 in direction D3, after which the electric motor is switched off and it returns to its neutral position. Electrical door opening is achieved by driving the shuttle in the opposite direction D5, from the neutral position to the second extreme position P2, which pulls the actuation plate 52 and releases the pawl.

This arrangement uses a potentially smaller drive motor, due to the greater gearing ratio.

A further modification of the door opening and closing mechanism is shown in Figure 14. Instead of the rack and pinion arrangement, a linear shuttle 71 is driven in either linear direction by the cam pin 34 of the rotary indexing and driving member 50, in direction D1 or D2 as the case may be. The cam pin 34 rides against a cam 74 fixed to the shuttle 71, so that drive is effected over a limited angular range or phase, for example about 40°, of rotation of the rotary member 50. Once again, the shuttle 71 is biased towards its neutral position by a tension-compression spring 72 mounted to a frame 73. The shuttle has an end formation 78 which drivingly abuts against the latch bolt extension 37 to move it from position A to position B. For electrical door opening, an actuator plate 77 corresponding to plate 52 is provided to link the shuttle 71 with the pawl 20. As with the arrangement of Figure 13, a pin 75 on the shuttle slides within a groove 76 of the actuator plate 77.

The arrangement of Figure 14 has the additional advantage of adaptability, and it provides for an easier movement of the drive gear to its neutral position in the event that electrical actuation is prematurely interrupted.

An alternative arrangement for electrical door opening is shown in Figure 15. In this example, the shuttle 83, which is again constrained to move linearly, is driven from the electric motor 70 by means of leadscrew gearing taking the form of screw 81 and internally-threaded nut 82. The leadscrew 81 is driven by bevel gearing 80 from the rotary output drive. Once again, the shuttle is spring biased to its neutral position by a tension-compression spring 86. The slot 84 which couples to the pin 85 of the pawl 20 gives sufficient freedom to allow for independent mechanical door opening, as before. In this example, there is no provision for door closing, although of course this arrangement could be incorporated in the door closing arrangements

of Figures 12 and 13 for example. The arrangement is simplified, and provides for just one neutral position A and one actuated position B of the shuttle 83.

This arrangement has the further advantage of complete independence of the mechanical door opening and closing from the electrical arrangement, at all stages of electrical door opening. It also has the advantages of enabling use with a relatively small motor, due to the high gearing ratio, and is extremely adaptable and simple. As before, the compression-tension spring provides an anti-backlash arrangement which reduces noise by absorbing the inertia of the mechanism after the motor has been switched off; this also prolongs the life of the drive mechanism.

A further variation of the door opening and closing mechanism is shown in Figure 16. The shuttle 95 in this example is driven linearly by a leadscrew 96 between two spaced tension springs 97 and 98 which are mounted on the leadscrew 96 between fixed brackets 99 and 200. The leadscrew is driven by a bevel gear 80 powered by the motor 70. The actuator plate 91 is again coupled to the shuttle 95 by a pin 92 sliding in a slot 94, and the shuttle 95 has an abutment surface at its end 93A which moves between a neutral position 93B, position A, a lower position 93C, position C, at which the pawl is unlatched, and an upper extreme position 93A, position B, at which the latch bolt is completely closed.

Preferably, the nut 95, formed integrally with the shuttle, and the screw 96, have their meshing teeth cut at 45° in relation to the axis of rotation of the leadscrew 96, so that the shuttle can drive the leadscrew and vice-versa. The means for constraining the nut 95 to move linearly may take any suitable form, such as grooves and rails (not shown) fixed to, or integral with, the latch housing (not shown).

The springs 97, 98 may be replaced by a single spring capable of use as a compression or tension spring coupled to the nut 95. It may also be a torsion spring coupled to the drive gear.

As with previous arrangements, electrical position sensing is employed to control the powering of the electric motor. A current sensor may be incorporated with the control electronics as an indicator that the latch bolt, for example has reached its latching position, since only overtravel beyond that point raises the current. Again, polarity of the electrical drive may temporarily be reversed, to counteract the inertia of the moving components.

This arrangement has advantages corresponding to the advantages of the arrangements of Figures 14 and 15.

With any of the arrangements of Figures 9 to 16, a clutch mechanism may be provided in the rotary output drive of the electric motor 70. A conventional centrifugal clutch is preferred. This would eliminate any inductive current generated in the motor when it is driven by the mechanical components. It also helps to reduce the load on the return springs which are used for bringing the mechanism back to its neutral position after motorised actuation.

A further modification of the previously-described electrical door opening and closing latch arrangements is shown in Figure 17. In this example, the actuator plate 202 is connected pivotally at 203 to the pawl 20 near to the point of engagement with the latch bolt 11. It therefore operates in the reverse direction, as there is no lever action. This actuator plate 202 is constrained to rotate about the pivot axis of the rotary indexing and driving mechanism 50, or to move linearly in the actuation direction D4, by virtue of an end fork with limbs 205 and 206 on either side of the pivot axis.

In this example, the cam pin 34 is replaced by an arrangement of radial cams all integral with the rotary mechanism 50 and arranged in two separate planes normal to the pivot axis. In a first plane, radial cam 207 is arranged selectively to abut and drive the latch bolt extension 37. In a separate plane, radial cams 209 and 208, spaced by approximately by 100°, respectively engage a depending lug 204 of the actuation plate 202 of the door opening, and a W-shaped leaf spring 210 fixed to the latch housing. The W-shaped spring 210 is a shock-absorber for the cam 208 as it rides up either limb, and locates it centrally. The spring 210 prevents backlash as well as locating the arrangement in its neutral position as shown.

To close the door, the rotary member 50 is driven clockwise in direction D1 to drive cam 207 against the latch bolt extension 37, as previously described. To open the door electrically, the rotary member 50 is also driven in direction D1 from its neutral position, to engage the lug 204 to drive the actuator plate 202 in direction D4 to unlatch the pawl.

Should electrical actuation be interrupted for whatever reason, the drive gear is moved back to its neutral position by means of a sliding spring (not shown) coupled to the drive gear. This guarantees full mechanical override, in the case of electrical malfunction.

The latch arrangement of Figure 18 importantly illustrates the use of one electric motor 70, and one rotary indexing and driving mechanism 50, to control independently the door opening and closing mechanism on the one hand, and electric locking, on the other hand. The door opening and closing mechanism involves a shuttle 215 constrained to move linearly, and coupled to a tension-compression spring 218, as previously described in relation to Figure 14. The rotary member 50 has a single cam pin 34 which is rotatable in either direction D1,

D5 between two neutral positions Np1 and Np2, at which it is retained respectively by W-shaped fixed springs 220 and 219. An actuation member 222 is constrained to move linearly in either direction D11, D12 between positions C1 and C2, and it has the toggle lever 221 at its end for engagement with the cam pin 34. The toggle lever 221 may be of the type illustrated and described below with reference to Figure 35. It is mounted pivotally at the end of the actuation member 222 and biased by a torsion spring 223 to its neutral position normal to the length of the actuation member. This arrangement enables the cam pin 34 to abut drivingly against the toggle 221 to drive the actuation member 222 in direction D11, but then to release it as it is resiliently deformed against the spring torsion, to enable the cam pin 34 to continue its rotary movement. In this example, it is capable of being driven in either direction by the cam pin 34.

As with W-shaped spring 210 of Figure 17, the springs 219, 220 have the function of absorbing rotary impact, as the pin rides up against the external limb of the spring from either direction. The cam pin then moves on to settle between the two outer limbs of the pin in the central recess. This prevents accidental overrunning.

Electrical door locking and unlocking, using the actuation member 222, is described below in greater detail with reference to Figures 24, 26, 30 - 38. Briefly, it interacts with a key mechanism and selectively unlocks or locks the pawl 20 to prevent or allow actuation of door handles or the like being transmitted to the pawl.

A variation of the door opening mechanism of Figure 10, which also provides for electric locking and unlocking under the control of the same electric motor 70, is shown in Figure 18A. In this example, a rack and pinion arrangement integral with a linear shuttle drives the pawl 20 by means of an abutment surface 231. The pawl

20 has an extension lever 232 which is driven either by the abutment surface 231, or else by a cable or other link to the latch locking mechanism (not shown). A tension-compression spring 235 again biases the shuttle towards a neutral position N.

For electric locking, the notch 234 in the shuttle selectively engages with the end 1814 of a lever on 1810 pivoted at its centre 1812, and spring biased by a torsion spring 1813 on the pivot axis 1812 towards the neutral position as shown. The opposite limb 1811 engages in a notch of an actuation member 300 capable of moving in either direction D7, for locking and unlocking the latch.

Figure 18B shows a further arrangement for door opening and closing, which is analogous to the arrangement described below with reference to Figure 33. The rotary member 50 acts directly on the pawl 20, which has an extension arm 20A, and on the latch bolt extension 37. The cam pin 30 is biased by spring 1802, located around fixed lock 1801, to its neutral position N.

Door closing is effected by driving the cam pin 30 against the extension 37 at the position A towards B; it is then impelled back to its neutral position N by the spring. Driving the motor in the reverse direction, the cam pin 30 moves in direction D2 to abut against the pawl 20A to release the latch bolt. Again, the cam pin 30 can be returned to its neutral position, either electrically or by the return spring.

The pawl 20 can alternatively be released manually by externally operable means such as the handle through a lever 246 and cable 245.

In this example, the distal end 20A of the pawl 20 is elevated by bending so that it can override the latch bolt extension 37.

This particular arrangement enables a reduction in the drive torque and renders it more adaptable.

Door Opening and/or Closing under Electric Power

The arrangement of Figures 19-21 provides electric door opening by which the pawl is first released and then the latch bolt is driven under electric power to ensure that it opens fully. The arrangement also provides for powered door closing, as with arrangements described above.

With reference first to Figures 19 to 21 of the drawings, a vehicle door closure arrangement comprises a striker 10 connected to the door frame of a vehicle, and a latch bolt 11 forming part of a latch arrangement supported on the edge of the vehicle door. Whilst the shape of the latch bolt 11 in Figure 19 is special to the present invention, its general function is conventional and need not be described in detail here. The latch bolt 11 is mounted pivotally at 15 for rotary motion as shown by arrow 18, driven by the relative motion 17 of the striker 10 in a U-shaped notch 12 formed in the latch bolt 11. The latch bolt 11 has two further notches 13, 14 formed in its periphery, for engagement with a locking pawl 20. Notch 13 is for locking the latch bolt at a latching rotary position, which retains the striker 10 and maintains closed the vehicle door. The door is capable of being opened, towards the right in Figure 1, by releasing the pawl 20 from its locking position in notch 13, allowing the striker 10 to drive the latch bolt 11 clockwise 18 under the camming action of the indentation 12, until it is no longer detained by the striker 10. However, if the locking pawl 20 is allowed to engage the further notch 14, at a so-called half latch position, then the door can be half latched, partially open.

The locking pawl 20 is mounted pivotally at 21, and pivot points 15 and 21 are both fixed to a latch housing (not shown). The pawl 20 has an end tooth 24 for locking engagement in notches 13, 14. At the same end, it is formed with a pin 23 on which there is pivotally mounted a link arm 25 which is coupled to a door handle for actuating the pawl. Lifting the door handle causes the link arm 25 to move in the direction shown by arrow 26, pulling the pawl 20 anticlockwise as shown by arrow 22, and moving the pawl to its unlocking position (not shown).

In accordance with the present invention, the latch bolt 11 is coupled drivingly to an electric drive motor 70, of the type commonly used for the central locking of vehicle doors. This coupling arrangement, to be described in greater detail below, also incorporates an arrangement for releasing the pawl.

The motor 70 is coupled to the latch bolt 11 through gears 40, 50, 60. Gear 40, shown in isolation in Figure 20, meshes at 45 with teeth 16 on the latch bolt 11. It is mounted for rotation about axis 42, which is shared by the larger-diameter gear 50, shown in isolation in Figure 21. Gear 50 is drivingly coupled to gear 40, with 60 degrees of rotary free play, by means of a pair of slots 52, 53 in one of the plates of gear 50, through which slots project a pair of driving pins 44, 43 connected to gear 40. This 60° free play is important, in this embodiment, to allow for proper sequencing of the pawl release and latch bolt drive.

Rotary motion of gear 50 in the direction shown by arrow 41 is controlled by its direct meshing engagement with the spindle of the motor 70. In the embodiments shown in Figure 19, this coupling is through the meshing of gear 71 on the motor spindle and teeth 62 on crown gear 60, gear 60 being connected to a smaller-diameter gear 61 which drives teeth 54 on gear 60. In the alternative

embodiment shown in Figure 21, worm gear 72 is driven directly by the motor spindle, and drives gear 50 directly.

One section of gear 50 has a U-shaped indentation 51 which cams against a limb 33 projecting from a hook 32 at the end of a pawl actuator 30. The actuator 30 is constrained by formations on the latch housing (not shown) to reciprocate generally in the direction shown by arrow 34 in Figure 19, so as to link mechanically with pin 23 of the pawl 20. The upper end of the pawl actuator 30 is shaped as a dog leg with an extension formed with a slot which surrounds the pin 23. This arrangement provides free play in the driving connection between the pawl actuator 30 and pawl 20.

The operation of the power-assisted door latch will now be described. It will be appreciated that the door latch can be operated either mechanically, without motor power, or else under motor power. This of course is an important safety feature.

Powered operation will be described first. With the door in its closed position, as shown in Figure 19, the latch bolt 11 is at its latching position, and the locking pawl 20 at its locking position. Pawl actuator 30 is engaged by the gear 50. Upon receipt of a command to open the door, from the central electronic control circuit 90, the motor 70 drives the gear 50 anticlockwise as shown at 41. For the first 60° of rotation, the gear 40 will remain stationary, and no attempt is made to rotate the latch bolt 11. Otherwise, the latch and pawl would jam. The indentation 51 pushes the pawl actuator 30 in the direction of arrow 34, and this immediately pushes against pin 23 and drives the pawl anticlockwise as shown by arrow 22, to move it to its unlocking position. Continued rotation of gear 50 cams out the extension 33 of the pawl actuator 30, so that it rests on the outer periphery of gear

50, and is temporarily prevented from re-entering. Continued rotation past the first 60° causes the walls of slots 52, 53 to engage the pins 44, 43 of the smaller gear 40, which drives the latch bolt 11 in the direction shown by arrow 18. With powered operation in this way, half latching is deliberately prevented. Thus the latch bolt is rotated so that notch 14 passes tooth 24, and until the outer surface of latch bolt 11 engages tooth 24 the pawl 20, preventing re-entry of the pawl.

Electronic position sensors, to be described below, cause the motor drive to switch off at the point that the vehicle door is partially open, and has passed its unlatched position. The door can then conveniently be opened fully by the passenger or driver.

Driving the latch bolt 11 clockwise has the desirable effect of pushing the door open, by reacting against the striker 10. This accelerates opening movement of the door, and such opening movement will continue until it is decelerated by friction in the door hinges, by an amount dependent on the inclination of the vehicle.

When the door is closed, it will reach the same position, just beyond the half latch position, and will then cause the electric motor to be switched on again, with reverse polarity (to be described below). The motor then provides power-assisted door closing, to ensure that the door is properly closed and latched. Again, the half latch position is not possible, with power assisted closing. As the door commences full closure, anticlockwise rotation of the latch bolt 11 accompanies clockwise rotation of the smaller gear 40 together with the larger gear 50. After the first phase of such rotation, the extension 33 of the pawl actuator 30 translates back downwards. The free play between the pawl actuator and the pawl 20 allows the pawl 20 to ride over the slot 14 and into the slot 13, under a clockwise spring bias

(not shown), without jamming. As the tooth 24 lodges in the slot 13, the arrangement returns to the position shown in Figure 19.

Without power assist, the latch can be controlled by the door handle through the link arm 25. The mechanical interactions remain, and opening and closing the door causes rotation of the motor spindle, but this simply provides a small amount of mechanical resistance. Lifting the link arm 25 releases the pawl, allowing the door to be opened, whereby the latch bolt 11 is turned clockwise by the striker 10. Again, the pawl actuator 30 is released from engagement with the gear 50 until the door is reclosed. It will also be appreciated that since the mechanical sequence is the same, power assisted closing can follow non power assisted opening, and vice versa. When the latch is operated purely mechanically, it is capable of lodging in the half latch position, with tooth 24 of pawl 20 in notch 14. This is an additional convenience and safety feature.

A modification of the arrangement of Figures 10 and 18A, which provides door opening and closing, is shown in Figure 22. As will be apparent, the abutment surface 231 on the shuttle 233 drives the pawl by way of its extension arm 232, moving it to position 232A. Continued motion in the same direction drives the latch bolt extension 37 to its unlatched position 37A. As with the arrangement of Figure 18A, the notch 234 engages a link lever (1810 Figure 18A) for electrical locking and unlocking.

An electric opening mechanism especially suitable for a boot or tailgate latch is shown in Figure 23. The rotary output drive 50 of the motor 70 is coupled rigidly with a leadscrew 240 which causes linear reciprocating movement of a shuttle block 242 which is internally threaded in a nut portion 243 and which has an internal bore to receive the leadscrew 240. An end abutment surface of the shuttle 242 engages

and drives the pawl 20 for door opening. As with other arrangements, a portion 244 of the pawl is connected by a link 245 to an external manual control such as a handle through a lever 246, to enable the door to be opened provided first the latch has been unlocked by a key mechanism, an interior door knob or an electrical control (not shown). The nut 243 and shuttle returns after each actuation to its neutral position, as shown, by at least one of the following mechanisms: a return spring acting on the nut; a return nut acting on the pawl; and repowering the motor so as to cause the nut to move in direction D6. The nut 243 is constrained to move linearly, by suitable means such as rails fixed to the housing.

In an alternative arrangement, the leadscrew 240 meshes with an internal thread 241 in the rotary drive gear 50, and the leadscrew is formed integrally with the shuttle 242. Further mechanical equivalent configurations will occur to the skilled reader.

A compact door latch arrangement is shown in Figure 24. The housing 250 is in the form of a flat rectangular box with a rounded corner and a U-shaped opening for receiving the striker 10. The housing comprises mutually opposed end plates 252 and a side wall 251 defining an internal compartment 253 for housing the electric motor 70 and rotary output gearing 50. Cables 256, 258 for controlling respective levers 255 and 257 project through the side wall and are connected to the levers by nipples held within end formations. The particular connection which is preferred is described below with reference to Figure 46.

It is especially important for the compactness of this arrangement that several components are all mounted on the same pivot axis 21, including the pawl 20. This latch arrangement provides electric locking and unlocking.

The pawl 20 has a lever arm formed with a fork 259 to enable it to be driven rotationally. A pawl release lever 255 is pivotally connected on the pawl axis 21, for actuation by an external manual control such as an interior or exterior door handle. Rotary motion of the pawl release lever 255 is transmitted to the pawl fork 259 only by means of a rotary coupling member 300, 400 which carries a dependent elongate lug 262 disposed parallel to the pivot axis. Clockwise actuation of the pawl release lever 255 causes its end notch 263 to engage the lug 262, which is then driven against the fork 259. This leads the pawl 20 to its unlatching position, to allow the door to open.

The rotary coupling member 300, 400 comprises two components connected pivotally at the pivot axis 21 but capable of sliding movement, normal to the pivot axis, by virtue of an oval slot formed in both components 300, 400. Locking member 300 is constrained to move linearly between the left-most position as shown in Figure 24, at which the door is unlocked, and a right-most position at which the door is locked because the pawl release lever 225 is no longer coupled to the pawl 20, i.e. it is rendered neutral. A rotary sliding member 400 has an arcuate slot which rides over the pin 301 on the locking member 300, and is integrally formed with the dependent lug 262. The slot is sufficient to allow the rotary sliding member to rotate with the pawl release lever 255 when they are coupled by virtue of the lug 262. When the locking member 300 is moved rightwards to its locking position at which it neutralises the pawl release lever, the lug 262 is moved with it, so that it can no longer be engaged by the notch 263 of the pawl release lever.

The rotary coupling member 300, 400, is driven selectively by an output disc 500 with an eccentric pin, driven by the bevel gear 50 of the motor 70. The pin drives the locking member 300 through a notch or other formation 302. Such

coupling arrangements will be described in greater detail, in various alternative forms, with reference to Figures 25, 26, 35-38.

Mechanical locking and unlocking is achieved through lever 257, for example from a key mechanism or interior door knob. This drives the locking member 300 and forces the electric motor drive when it is not powered. Thus the latch arrangement provides independent mechanical and electric locking and unlocking.

A member 254, of which only a portion is shown, also couples drivingly with part of the locking member 300, for locking and unlocking.

The rotary sliding member 400 with the lug 262, which is permanently coupled with the fork 259 of the pawl 20, is prevented from moving between its locking and unlocking positions for as long as it is in the course of being actuated rotationally, by means of a boss or elongate block 260 projecting from the housing. Whilst the fork 259 rides over the boss 260, the lug 262 cannot move radially of the pivot axis 21 past the boss 260, in either radially direction.

Anti-slam Locking

The boss 260 also has the desirable function of providing anti-slam locking of the latch. The boss 260 prevents inadvertent locking of the door whilst the door handle is held open and the pawl is in its unlatching position, by preventing sliding movement of the locking member 300, due to the radial engagement of lug 262 with boss 260. Thus if the door latch were unlocked and the door then slammed shut, the door could not inadvertently be locked, since the rotary coupling member 300, 400 is held within the housing.

Even without such locking arrangement with the boss 260, the latch arrangement can be configured for anti-slam locking. In the configuration shown in

Figure 24, and also in the arrangements of Figures 25 and 26, the locked position of the locking member 300 is to the right-hand side, away from the striker 10. The orientation of the latch bolt is such that the door closes in the leftwards direction. Thus, if the latch is unlocked before door closing, the locking member 300 will be fully to the left, and any impact upon slamming the door will have no effect on its position. If however the door is locked and the door is then slammed, the locking member 300 may be forced, under the impact, to continue its motion leftwards to the unlocking position, and it may rebound to its locking position, but either way there would be no inadvertent movement from an unlocking to a locking position. Thus, the orientation of the latch bolt and the path of the coupling member 300 are such that, in use, the locking position is substantially further than the unlocking position of the coupling member 300 from the striker 10.

Selective Electric Locking

Two alternative latch arrangements for electrical locking and unlocking will be described with reference to Figures 25 and 26. Each arrangement has two pawl release levers 700, 800 for connection to external manual controls such as interior and exterior door handles, and each corresponding generally to the pawl release lever 255 described above with reference to Figure 24. Each pawl release lever is selectively coupled to the pawl 20 by its own rotary coupling member 300, 400 and 350, 450 respectively. Each such rotary coupling member comprises a locking member 300, 350 connected respectively to a rotary sliding member 400, 450 which have analogous functions to the corresponding components described above with reference to Figure 24. They are all disposed around the common pivot axis 21, providing maximum compactness and simplicity, and enabling the pawl release

levers to have sufficient leverage over the pawl to be accommodated within the housing.

In addition, each latch arrangement has a further lever 900 connected to an external control mechanism through a cable 901, such as to a child-safety switch, or an interior door knob, depending on whether the arrangement is to be used in a rear door or a front door. This further lever 900 has a pivot point at 902 within the housing, and is connected to a lever arm with an end pin 903 coupling with an appropriate one of the rotary coupling members.

In the arrangement of Figure 25, the locking members 300 and 350 have respective projecting pins 304 and 354 which engage with a cam pin 501 on the rotary indexing and driving member 500. In Figure 25, the locking members are driven independently in opposite directions, whereas in the arrangement of Figure 26 they may be driven together, to reciprocate in the directions D7 and D8, although they may alternatively be driven independently. The latch arrangements of Figures 25 and 26 are sufficiently flexible to be adapted for use with child-safety locking and/or panic door opening, and enable selective engagement of either or both exterior door handles. They may also be integrated with electric locking, controlled by the same electric motor or by a different motor.

In the case of Figure 25, for example, for use in front doors, the exterior door handle would be connected to pawl release lever 700 through cable 701, and would be lockable by the interior door knob through lever 900. The interior handle would drive lever 800. For the rear doors, however, the connections with the door handles would be reversed, and lever 900 would be redundant or else could be used as a mechanical child safety lever.

The arrangement of Figure 25 operates as follows. Rotary coupling member 300, 400 drives lugs 410 and 420 between a left-most position, as shown, and a right-most position at which lug 420 is free of notch 803 and lug 410 is free of notch 453. Lug 420 permanently engages in the jaw of the fork 259 on the pawl 20.

Rotary coupling member 350, 450 has a lug 451 on the left-hand side which is capable of being driven clockwise by notch 702 on pawl release lever 700. As mentioned above, it is also coupled pivotally to lever 900 through pin 903. The rotary sliding member 450 is formed with a notch 452 capable of being driven clockwise by a lug 802 on the pawl release lever 800. It is also formed with the notch 453 which drives lug 410 of the other rotary sliding member 400, when at its left-most position.

Thus actuation of lever 700 drives the pawl through lugs 451 and 420 only in the position shown. If rotary sliding member 450 were to be moved to the left, then lug 451 would no longer couple with notch 702, and lever 700 would be neutralised.

Actuation of lever 800 through notch 803 drives the lug 420 directly, but only if the rotary sliding member 400 is at its left-most position as shown. This in turn drives the pawl 20.

Wherever the rotary coupling member 350, 450 is at its neutral, left-most position (not shown), neutralising lever 700, it is automatically returned to its coupling position, as shown, by the action of the other release lever 800 with its lug 802 acting on the notch 452 of rotary sliding member 450. Thus if for example the exterior door handle is operated on a door latch in which the interior door handle has been neutralised by a child-safety lever, subsequent operation of the interior door handle serves to open the door; in other words, operation of the exterior

handle overrides the child-safety function. Similarly, this arrangement provides for a panic override of door locking, enabling lever 800 to raise the interior door knob coupled to lever 900 when an interior front door handle is operated.

The arrangement of Figure 26 is operated analogously to that of Figure 25, except that both rotary sliding members 400, 450 co-operate with the pawl fork at the right-hand side of the arrangement. Corresponding parts are denoted with the same reference numerals. Figure 26A shows schematically the detailed arrangement at the right-hand side.

These arrangements avoid the need for a mechanical child-safety lever, since the selective operation of an interior door handle can be controlled electrically from an electronic central control unit. The use of the exterior door handle as a mechanical override allows the interior handle to be opened, and this is useful for police vehicle use as well as for child safety.

The arrangements also enable double locking to be achieved, by rendering neutral the interior door knob connected to lever 900 in Figure 25, for example. Thus a single electric motor is capable of controlling double locking, selective locking of interior and exterior handles, and child-safety control. Electrical child-safety locking is possible even without any separate mechanical arrangement, by virtue of the selective independent control of the interior door handle.

Existing door latches require a number of mechanical units for double locking, and often employ two motors.

<u>Continuation of Locking or Unlocking Function after Temporary Blocking by Mechanical Door Handle Actuation</u>

Pawl release lever 700 of Figures 25 and 26 is shown in its neutral position 700A and its fully actuated position 700B in Figure 27. When actuated, at

position d the lug 420 of the corresponding rotary coupling member is capable of being driven only partially from its unlocking, neutral position 420A towards its fully locking, coupling position 420C. This is because the lug abuts at 420B against the edge of the lever 700. Once the door handle is released and it returns to position e, with the notch raised to position 702A, the lug 420 is free to move from position 420B to its fully coupling position 420C. In order to achieve this continued motion leftwards from B to C, even after an initial attempt which was blocked, the electric motor could be repowered, under the control of the central locking control unit 90. However, an alternative mechanical arrangement is to provide a mechanical resilient bias which directs the lug from 420B to 420C. Preferably, there is an over-centre spring arrangement whose centre position of instability corresponds to the halfway position of the lug between positions 420A and 420C, which is slightly to the right of the intermediate position 420B at which it engages the lever 700. Thus the lug is biased to the right until it has moved to its midway position; beyond its midway position it is biased to the left. Such over-centre spring arrangements are well known, and typically employ a torsion spring whose ends are connected respectively to the lug and to the housing.

An alternative configuration for the rotary sliding members 400 and pawl 20 of Figures 25 and 26 is shown in Figure 28. The fork is formed on the rotary sliding member 400, with fork arms 430 and 431 of different length, instead of being on the pawl. The pawl is formed with a downwardly depending pin 20A engaging in the fork. This facilitates separate sealing or isolation of the rotary coupling member and levers, which may be sealed jointly with the drive gear and motor. The pawl and latch bolt may be more easily separated from this sealed assembly, with the arrangement of Figure 28, because the pin 20A can pass through a sealable

opening in the housing over the pivot 21. This can achieve better sound proofing and can improve the life of the latch actuator by excluding grit and other abrasive materials.

Electromechanical Child-Safety Arrangement

An electromechanical child-safety arrangement for use with the aforesaid latch arrangements is shown in Figure 29. A separate electric motor 70 drives a lever 194 pivoted at 195, by way of a sliding block 191 to which it is pivoted at 192 through a slot 193. The block 191 is constrained to move linearly and is driven by a leadscrew 198 driven by the motor through reduction gearing. The lever 194 at its pivoted end has a pin 196 connected to an actuation lever 197 capable of reciprocating linearly in directions D3 and D4 between positions c and d, to operate the child-safety mechanism. This couples the mechanism to the pawl selectively, as described above, for selective decoupling of the interior door handle. The electrical control avoids the need for a mechanical child-safety lever or switch in the rear door latch.

Combined Electrical Locking and Door Opening and Closing

The arrangements shown in Figures 30 to 38 enable a single electric motor to control independent functions for the latch arrangement, such as electric door locking and unlocking (central locking) and door opening and/or closing. Several independent innovations are disclosed, as with the other arrangements.

The latch arrangement in Figure 30 has a rotary indexing and driving member 50 with a single cam pin 30 having two neutral positions Np1 and Np2, and spring biased into those positions by spring 1009 which also absorbs shock. Controlled operation in directions D1 and D2 causes independent actuation of a lever arm 1001, for door locking, and cam finger 1004 of a shuttle mechanism 1006.

Electric locking is achieved by rotating the lever 1001, against its return torsion spring 1002, in directions D11 or D12, appropriately to actuate the pair of locking members 300 and 350 together. As shown, the cam 1003 of lever 1001 rotates from a neutral position C to either extreme positions C1, C2, depending on the rotary direction of the cam pin 30.

Door opening is achieved by the shuttle 1006 which has an abutment surface 1005 acting on the lever 1008 of pawl 20. Door closing is achieved by the abutment surface 1010 at the lower end of the shuttle which abuts against the latch bolt extension 37 to move it from position B to position B1. As shown, the cam finger 1004 moves between a neutral position Np and extreme positions P1 and P2. As before, the shuttle is controlled by a tension compression coil spring 1007.

The arrangement of Figure 31 shows how a single cam finger 1012 on the rotary indexing and driving member 50 selectively controls three functions: the single lever 1001 of Figure 30 is replaced by two such levers 1010, 1011, equi-angularly disposed around the rotary member 50. The cam finger 1012 has three neutral positions Np1, Np2 and Np3, to which it is spring biased by means not shown. This enables the independent control of the two locking members 300 and 350 as shown.

A further variant is shown in Figure 32 in which a fourth actuation member is selectively driven by the cam finger 1012, and the four actuation members 1020 to 1023 are equi-angularly disposed around the rotary member 50. This enables a single electric motor to control the selective locking of two handles and electric door opening and closing, as in Figure 31, and an auxiliary function, such as a child-safety operation. In a variant of the arrangement of Figure 32, not shown, different

cams 1012 could be disposed in different planes spaced axially of the rotary member 50, as on a cam shaft, to increase the flexibility of the multiple actuations.

A further variation is shown in Figure 33, especially suitable for use with a tailgate or boot latch. The single cam pin 30 selectively drives pawl 20 through a rotary lever 1030 mounted co-axially with the pawl, and arranged with a dependent flange 1031 to drive the pawl in direction D3, but to rotate in direction D7 freely without actuating the pawl. Thus the cam pin 30 is able to rotate clockwise in direction D6 to rotate the lever 1030 without being hindered by the pawl. The cam pin 30 also actuates a lever arm 1034 for operating the locking member 300 which is also coupled to the key mechanism through link 1033. The lock mechanism selectively couples the handle or knob through linkage 245 to the pawl 20.

As with other arrangements, the rotary member 50 may be spring biased into its neutral positions for example by a sinuous rotary cam surface against which the leaf spring 1037 is forced radially.

Figure 34 illustrates how the cam pin 30 can be arranged to drive two sliding locking members 300 and 350 through appropriate pins or projections 304 and 354 respectively. Projection 354 is moveable by the cam pin 30 between positions A, A1, A2 and A3; projection 304 is correspondingly moveable between positions B, B1, B2 and B3. The stable positions of the projections 304, 354 are those positions on the broken line, shown as A1, A2 and B1, B2, and they are displaced between those positions by the cam pin 30 and they return to those positions after the passage of the cam pin 30. In order to allow the passage of the cam pin 30, they are resiliently moveable outwardly to the corresponding extreme positions A, A3, B and B3. By way of example, the resilience is achieved, as shown in Figure 35, by arranging for the projection on the locking members 300, 350 to take the form of a

toggle 1050 pivoted at 1052 and biased into its central position by torsion spring 1053 disposed on the pivot and held by and held by fixed block 1054. The toggle or finger 1050 can be displaced rotationally to position P1, to be returned to its neutral position P, by spring arm 1051. Similarly, it can be displaced to position P2 to be returned to its neutral position by spring arm 1055.

Alternative resilient formations are of course possible. As shown in Figure 36, the cam pin 30 is fixed, and rides over a V-shaped leaf spring 1070 retained within a box formation in actuator 1080 which is part of one of the locking members, for example. Alternatively, as shown in Figure 37, a pin or button 30 is mounted for sliding movement in the housing either of the actuator of the rotary member 50, so that it can be depressed to allow the passage of the co-operating cam.

In the arrangement shown in Figure 38, a rotary cam 1083 engages flexible elongate arms 1081 and 1082, capable of resiliently deforming in the radial direction of the rotary member 50 to allow the passage of the cam 1083 after actuation phase of rotation.

Key Operation Mechanisms

The operation of a key mechanism suitable for use with the latch arrangements for example of Figures 25 and 26 will now be described with reference to Figures 29 to 44. Typical cylindrical key mechanisms have rotary outputs, and these need to be converted to linear displacements of the locking members 300, 350, for example. This is achieved by means of a specially-formed cam disc 5000 arranged to be driven by the key mechanism. In the arrangement of Figures 39 and 41, the cam surfaces cause opposite linear motion of the locking members; in the arrangement of Figures 40 and 42, they cause motion in the same

direction. In each case, the arrangement allows for independent mechanical actuation of the same locking members.

As shown in Figures 39 and 41, the cam disc 5000 has wedge-shaped cam surfaces in each of four quadrants Q1 to Q4, sloping steadily from low positions, in the plain of the disc, to high positions, spaced radially from the plane of the disc sufficient to displace the locking members the required linear distance. In this example, diametrically opposite quadrants of the cam surfaces are on opposite faces of the disc. In the corresponding example of Figure 40 and Figure 42, opposite quadrants of the cam surfaces are on the same face of the disc. Areas D3 and D4 in Figures 39 and 40 represent directions normal to the plane of the disc 5000, with which the locking members move.

In operation, the key drives the disc 5000 through a quarter turn either clockwise or anti-clockwise, for locking or unlocking, and this motion is converted, by the quadrant ramps, into corresponding linear motion of the locking members 300, 350.

The locking arrangement is shown further in Figure 43, which corresponds to the system of Figures 39 and 41 in which the locking members move in opposite directions when actuated. Adapter 2007 with a splined cylindrical recess 2006 is coupled to drive the converter disc 5000, and it is capable of being driven by a key 2001 having a splined end 2005. In this arrangement, angular tolerance is allowed over a cone 2003, by virtue of the arcuate splines 2005. Rotation of the key in the direction 2004 drives the adapter 2007 which in turn drives the disc 5000 in the appropriate rotary direction.

For extra security against theft, the tubular sleeve 2002 is disposed over the shaft of the key 2001, and is coated preferably with an anti-stick material such as

Teflon, silicon or adhesive grease. This prevents the teeth of a saw from biting into the shaft.

In alternative arrangements, a conventional key mechanism is coupled to the latch by means of a cable or a rod or lever.

Some cylinder key mechanisms as shown in Figure 44 have a radial arm 2011 connected to the key shaft 2001. With such a rotating lever 2011, the arrangements of Figures 44a and 44b can be used to drive the respective locking members 300, 350, by providing rhombus-shaped apertures 2010 (Figure 44a) or 2100, 2200 (Figure 44b) in end flanges of the locking members. The edges of the rhombus-shaped apertures act as cam surfaces with the rotation of the lever 2011, and drive the locking members linearly in the appropriate directions, either in the same direction, as in Figure 44a or in opposite directions, as in Figure 44b. In the arrangements shown in Figure 44c, a key locking arrangement 3003 has a radial cam 3004 which is arranged to engage in a notch 3005 of a lever 3001 pivoted and 3006 to rotate in the direction 3007. The level 3001 has a projection which engages in a notch formed in an actuation level 3002 moveable linearly in the direction 3008; this may of course may be one of the locking members 300, 350. In the case of two locking members, two levers 3001 are provided on the same rotary axis 3006.

Double locking

As an alternative or addition to the electric double locking arrangements described above, a mechanical arrangement is shown in Figure 45. The key mechanism lever 451 is arranged to move parallel with the interior door knob mechanism 452, and the ends of these mechanisms are coupled by a pivot lever 453 pivoted to both mechanisms as shown. A torsion spring 455 mounted on the pivot axis of the lever 453 on the key mechanism 451 has two limbs disposed

around a stationary guide 456, and extending also around a cam pin 457 on the lever 453. Rotation of the lever 453 away from the neutral position shown in Figure 45 in either rotary direction tensions the spring and the appropriate limb of the spring then acts on the pin 457 to return it to the neutral position. A projection 460 on the key mechanism 451 prevents rotation of the lever 453 beyond the position shown as AA.

Two parallel guide rails 458, 459 are fixed to the latch housing, and are of equal length but displaced linearly as shown.

In the unlocked position as shown in Figure 45, the door can be locked by the key mechanism moving in direction D1, causing the pin 457 to follow line BB. It can then only be unlocked by the key mechanism, by reversing the process. If unlocking is attempted by lifting the interior door knob 452 in direction D3, the lever 453 is rotated in direction D4 so that the pin moves to position 457A at which it abuts and is retained by the right hand guide rail 458. This constitutes double locking, dead locking or super locking.

If, however, the door has been locked by the interior door knob 452, then the lever 453 will have been rotated in direction D2 so that the pin will have followed the path AA, to the left of the guide rail 459, against which the pin 457 can slide. The guide rail 459 extends downwardly sufficiently so as not to block the return of the pin 457 along the line AA.

The pawl release levers 460, or indeed any actuator, may be constructed as shown in Figure 46. During manufacture, a sheet metal blank 460 is formed with a transverse flange 469 at one end, with circular apertures 461 and 462, aligned transversely on the lever, being formed in both end portions. A slot 463 is also cut in the flange 469 so as to open the aperture 462 outwardly. During manufacture,

the flange 469 is folded at 467 and 468 so as to face the main portion 460 as shown, at which the apertures 461 and 462 are aligned. A cylindrical nipple 466 at the end of a cable 465, for example a Bowden cable, is joined to the completed lever 460 by inserting the nipple from the flange side into the apertures, slotting the cable 465 through the slot 463, and then rotating the cable clockwise so as to lock it into position, at which it is rotatable freely. It is also possible to trap the cable nipple as the flange is folded over, during manufacture. This avoids the need for rivets, or the moulding of the release lever. The lever can also be made more compact than if it were moulded.

Housing for Latch Actuator

As described above, the latch actuator can be formed in a compact box-shaped housing. As shown in Figure 47, the housing can be formed from two opposed end plates 3017 and 3018 together with a side wall 3027. This arrangement can be secured to the door frame 3023 by appropriate bolts 3024, 3025 and 3026 screwing respectively into an axis 3019, the pivot axis 21 for the pawl 20 and other mechanisms 3020, 3021 and 3022, and the pivot axis 15 for the latch bolt 11. These pivot axes 21 and 15 have axial upward projections extending through the face plate 3017, and include radial enlargements 3015 and 3028 respectively.

An elongate closure plate 3010 has keyhole-shaped apertures 3012 and 3013, coupling with the projecting pivot axes 3015 and 3028. During manufacture, once the latch arrangement components have been assembled as shown, and the face plate 3017 inserted over the three spindles, the closure plate 3010 is located with the larger circular portion of each keyhole 3012, 3013 passing over the enlargements 3015, 3028. At this point, a corresponding aperture 3011 in the

closure plate is slightly misaligned with the axis of the spindle 3019 as shown. The closure plate 3010 is then slid, in direction A, over the face plate 3017, to lock it into position. The inner portions of each keyhole slide over and retain the respective spindles on the pivot axes 21 and 15. The closure plate then bears against the enlargements or studs 3015 and 3028. At this point, aperture 3011 in the closure plate reaches the axis of the spindle 3019, and a closure cap 3014 is inserted with a push fit through aperture 3011 and a corresponding aperture in the face plate 3017, to secure the closure plate against sliding movement.

This arrangement allows non-destructive disassembly of the latch arrangement, simply by removing the cap 3014 sliding the closure plate 3010 and then removing the closure plate and disassembling the remainder of the latch assembly. Thus faulty components can be replaced at any time.

Each end of the latch housing may have its own such closure plate.

Key Mechanism Operating Multiple Locks

As shown in Figure 48, a single rotary key mechanism 481 with an output radial lever 482, rotatable in either direction D1 or D2, can be arranged through respective cables 483 and 484 to actuate two different lock mechanisms 485 and 486 respectively. Bowden cables are preferred, although alternative linkages are of course possible. In one example, the key mechanism on a vehicle door can be connected by respective cables to the latches on that door and on a different door. However, the key mechanism could be elsewhere on the vehicle body accessible from outside. This reduces the number of key mechanisms required and can make doors more streamlined. It is, of course, applicable to other closures, not just doors, and three or more locks can be connected through respective cables to the same

key mechanism. Further, it is an adaptable system, enabling the key mechanism to be located remotely from the latches.

Clutch Mechanism

As shown in Figure 49, the electrical drive to the mechanism for door opening or closing can be decoupled by operation of the mechanical actuator such as the door handle. This ensures that the mechanism cannot jam, even if there is a power failure. The motor output spindle 60A drives a rotary output drive 60 from a spindle 492 extending through the housing 491. This rotary drive 60 is connected to a splined gear 496 in meshing engagement with an internally splined coupling gear 498. The coupling gear 498 is formed with a conical cam surface 497, and is spring biased axially into meshing engagement with an output gear 1490 driving a rotary cam unit 1493, with a first cam 1495 for actuating the pawl by means of a link arm 1491, and a second cam 1494 for driving the latch bolt 11. The coupling gear 498 selectively engages with the final output gear 1490 by mutually opposed teeth in meshing engagement, at 499. The coupling gear 498 moves axially away from engagement with the output gear when driven by a link arm 495, whose end is also shown in Figure 50. An end flange 494 on the link arm is formed with a wedge-shaped cam 4941 which co-operates with the conical cam surface 497 to drive the coupling gear 498 axially, so compressing the spring. The link arm 495 is resiliently biased by spring 493 to its neutral position as shown in Figure 49.

Thus the link arm selectively decouples the clutch, and prevents the electric drive from interfering with the mechanical drive and vice versa.

CLAIMS

C.1 Clutch for door opening and closing drive mechanism

1. A latch arrangement for releasably retaining a striker, comprising a latch bolt shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a locking mechanism moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; means for linking the locking mechanism to a latch-opening external manual control such as a door handle; drive means coupled to the locking mechanism and/or the latch bolt for powered actuation thereof to latch or unlatch the locking mechanism and/or to drive the latch bolt to its latching position or to its unlatching position; a rotary clutch coupling the drive means to an electrical drive motor; and a clutch release mechanism drivingly coupled to the said external manual control such that operation of the latch-opening external manual control isolates the latch bolt and locking mechanism from the drive means.

2. A latch arrangement according to Claim 1, in which the rotary clutch comprises a ring driven rotationally by the drive means and resiliently biased axially into rotary driving engagement with the locking mechanism and/or the latch bolt.

3. A latch arrangement according to Claim 2, in which the clutch release mechanism comprises an arm with a cam surface co-operating with a cam surface on the clutch ring such that linear movement of the arm drives the ring axially to cause it to disengage the drive means from the electrical drive motor.

4. A motor vehicle door latch with electrically-powered door opening and closing, having an arrangement according to any preceding claim.

5. A clutch mechanism for use with a motor vehicle door latch, as defined in any preceding claim.

C.2 Double locking mechanism

1. An automobile door latch having a deadlocking arrangement, comprising a primary actuation member arranged to be driven linearly by a key mechanism and/or by an electrical central locking mechanism between a locking position and an unlocking position at which it respectively locks and unlocks the door latch, in use; a secondary actuation member adapted to be connected, in use, to an interior door knob to move adjacent the primary actuation member, a link lever pivotally connected to the primary and secondary actuation members and having a lever arm which moves transversely of the primary actuation member, as a result of relative movement of the primary and secondary actuation members, between two transverse positions; and longitudinal formations, fixed with respect to a latch frame, arranged to guide the lever arm and selectively to retain it to prevent unlocking by pulling on the secondary actuation member; the arrangement being such that locking by the primary actuation member causes the lever arm to follow a first path along the longitudinal formations to a selectively lockable position adjacent one of the longitudinal formations, such that the lever arm is returnable along the first path only by retracting the primary actuation member, and it is locked against the longitudinal formation for as long as the secondary actuation member is pulled; but that locking by the secondary actuation member causes rotation of the lever arm which then follows a second different path along the longitudinal formations and is always free to be retracted along the second path by either actuation member.

2. An automobile door latch according to Claim 1, in which the lever arm is formed with a cam follower, such as a pin, for following the surfaces of the longitudinal formations.

3. An automobile door latch according to Claim 1 or 2, in which the longitudinal formations, fixed with respect to the latch frame, comprise a pair of parallel rails generally parallel to the path of movement of the primary actuation member, a first of the rails arranged to guide the lever arm downwardly and upwardly when locking has been effected by the primary actuation member, and which allows return upward movement only when effected by the primary actuation member, and the second of the rails being arranged to guide the lever arm downwardly and upwardly without hindrance when locking is effected by the secondary actuation member.

4. An automobile door latch according to any preceding claim, comprising electric position sensors for the primary actuation member, to enable central locking arrangement to effect electric central locking thereof.

C.3 Electrically-operable child safety mechanism

1. A latch arrangement for an automobile door having interior and exterior handles for unlatching and opening the door, comprising an actuator for coupling the interior handle drivingly with a latching member in the latch arrangement, and a child-safety lock control mechanism for selectively decoupling the said actuator from the latching member, wherein the child-safety lock control mechanism comprises an electric motor connected drivingly to the actuator, and a switch for controlling the electric motor.

2. A latch arrangement according to Claim 1, in which the electric motor is reversible for selectively coupling and decoupling the said actuator from the latching member.

3. A latch arrangement according to Claim 1 or Claim 2, in which the latching member is lockable under the control of an external mechanical arrangement such as a key mechanism.

4. A latch arrangement according to Claim 3, in which the locking of the latching member is independently controlled by an electric central locking mechanism whose motor may be the same as the electric motor driving the said actuator, or else an auxiliary motor.

5. A latch arrangement according to any preceding claim, in which position sensors for the actuator provide a signal to the electric central locking mechanism.

6. A latch arrangement according to any preceding claim, comprising a mechanical control accessible externally, for overriding the electrical control of the child-safety mechanism.

7. An automobile having front and rear passenger compartments with respective doors each having a latch arrangement, the rear doors having a latch

arrangement according to any preceding claim, and the switch being operable either manually from the front compartment or by a remote control device.

8. An electrically-operable child-safety mechanism in a latch arrangement, according to any preceding claim.

C.4 Coupling plural latches to one key mechanism

1. A locking system suitable for automotive use, comprising:

at least two separate latch arrangements for closures such as doors and a tailgate, each latch assembly having a latch for holding the closure closed and a latch actuator for selectively releasing or locking the latch assembly; and a single key mechanism operable by a key to actuate both or all of the said latch actuators together, the key mechanism being drivingly coupled to the latch actuators by respective cables.

2. A locking system according to Claim 1, in which the cables are Bowden cables.

3. A locking system according to Claim 1 or 2, in which the key mechanism is a cylinder key with an output lever drivingly coupled to the respective cable.

4. An automobile comprising at least one door and one tailgate, and a locking system according to any preceding claim, the single key mechanism being located accessibly from the exterior of the automobile and being connected by respective cables to a latch actuator in the door and a latch actuator in the tailgate.

5. An automobile comprising at least two doors and a locking system according to any preceding claim, in which the latch actuators are arranged in respective doors and the single key mechanism is arranged in one of the doors.

6. An arrangement according to any preceding claim, for coupling a plurality of door latches to one key mechanism.

C.5 Accommodation of door handle-operated levers inside the latch housing, by providing a common axis of rotation for pawl, locking member and handle lever

1. A latch assembly for an automobile door or other closure, for releasably detaining a striker, comprising: a housing; a pivotally-mounted latch bolt, within the housing, shaped to retain the striker at a latching rotary position and to release the striker at an unlatching rotary position of the latch bolt; a pawl pivotally mounted within the housing for movement between a locking position, at which it retains the latch bolt at its latching rotary position, and an unlocking position, at which it allows the latch bolt to move to its unlatching rotary position; and a pawl release lever connectable drivingly to an external control such as a door handle and selectively coupled to the pawl for unlocking the pawl; wherein the pawl release lever is mounted co-pivotally with the pawl within the housing.

2. A latch assembly according to Claim 1, comprising a rotary coupling member selectively moveable between a coupling position, at which it couples rotary drive from the pawl release lever to the pawl, and a neutral position at which it does not.

3. A latch assembly according to Claim 2, in which the rotary coupling member is mounted for rotational and sliding movement about and over the axis of pivotal motion of the pawl.

4. A latch assembly according to any preceding claim, comprising two such pawl release levers, each mounted on the common pivot axis within the housing, for operation by separate external controls such as interior and exterior door handles.

5. A latch assembly according to Claim 4, in which each pawl release lever has a respective rotary coupling member mounted for rotational and sliding movement about and over the common axis of pivotal motion of the pawl.

6. A latch assembly according to any preceding claim, comprising at least one further lever mounted on a separate pivot axis within the housing and connectable to an exterior control such as an interior door knob, and coupled drivingly to a respective one of the rotary coupling members.

C.6 Disassemblable latch housing, closed by a locking plate, and associated assembly process

1. A latch assembly for an automobile door or other closure for releasably detaining a striker, comprising: a housing; a pivotally-mounted latch bolt, within the housing, shaped to retain the striker at a latching rotary position and to release the striker at an unlatching rotary position of the latch bolt and a locking member; the housing comprising two parallel-opposed end plates joined by a side wall, the ends of the pivot for the latch bolt being anchored in the respective end plates with the pivot extending normal to the plates, and means for retaining the plates releasably for non-destructive disassembly.

2. A latch assembly according to Claim 1, in which the locking member is a pawl pivotally-mounted within the housing for movement between a locking position, at which it retains the latch bolt at its latching rotary position, and an unlocking position at which it allows the latch bolt to move to its unlatching rotary position, and the ends of the pawl pivot are anchored in the respective end plates with the pawl pivot extending normally to the plates.

3. A latch assembly according to Claim 1 or 2, in which the retaining means comprises at least one closure plate slideable over a respective end plate or end plates, the pivot or pivots extending through apertures in the said one end plate and the closure plate, and the closure plate being slideable between an unlocked position at which it is removable from the pivots and the housing is disassemblable, and a locked position at which it is held against the one end plate by an enlargement at the end of the pivot or pivots.

4. A latch assembly according to Claim 3, in which the closure plate is detained releasably at its locked position by a closure pushed into two overlying apertures in

the one end plate and the closure plate respectively, whereby removal of the closure enables disassembly.

5. A latch assembly according to any preceding claim, comprising an electric motor arranged to drive the latch bolt and/or a pawl-locking and unlocking mechanism, the electric motor having a separate housing connected to the said housing to form a joint rigid structure in which the electric motor and the latch bolt and pawl are independently sealed except for mutually-opposed openings for the driving interconnection of the motor and the components within the said housing.

6. A method of assembly of the latch assembly of any preceding claim, comprising locating the closure plate over the end plat, sliding it to lock against the pivot, and removably securing the closure plate against sliding movement.

C.7 Mechanical continuation of locking/unlocking actuation

1. A latch arrangement for releasably retaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position and to release the striker at an unlatching position of the latch bolt; a locking mechanism moveable between a locking position at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; means for linking the locking mechanism to a latch-opening external manual control such as a door handle; and drive means coupled to the linking means for powered actuation to latch or unlatch the locking mechanism; wherein the linking means comprises a pivoted release lever driven by the manual control and selectively coupled by a rotary coupling member to the locking mechanism, the release lever being rotatable from a first position to a second position thereby to drive the rotary coupling member and the locking member; the rotary coupling member being moveable by the drive means between a coupling position, at which it couples rotary drive from the release lever to the locking mechanism, and a neutral position at which it does not; and the release lever being such as to prevent the movement of the rotary coupling member fully to its coupling position when the release lever is at its second position; the rotary coupling member being controlled such as to continue any motion towards its coupling position fully to completion, initiated whilst it is blocked temporarily by the release lever being in its second position.

2. A latch assembly according to Claim 1, in which the release lever is controlled by an electric locking mechanism which drives the rotary coupling member to its coupling position after the release lever has resumed its first position.

3. A latch assembly according to Claim 1, in which the rotary coupling member is mounted to a fixed frame by means of an overcentre spring which regulates its

motion between its coupling and its neutral positions such that the rotary coupling member first abuts the release lever only when it has passed its overcentre spring position, whereby the overcentre spring drives the rotary coupling member fully towards its coupling position.

4. A latch assembly for an automobile door or other closure member, comprising a latch releasable by a manual control such as a door handle, exterior to the assembly, and a locking/unlocking mechanism which selectively couples or decouples the motion of the manual control to drive the latch to unlock the door or closure member; the arrangement being such that after the manual control has been actuated but before it has returned to its normal position, the locking/unlocking mechanism is prevented from coupling the motion of the manual control to the latch, but it nevertheless assumes an intermediate state, and, once the manual control has returned to its normal position, the locking/unlocking mechanism is then driven automatically from its intermediate state to the coupling position.

5. A latch arrangement according to any preceding claim, for completing an unlocking actuation when a handle is being actuated.

C.8 Rotary-to-linear conversion of key, and use of linear actuators

1. A latch arrangement for an automotive door or other closure, comprising a key mechanism having a rotary output drive, a rotary-to-linear motion converter coupled to the rotary output drive to cause at least one actuator arm to move linearly with the turning of the key mechanism, and a latch selectively lockable under the control of the actuator arm.

2. A latch arrangement according to Claim 1, in which the rotary-to-linear motion converter is arranged to cause at least two parallel actuator arms to move linearly to operate independent locking mechanisms in the latch assembly.

3. A latch arrangement according to Claim 2, in which the parallel actuator arms move together in the same direction.

4. A latch arrangement according to Claim 2, in which the parallel actuator arms move in opposite directions.

5. A latch arrangement according to any preceding claim, in which the rotary-to-linear converter comprises a cam disc coupled to rotate with the rotary output drive, and a cam follower surface in the or each actuator arm.

6. A latch arrangement according to Claim 5, in which the cam follower surface is the edge of a notch or aperture in the or each actuator arm.

7. A latch arrangement according to Claim 5 or 6, in which the cam surfaces are slopes which project axially by a distance which is a function of rotational angle of the cam disc.

8. A latch arrangement according to Claim 7, in which the cam surfaces are formed on both sides of the cam disc, to actuate different respective actuator arms or to actuate the same actuator arm in a different direction.

9. A rotary-to-linear converter for coupling with a key mechanism, suitable for use in a latch arrangement according to any preceding claim.

10. An arrangement according to any preceding claim, for coupling a key mechanism with a motor vehicle door latch.

C.9 Rotary indexing mechanism for driving actuators

1. A latch arrangement for an automotive door or other closure, comprising an electric motor coupled to a rotary driving and indexing member, having at least one projection, at least one actuation member arranged to be driven by a respective projection from the driving and indexing member, and means for controlling the electric motor selectively to position the driving and indexing member and thereby to drive the, or a selected one of the, actuation member(s) to perform a required action in the latch assembly for locking or unlocking the latch and/or completing closure of the door or other closure member, wherein the or each projection and/or the or each actuation member is resiliently displaceable at the point of mutual contact to allow a limited displacement after completion of the required actuation, sufficient thereby to allow the driving an indexing member to rotate a full circle.

2. A latch arrangement according to Claim 1, in which the projection is resiliently displaceable.

3. A latch arrangement according to Claim 2, in which the projection comprises a spool such as a ball bearing, spring biased outwardly of the driving and indexing member.

4. A latch arrangement according to Claim 1, in which the or each actuation member is spring-biased towards its point of contact with the driving and indexing member projection.

5. A latching arrangement according to Claim 4, in which the actuation member is rotationally pivoted to a fixed frame, and the pivotal motion is spring-biased.

6. A latch arrangement according to Claim 4, in which the actuation member is articulated at its end, and the articulation is spring-biased.

7. A latch arrangement according to any preceding claim, in which the driving and indexing member is resiliently biased towards neutral stable rotary positions thereof, those stable rotary positions being between two or more actuation members, so that it is driven preferentially to such positions from intermediate, unstable positions.

8. A latch arrangement according to Claim 7, comprising a spring-biasing arrangement acting on a rotary cam surface of the driving and indexing member, to provide the said resilient bias as a function of rotary position.

9. A latch arrangement according to Claim 7, in which the driving and indexing member carries a spring arrangement which bears against a fixed cam surface to provide the resilient bias as a function of its rotary position.

10. A rotary indexing mechanism for driving actuators in a latch arrangement according to any preceding claim.

C.10 Selective coupling of interior or exterior door handle to door opening mechanism, for electric control

1. A latch arrangement for an automotive door or other closure for releasably detaining a striker, comprising: a latch bolt shaped to retain the striker at a latching rotary position and to release the striker at an unlatching rotary position of the latch bolt; a locking member for movement between a locking position, at which it retains the latch bolt at its latching rotary position, and an unlocking position at which it allows the latch bolt to move to its unlatching rotary position; at least two locking member release levers connectable drivingly to respective external controls such as interior and exterior door handles and coupled to the locking member for unlocking it; and at least two respective coupling members, each selectively moveable between a coupling position at which it couples drive from the respective locking member release lever to the locking member, and a neutral position at which it does not; and an electric motor drivingly coupled to each coupling member for selective actuation thereof either separately or together, whereby controlled movement of the motor controls the selective coupling or decoupling of each external control.

2. A latch arrangement according to Claim 1, comprising an electronic central locking arrangement for locking and unlocking the locking member and also for controlling the said electric motor for the selective coupling of the external controls.

3. A latch arrangement according to Claim 2, comprising electric position sensors for at least one of the components of the arrangement, to provide signals to control the electronic central locking arrangement and/or the electric motor.

4. A latch arrangement according to Claim 2 or 3, in which the or each electrical control is capable of being overridden by an appropriate respective externally-accessible mechanical control.

5. A latch arrangement for an automotive door or other closure, having two external controls for unlatching the latch assembly, and an electric motor for locking and unlocking the latch, and a selective coupling mechanism controlled by the said motor such that either or both external controls are selectively coupled to the latch assembly to enable them to unlatch it.

6. A latch arrangement according to any preceding claim, in which the same electric motor is drivingly coupled also to the locking member for selectively unlocking it and thereby allowing the closure to open.

7. A selective central locking latch using only one motor, comprising a latch arrangement according to any preceding claim.

8. A combined selective central locking and electrically-powered door opening latch using only one motor, according to Claim 6.

C.11 Panic door opening, unlocking door by interior handle

1. A latch arrangement for an automotive door or other closure for releasably detaining a striker, comprising: a latch bolt shaped to retain the striker at a latching rotary position and to release the striker at an unlatching rotary position of the latch bolt; a locking member for movement between a locking position, at which it retains the latch bolt at its latching rotary position, and an unlocking position at which it allows the latch bolt to move to its unlatching rotary position; at least two locking member release levers connectable drivingly to respective externals controls such as interior and exterior door handles and coupled to the locking member for unlocking it; and at least two respective rotary coupling members, each selectively moveable between a coupling position at which it couples rotary drive from the respective locking member release lever to the locking member, and a neutral position at which it does not; wherein a first of the rotary coupling members is formed to co-operate with the locking member release lever associated with a second of the rotary coupling members, such that the operation of the said locking member release lever, when the first rotary coupling member is in its neutral position, moves the first rotary coupling member to its coupling position to enable the other pawl release lever thereafter to release the pawl.

2. A latch arrangement according to Claim 1, suitable for use in a rear door of an automobile, combining a child-safety lock control mechanism for selectively moving the second rotary control member to its neutral position, in which the neutralising action of the child-safety lock control mechanism is reversed by the operation of the said locking member release lever.

3. A latch arrangement according to Claim 2, in which the child-safety lock control mechanism is driven by an electric motor between positions at which it respectively neutralises and couples the second rotary coupling member, to provide electrical child-safety locking capable of being overridden by the operation of the said release lever, for example upon operation of an exterior rear door handle.

4. A latch arrangement according to Claim 2, in which the child-safety lock control mechanism is controlled by a mechanical control adapted for positioning adjacent the latch arrangement or within the latch arrangement.

5. A latch arrangement according to Claim 1, comprising an interior door knob for locking the door, drivingly coupled to the first rotary coupling member such that the operation of the said locking member release lever raises the door knob and unlatches the locking member, providing a panic override of the lock in the case that an interior door handle operates the release lever, ensuring unlocking and thereby enabling re-entry by operation of the exterior door handle.

6. A latch arrangement according to any preceding claim, in which the locking member is a pawl.

7. A panic door opening arrangement for use with a motor vehicle door latch, according to any preceding claim.

C.12 Central locking combined with electrical door latch release using a common motor

1. A latch arrangement for an automobile door or other closure, for releasably detaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position and to release the striker at an unlatching position of the latch bolt; a locking member mounted for movement between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; and means for locking the locking member; and an electric motor with a driving and indexing output drive coupled for selectively and independently driving the locking member, for electric door opening, and also the locking means, for electric locking and unlocking.

2. A latch arrangement according to Claim 1, comprising an electronic central locking arrangement for controlling the said electric motor to selectively lock and unlock the latch.

3. A latch arrangement according to Claim 1 or 2, comprising at least one locking member release lever connectable drivingly to an external control such as a door handle and coupled to the locking member for releasing it to allow door opening.

4. A latch arrangement according to any preceding claim, comprising a key mechanism drivingly coupled to the locking means for locking and unlocking it manually.

5. A latch arrangement according to any preceding claim, in which the locking member is a pawl.

C.13 Central locking combined with electrical door latch release and powered door closing, using a common motor

1. A latch arrangement for an automobile door or other closure, for releasably detaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position and to release the striker at an unlatching position of the latch bolt; a locking member mounted for movement between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; and an electrically-driven locking means for selectively locking and unlocking the locking member, in which the electric locking means is driven by an electric motor, and the same electric motor is arranged to drive the latch bolt, directly or indirectly, in order to complete the closure of the door or other closure.

2. A latch arrangement according to Claim 1, in which the electric motor has an output which drives a rotary driving and indexing member, and, over different phases of its rotary movement, the driving and indexing member selectively drives the locking and unlocking means and the latch bolt.

3. A latch arrangement according to any preceding claim, in which the same electric motor is arranged selectively to release the locking member to allow the door to open.

4. A latch arrangement according to any preceding claim, in which the locking member is a pawl.

C.14 Central locking combined with electrical door latch release and powered door closing together with selective electrical control of interior or exterior door handle to door opening

5. A latch arrangement according to any preceding claim, comprising at least two locking member release levers connectable drivingly to respective external controls such as interior and exterior door handles and coupled to the locking member for unlocking it; and two corresponding rotary coupling members each selectively moveable between a coupling position, at which it couples rotary drive from the locking member release lever to the locking member, and a neutral position at which it does not; and in which the same electric motor provides selective electrical control of the positions of the rotary coupling members in order to selectively couple one or both of the exterior controls for the opening of the door or other closure.

6. A combined selective central locking and power-assisted door closing latch using only one motor, according to Claim 5 as dependent on Claim 1 or 2.

7. A combined selective central locking and power-assisted door opening and closing latch using only one motor, according to Claim 5 as dependent on Claim 3.

C.15 Combination of C.14 with electrically-operable child safety mechanism (C.3)

8. A latch arrangement according to any preceding claim, suitable for use in the rear door of an automobile, comprising a child-safety lock control mechanism for selectively moving one of the rotary coupling members between its neutral and its coupling positions in order to selectively isolate the corresponding external control such as the interior door handle, and in which the child-safety lock control mechanism is driven by the same electric motor through an independent driving coupling.

C.16 Electrical door latch release and manual door opening, using a linear actuator acting directly on the latch pawl

1. A latch arrangement for releasably retaining a striker, comprising a latch bolt shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a pawl moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; means for linking the pawl to a latch-opening external manual control such as a door handle; drive means coupled to the pawl for powered actuation thereof to latch or unlatch it thereby to control door opening, wherein the drive means comprises an electrical drive motor with a reversible rotary output drive, a gearing which converts the rotary output drive to a reversible linear drive along a predetermined path, and a pawl drive member driven along the predetermined path by the gearing and arranged to abut and rotate the pawl to move it to its unlatching position, and to return to a position at which the pawl is free to return to its latching position.

2. A latch arrangement according to Claim 1, in which the rotary output drive comprises a gear fixed to a co-axial lead screw, and the pawl drive member comprises an internally-threaded portion in threaded engagement with the lead screw.

3. A latch arrangement according to Claim 1, in which the gearing comprises a rack and pinion arrangement, the rack being integral with, or fixed to, the pawl drive member.

4. A latch arrangement according to Claim 3, in which the pawl drive member has a projection which is arranged to drive the latch bolt to effect the completion of door closure.

5. A latch arrangement according to Claim 4, in which linear motion of the pawl drive member in one direction releases the pawl to allow the door to open, and linear motion in the opposite direction drives the latch bolt closed.

6. A latch arrangement according to any preceding claim, comprising a return spring acting on the gearing to return it to the position at which the pawl is free to return to its latching position.

7. An electrically powered door opening latch arrangement using a rack actuator, according to Claim 3.

8. An electrically powered door opening latch arrangement using a leadscrew actuator, according to Claim 2.

C.17 Electrical door latch release and manual door opening, using a rotary actuator directly on the latch pawl

1. A latch arrangement for releasably retaining a striker, comprising a latch bolt shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a pawl moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; means for linking the pawl to a latch-opening external manual control such as a door handle; drive means coupled to the pawl for powered actuation thereof to latch or unlatch it thereby to control door opening, wherein the electric drive means comprises a rotary output drive, and an eccentric formation on the rotary output drive which is caused to rotate uni-directionally in a circular drive path intersecting with the pawl, whereby to drive the pawl to its unlatching position and then to release it to allow it to return to its latching position, with each rotation of the rotary output drive.

2. A latching arrangement according to Claim 1, in which the pivot axes of the pawl and the rotary output drive are parallel.

3. A latch arrangement according to Claim 1 or 2, in which the eccentric formation is a pin or knob which is arranged to engage an edge of a release lever integral with the pawl.

4. An electrically powered door opening latch arrangement using a rotary actuator, according to any preceding claim.

C.18 Powered door closing using a rotary actuator acting on the latch bolt, with optional door opening

1. A latch arrangement for an automobile door or other closure, for releasably retaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position and to release the striker at an unlatching position of the latch bolt; a locking member moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlocking position; an electric motor having a rotary output drive, and an eccentric formation on the rotary output drive which is caused to rotate in a circular path, the eccentric formation being arranged to drive the latch bolt, either by direct abutment or through a mechanical drive coupling, to effect completion of the closure of the latch bolt.

2. A latch arrangement according to Claim 1, in which the eccentric formation is also arranged to drive the locking member either by direct abutment or through a mechanical drive coupling, the drive of the latch bolt and the locking member being effective over different phases of rotation of the rotary output drive, whereby driving the latch bolt effects completion of the closure of the latch bolt and door and/or effects powered opening of the latch bolt and door.

3. An electrically-powered door closing latch arrangement using a rotary actuator, according to any preceding claim.

4. An electrically-powered door opening and closing latch arrangement using a rotary actuator, according to any preceding claim.

C.19 Powered door closing, using a linear actuator acting on directly on the latch bolt, with optional door opening

1. A latch arrangement for an automobile door or other closure, for releasably retaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position and to release the striker at an unlatching position of the latch bolt; a locking member moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlocking position; an electric motor having a rotary output drive, and gearing converting the rotary output drive to a generally linear drive of a shuttle member, a shuttle member being coupled drivingly to the latch bolt to effect completion of the closure of the latch bolt when the shuttle member moves in one direction along its generally linear path.

2. A latch arrangement according to Claim 1, in which the shuttle member is also arranged to drive the locking member, directly or indirectly, for moving the locking member to its unlocking position to allow the door or closure to open.

3. A latch arrangement according to Claim 2, comprising a return spring acting on the shuttle member to return it to a position at which it allows the locking member to return to its locking position.

4. A latch arrangement according to Claim 1, 2 or 3, in which the gearing comprises an eccentric formation on the rotary output drive and a co-operating formation on the shuttle member which engage for a phase of the rotation of the rotary output drive to displace the shuttle member from a neutral position to an extreme position.

5. A latch arrangement according to Claim 1, 2 or 3, in which the gearing comprises a rack and pinion arrangement, the rack being integral with or fixed to the shuttle member.

6. A latch arrangement according to Claim 1, 2 or 3, in which the gearing comprises a bolt and leadscrew arrangement coupled respectively to the rotary output drive and the shuttle member or vice versa.

7. A latch arrangement according to any preceding claim, in which the shuttle member is coupled drivingly to abut the latch bolt to drive it closed, thereby selectively to complete the closure of the door or other closure.

8. An electrically-powered door closing latch arrangement using a leadscrew actuator, according to Claim 6.

9. An electrically-powered door closing latch arrangement using a rack actuator, according to Claim 5.

10. An electrically-powered door opening and closing latch arrangement using a rack actuator, according to Claim 5 as appendant to Claim 2.

11. An electrically-powered door opening and closing latch arrangement using a leadscrew actuator, according to Claim 6 as appendant to Claim 2.

C.20 Anti-slam lock, preventing inadvertent locking when a door is slammed: arranging the orientation of the lock such that the impact direction corresponds to the open position of the actuator

1. An anti-slam latching arrangement for releasably retaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a locking mechanism moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; a release mechanism arranged to be coupled drivingly to an external control, such as a door handle, for releasing the locking mechanism; an electrically-driven coupling member arranged for reciprocating sliding movement between a locking position at which it isolates the release mechanism from the locking mechanism, and an unlocking position at which it couples the release mechanism to the locking mechanism; the orientation of the latch bolt relative to the path of the coupling member being such that, in use, the locking position is substantially further than the unlocking position of the coupling member from the striker, such that, in use, when the closure of the door causes any moveable components of the latching arrangement to continue their motion relative to the remainder of the latching arrangement in the direction of closure towards the striker, the coupling member, if in its unlocking position before impact, will not be free to move so will remain there after impact; thereby preventing inadvertent locking upon door slamming.

2. An anti-slam latching arrangement according to Claim 1, comprising an electronic central locking control mechanism connected to control the coupling member.

3. An anti-slam latching arrangement according to Claim 1 or 2, comprising at least one further release mechanism arranged to be coupled drivingly to a different external control for releasing the locking mechanism, and a respective electrically-driven coupling member arranged for reciprocating sliding movement between a locking position and an unlocking position.

4. An anti-slam locking arrangement for use with a motor vehicle door latch, as defined in Claim 1, 2 or 3.

C.21 Anti-slam lock, preventing inadvertent locking when a door is slammed: actuator is retained by a projection abutting part of the latch housing.

1. An anti-slam latching arrangement for releasably retaining a striker, comprising: a latch bolt shaped to retain the striker at a latching position, and to release the striker at an unlatching position of the latch bolt; a locking mechanism moveable between a locking position, at which it retains the latch bolt at its latching position, and an unlocking position, at which it allows the latch bolt to move to its unlatching position; a release mechanism arranged to be coupled drivingly to an external control, such as a door handle, for releasing the locking mechanism; and an electrically-driven coupling member arranged for movement between a locking position at which it isolates the release mechanism from the locking mechanism, and an unlocking position at which it couples the release mechanism to the locking mechanism; the coupling member being moveable between a locking configuration at which it isolates the release mechanism from the locking mechanism, and an unlocking configuration at which it couples the release mechanism to the locking mechanism; wherein the latching arrangement has a fixed formation which co-operates with the coupling member only at its unlocking configuration, to prevent movement of the coupling member to its locking configuration until the door has closed and the locking mechanism has closed, whereby slamming the door, causing impulsive forces on the latch arrangement, fails to inadvertently lock the latch.

2. A latch arrangement according to Claim 1, in which the fixed formation is an elongate projection which allows rotation of the coupling member but prevents translational movement thereof when the coupling member is at its unlocking configuration.

3. An anti-slam locking arrangement for use with a motor vehicle door latch, as defined in Claim 1 or 2.

C.22 Folded plate for connection of lever to cable nipple.

1. A coupling arrangement comprising an elongate plate having at an end a flange folded over to face the plate and to define therebetween a channel, the plate and the flange having overlying apertures, one of which apertures is continued as a slot to the edge of the plate or flange, and a cable with an end nipple anchored in the channel and projecting through both apertures for free rotation about an axis normal to the plate.

2. A coupling arrangement according to Claim 1, in which the cable is part of a Bowden cable and the elongate plate is a pivotable lever.

3. A method of connecting a cable with an end nipple to an elongate plate formed as a blank, the plate comprising a co-planar flange depending from one side of the elongate plate, the plate and the flange having apertures aligned transversely of the plate, and one of the apertures being continued as a slot to an outer edge of the flange or plate, as the case may be; comprising locating the nipple over one of the apertures with the cable transverse to the plate, folding the flange a half-turn over the plate so as to trap the nipple therebetween with portions of the nipple engaging in the apertures, the cable passing through the slot, and rotating the cable away from the slot to lock it in place whilst still allowing it to rotate.

4. A method according to Claim 3, in which the cable is a Bowden cable.

5. An arrangement for coupling a Bowden cable with an actuation lever, according to any preceding claim.

C.23

1. A control system for a door or other closure mounted on a frame, the door being latchable to the frame by a latch engaging a striker, the latch being moveable between latching and unlatching positions such that movement from its latching to its unlatching position causes a reaction force from the striker onto the latch tending to open the door, comprising a motor coupled selectively to drive the latch from its latching to its unlatching position and thereby to unlatch and at least partially to open the door.

2. A control system for a door or other closure mounted on a frame, the door being latchable to the frame by a latch engaging a striker, the latch being moveable between latching and unlatching positions, comprising a motor coupled selectively (a) to drive the latch from its latching to its unlatching position and (b) vice versa whereby respectively (a) to unlatch and at least partially open the door and (b) to complete closure of the door and to latch it.

3. A control system according to Claim 1, in which the door is a vehicle door, and in which the vehicle has a central locking system for the vehicle doors, in which the central locking system comprises control means for selectively opening the door or doors.

4. A control system according to Claim 2, in which the door is a vehicle door, and comprising a vehicle central locking system comprising control means for selectively energising the motor to open or to close the door or doors.

5. A control system according to any preceding claim, comprising a portable remote control electronic unit capable of communicating with a motor control means for selectively opening the door.

6. A control system according to any preceding claim, comprising means for locking the latch at its latching position, and comprising a mechanical actuator coupled to the locking means for disengaging the locking means from the latch.

7. A control system according to Claim 6, comprising a linking means for coupling the motor to the locking means, the arrangement being such that, with the door closed and the latch at its latching position, initial movement of the motor causes the locking means to move from its locking position to its unlocking position to free the latch, and further movement of the motor then causes movement of the latch from its latching position towards it unlatching position.

8. A control system according to Claim 6 or 7, in which the latch comprises a pivotally-mounted latch bolt rotatable between its latching and unlatching positions, and in which the locking means is a pawl arranged to lock the latch bolt, the mechanical actuator being coupled to the pawl for releasing the pawl and thereby unlocking the latch bolt.

9. A control system according to Claim 9, comprising a motor control circuit for supplying power to the motor, and a pair of microswitches arranged in the motor control circuit such that closure of one microswitch causes motor drive in a direction such as to drive the latch to open the door, and closure of the other microswitch causes motor drive in a direction such as to drive the latch to close the door.

10. A control system according to Claim 9, comprising a camming member moveable with the latch and arranged to cam the switch actuators of the pair of microswitches so as to sequence the switching of the motor in its alternating polarities for opening and closing the door.

11. A control system according to Claim 10, in which the camming member comprises a cam track for each microswitch actuator, the cam tracks being

generally rectangular and mutually parallel, and further comprising means for causing the microswitch actuators to follow their respective tracks in only one direction of motion.

12. A control system according to Claim 11, in which the means for causing the microswitch actuators to follow their respective tracks comprises a spring biasing the camming member, relative to the pair of microswitches, in a direction in the plane of the tracks, and in which the camming member comprises a cam surface across one of the tracks which converts relative motion of the camming member and the pair of microswitches, corresponding to the opening or closing of the door, into a transverse relative motion so as to guide both microswitch actuators, as cam followers, to the next section of track in the said one direction of motion.

13. A control system according to any of Claims 9 to 12, comprising a third microswitch arranged adjacent the pair of microswitches, and connected electrically to a hazard light circuit, the third microswitch actuator acting as a cam follower in a third cam track in the camming member, so as to switch the hazard light on and off when the door is respectively open and closed.

14. A control system according to any preceding claim, comprising a relay switch for electronically switching on a motor, when the door is closed, to unlatch and partially open the door.

15. A control system according to Claim 9, in which the microswitch for opening the door is positioned such that it is actuated once the door has been partially opened; and a relay switch for electronically switching on the motor, when the door is closed, to unlatch and partially open the door, the relay switch being capable of being closed for a sufficient period to cause the motor to move the door to the point at which the door opening microswitch is actuated.

16. A control system according to any preceding claim, comprising stall current sensor circuitry associated with the supply of current to the motor, for temporarily disconnecting the power supply to the motor in the event that a stall current is detected.

17. An electrically-controlled door opening system for motor vehicles, substantially as described herein with reference to the accompanying drawings.

18. A central locking system for a vehicle, comprising for each of at least two doors, a control system according to any preceding claim, controlled by a central control circuit.

19. A motor control system comprising a motor coupled to drive a body in either of two opposite directions, between extreme positions of the body, dependent on the polarity of electric power supplied by a power supply circuit to the motor, and a pair of microswitches arranged in the power supply circuit such that closure of one of the microswitches supplies the electric power at one polarity and closure of the other microswitch supplies the electric power at the opposite polarity to the motor, the microswitches being responsive mechanically to the position and to the direction of movement of the body between its extreme positions.

20. A motor control system according to Claim 19, comprising a camming member moveable with the body and arranged to cam the switch actuators of the pair of microswitches so as to sequence the switching of the motor in its alternating polarities.

21. A motor control system according to Claim 20, in which the camming member comprises a cam track for each microswitch actuator, the cam tracks being generally rectangular and mutually parallel, and further comprising means for

causing the microswitch actuators to follow their respective tracks in only one direction of motion.

22. A motor control system according to Claim 21, in which the means for causing the microswitch actuators to follow their respective tracks comprises a spring biasing the camming member, relative to the pair of microswitches, in a direction in the plane of the tracks, and in which the camming member comprises a cam surface across one of the tracks which converts relative motion of the camming member and the pair of microswitches, into a transverse relative motion so as to guide both microswitch actuators, as cam followers, to the next section of track in the said one direction of motion.

23. A motor control system substantially as described herein with reference to Figures 4 and 5 of the accompanying drawings.

24. A microswitch cam control system for motor drive and motor vehicle door hazard light, comprising a motor control system according to Claim 20, 21 or 22, the microswitches being arranged also to operate the hazard light dependent on the vehicle door position.

C.24 Biasing a rotary actuator to a predetermined position

1. A rotary actuator adapted to be driven rotationally, and suitable for indexing and driving at least one latch actuator in a motor vehicle door latch, such driving occurring as the rotary actuator is driven over a respective predetermined limited angular range for the or each latch actuator, and resilient means co-operating with the rotary actuator and, in use, with a fixed frame, to bias the rotary actuator rotationally towards a predetermined stable position outside the said limited angular range.

2. An actuator according to Claim 1, in which the resilient means biases the actuator, in use, to one of a plurality of predetermined stable positions outside the or each limited angular range, to provide a neutral position or positions at which the latch actuators are not driven.

3. An actuator according to Claim 1 or 2, in which the resilient means comprises a radial spring carried by the rotary actuator.

4. An actuator according to Claim 1 or 2, in which the resilient means comprises a peripheral spring arrangement around the rotary actuator, co-operating with a cam on the actuator.

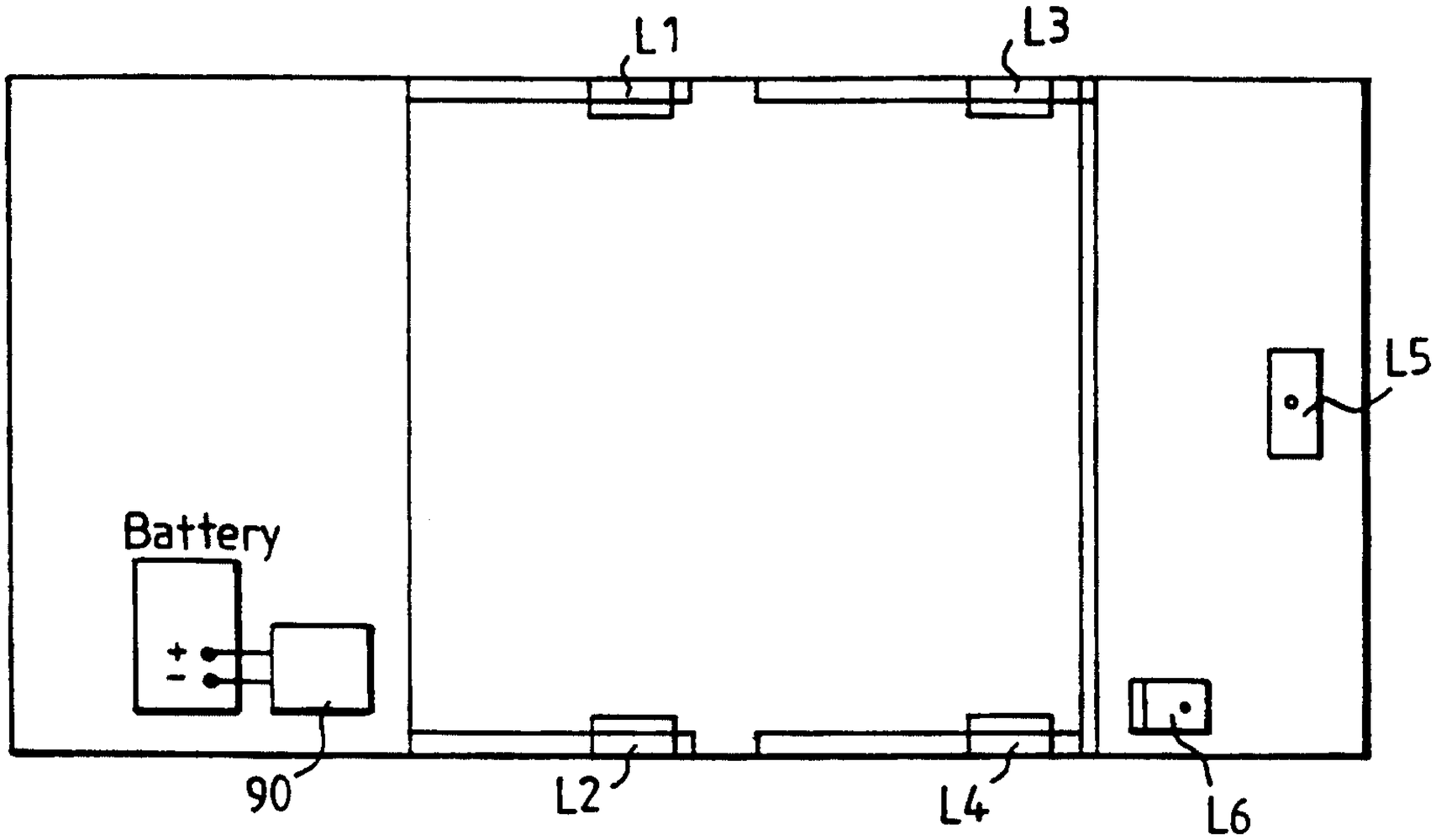

L1
L3
L5
Battery
90
L2
L4
L6

FIG.1

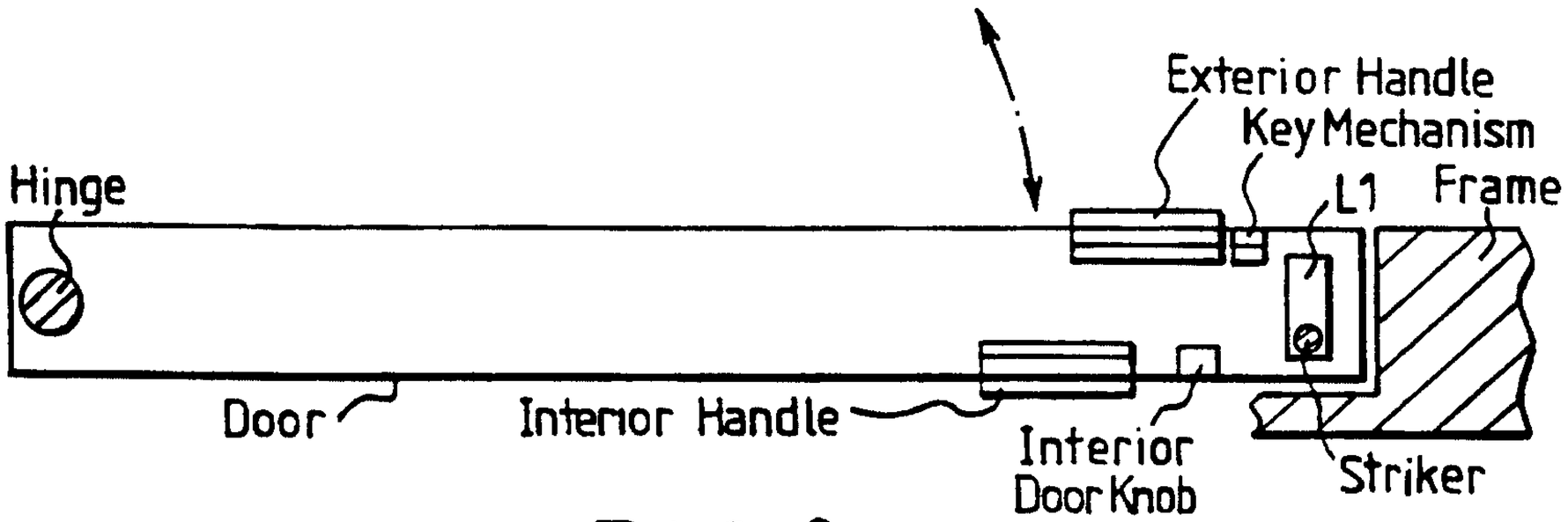

Exterior Handle
Key Mechanism
L1
Frame
Hinge
Door
Interior Handle
Interior
Door Knob
Striker

FIG.2

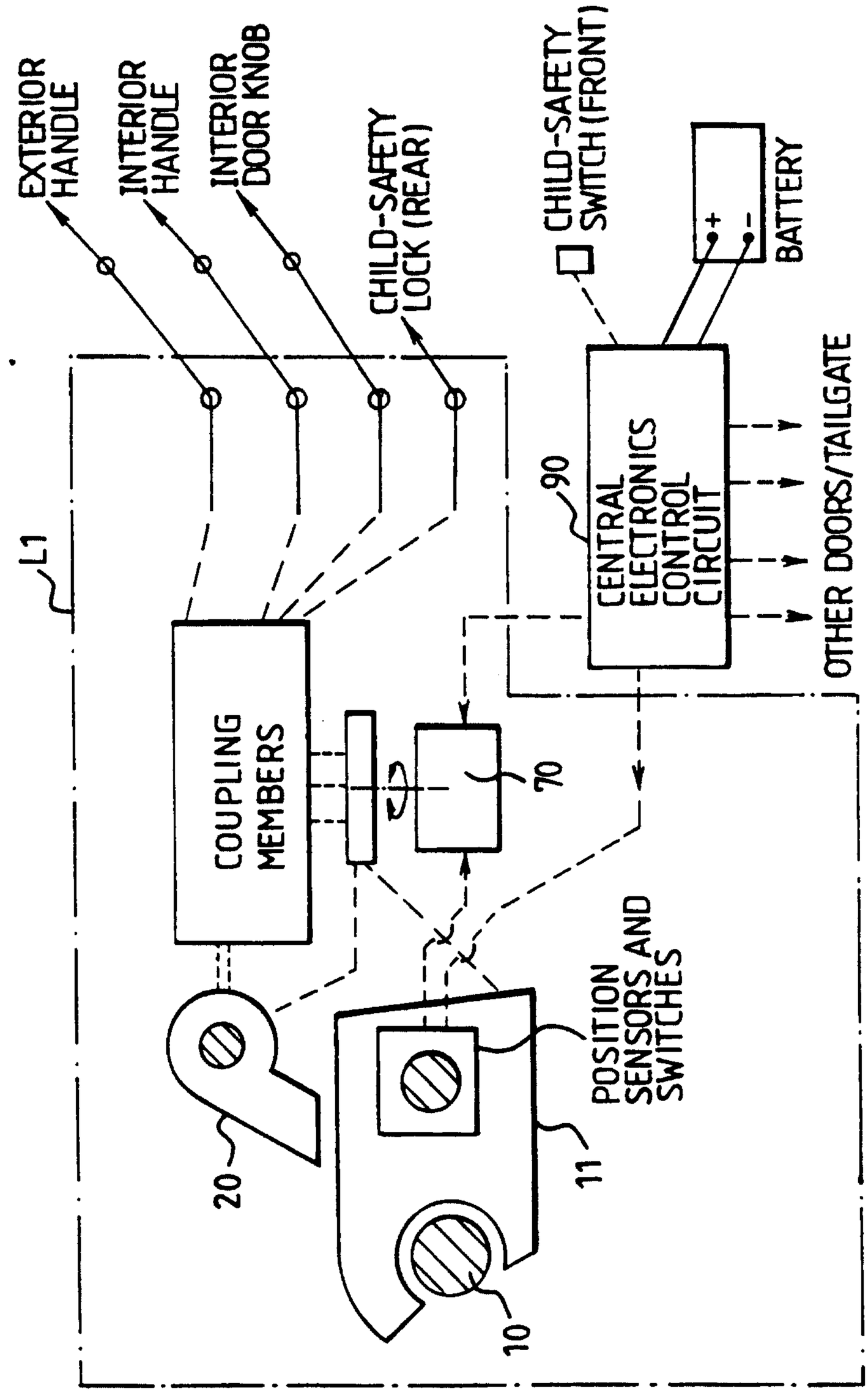

EXTERIOR HANDLE
INTERIOR HANDLE
INTERIOR DOOR KNOB
CHILD-SAFETY LOCK (REAR)
CHILD-SAFETY SWITCH (FRONT)
BATTERY
+
-
L1
90
CENTRAL ELECTRONICS CONTROL CIRCUIT
OTHER DOORS/TAILGATE
COUPLING MEMBERS
70
20
11
POSITION SENSORS AND SWITCHES
10

FIG 3

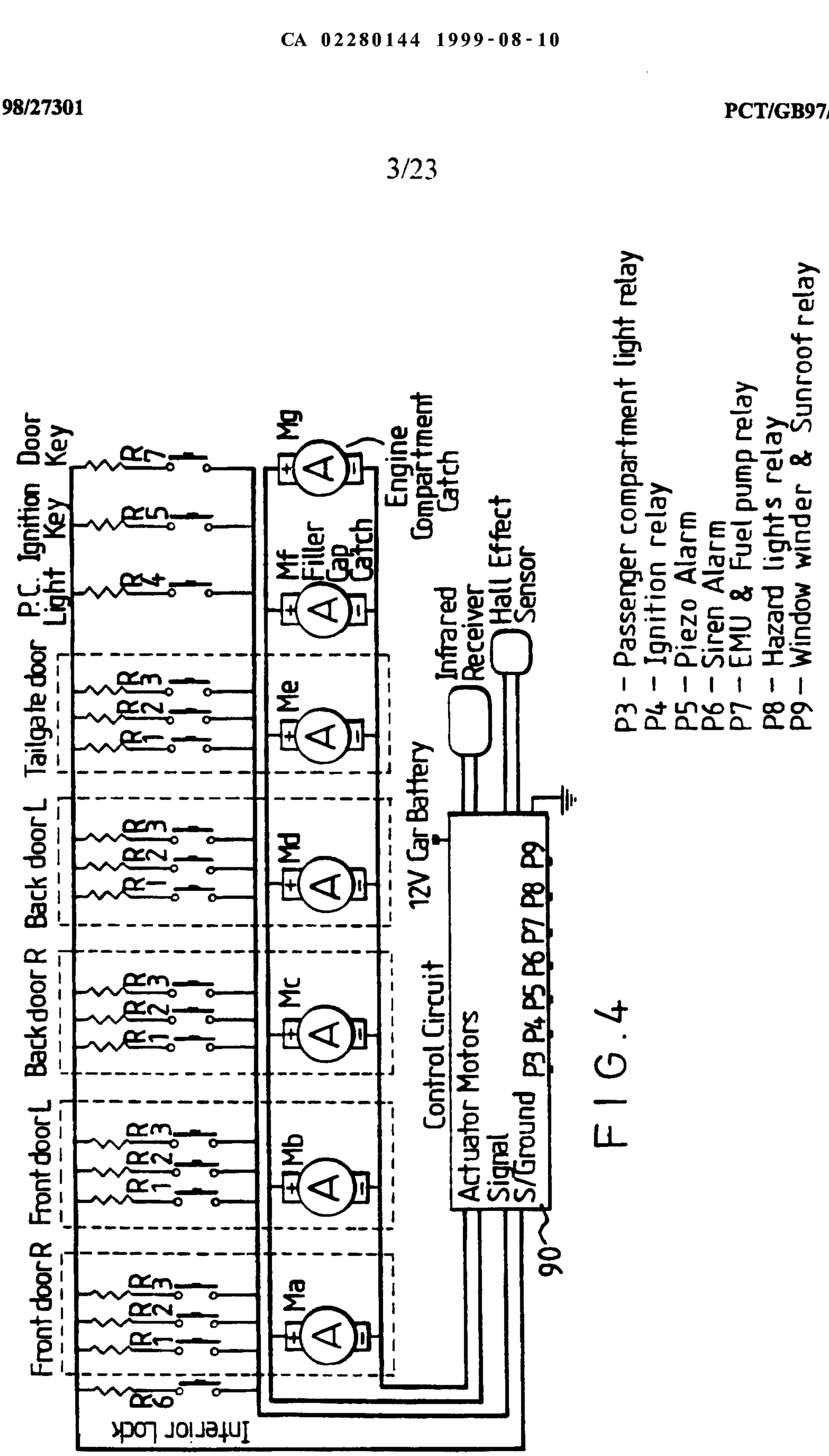

Door Key
Ignition Key
P.C. Light
Tailgate door
Back door L
Back door R
Front door L
Front door R
Interior Lock
R1
R2
R3
R4
R5
R6
R7
Ma
Mb
Mc
Md
Me
Mf
Mg
Filler Cap Catch
Engine Compartment Catch
Infrared Receiver
Hall Effect Sensor
12V Car Battery
Control Circuit
Actuator Motors
Signal
S/Ground
90
P3 P4 P5 P6 P7 P8 P9
P3 – Passenger compartment light relay
P4 – Ignition relay
P5 – Piezo Alarm
P6 – Siren Alarm
P7 – EMU & Fuel pump relay
P8 – Hazard lights relay
P9 – Window winder & Sunroof relay

FIG.4

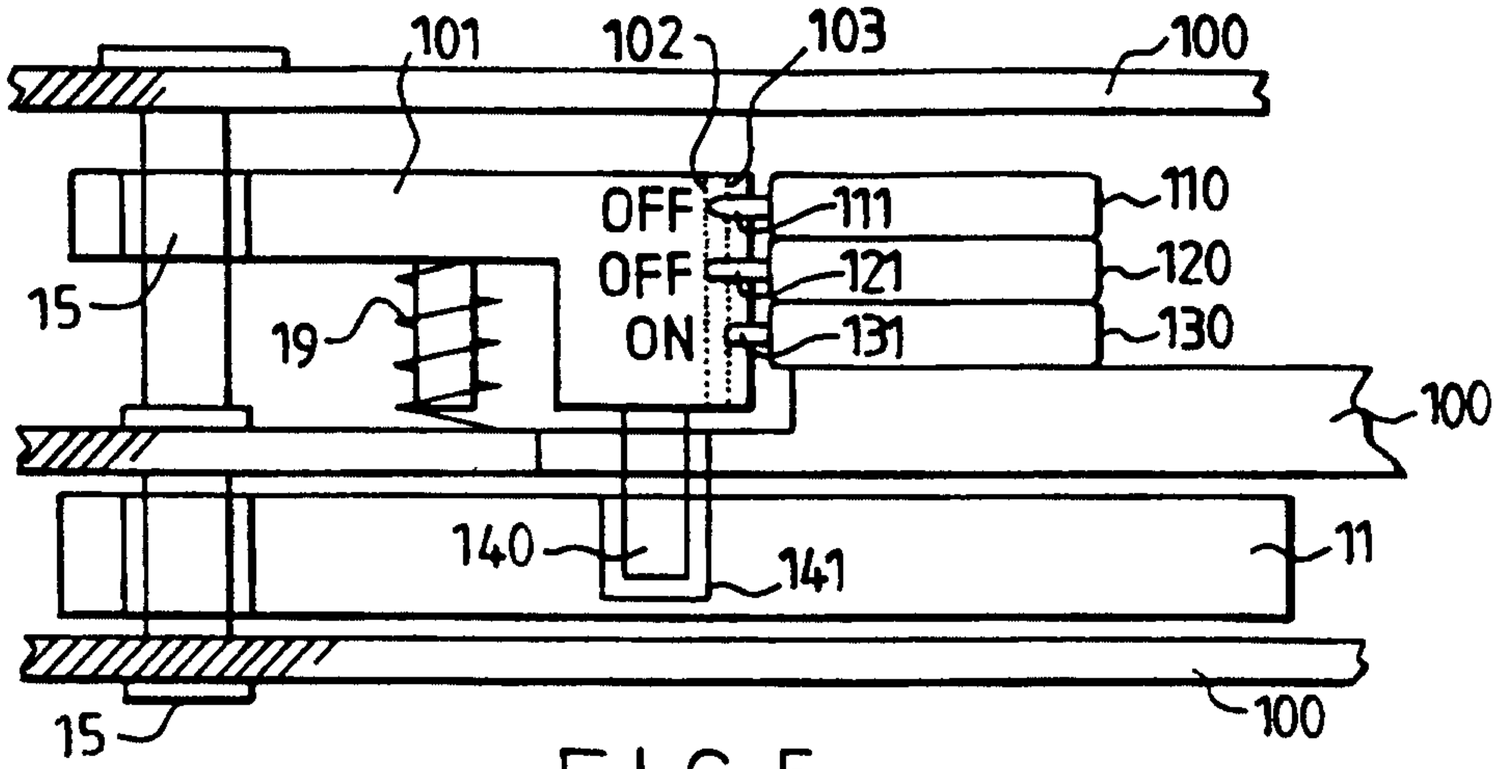


FIG.5

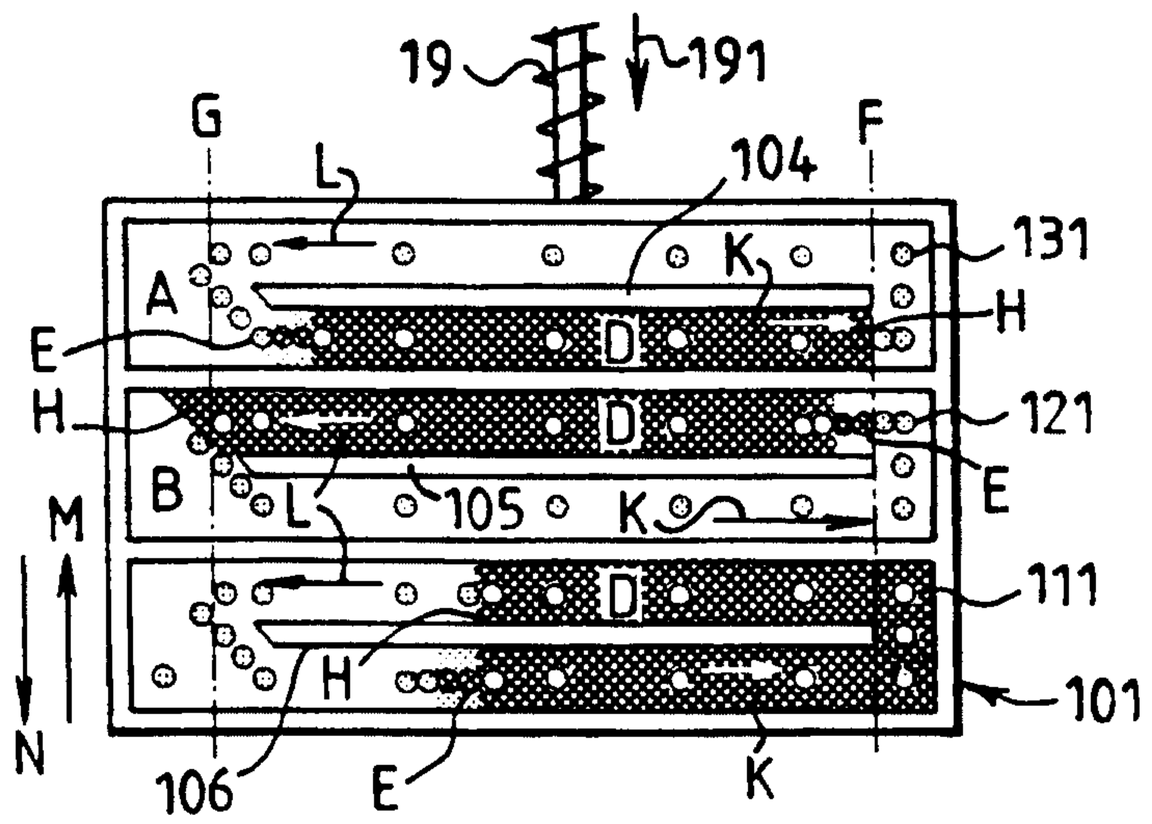


FIG.6

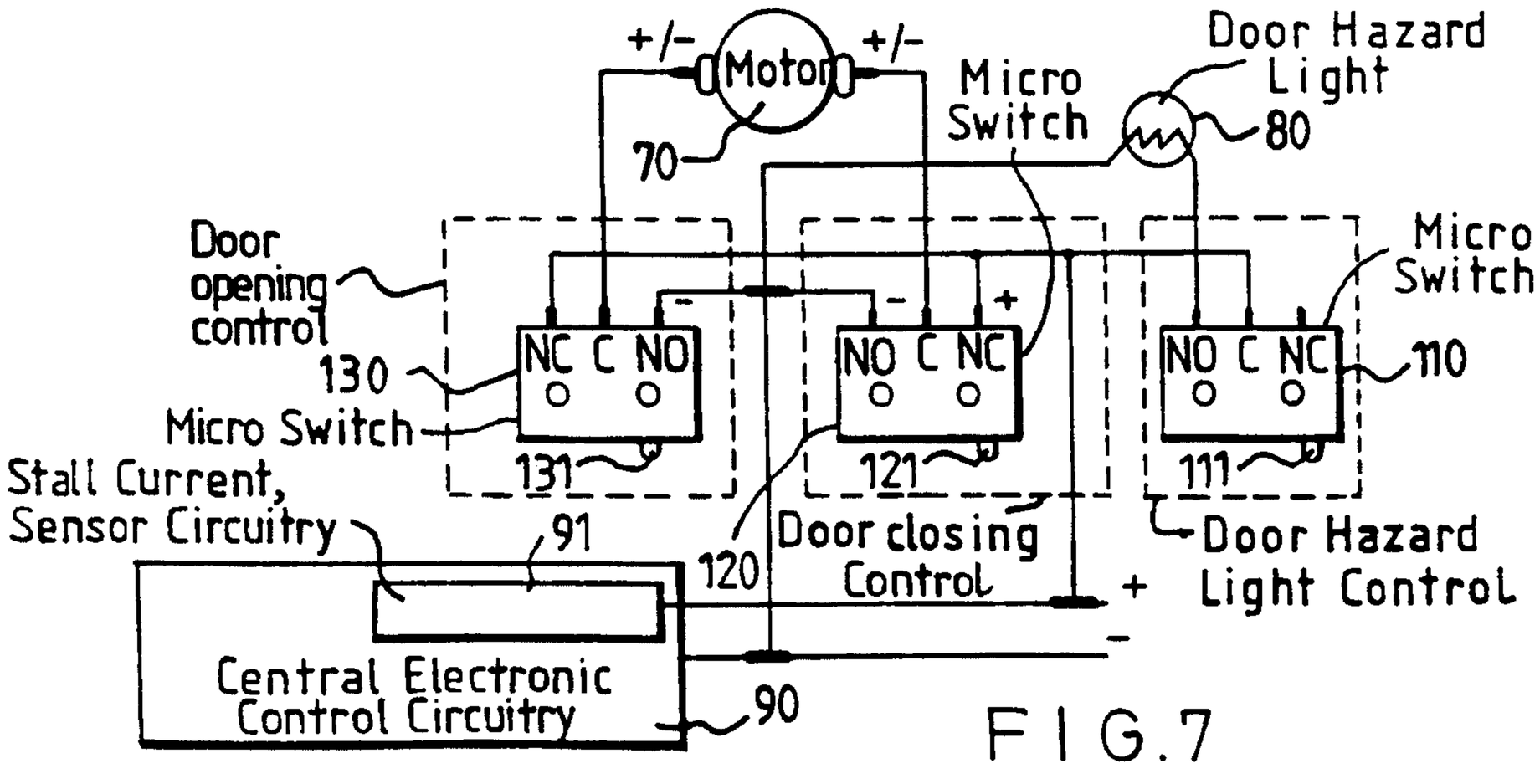


FIG.7

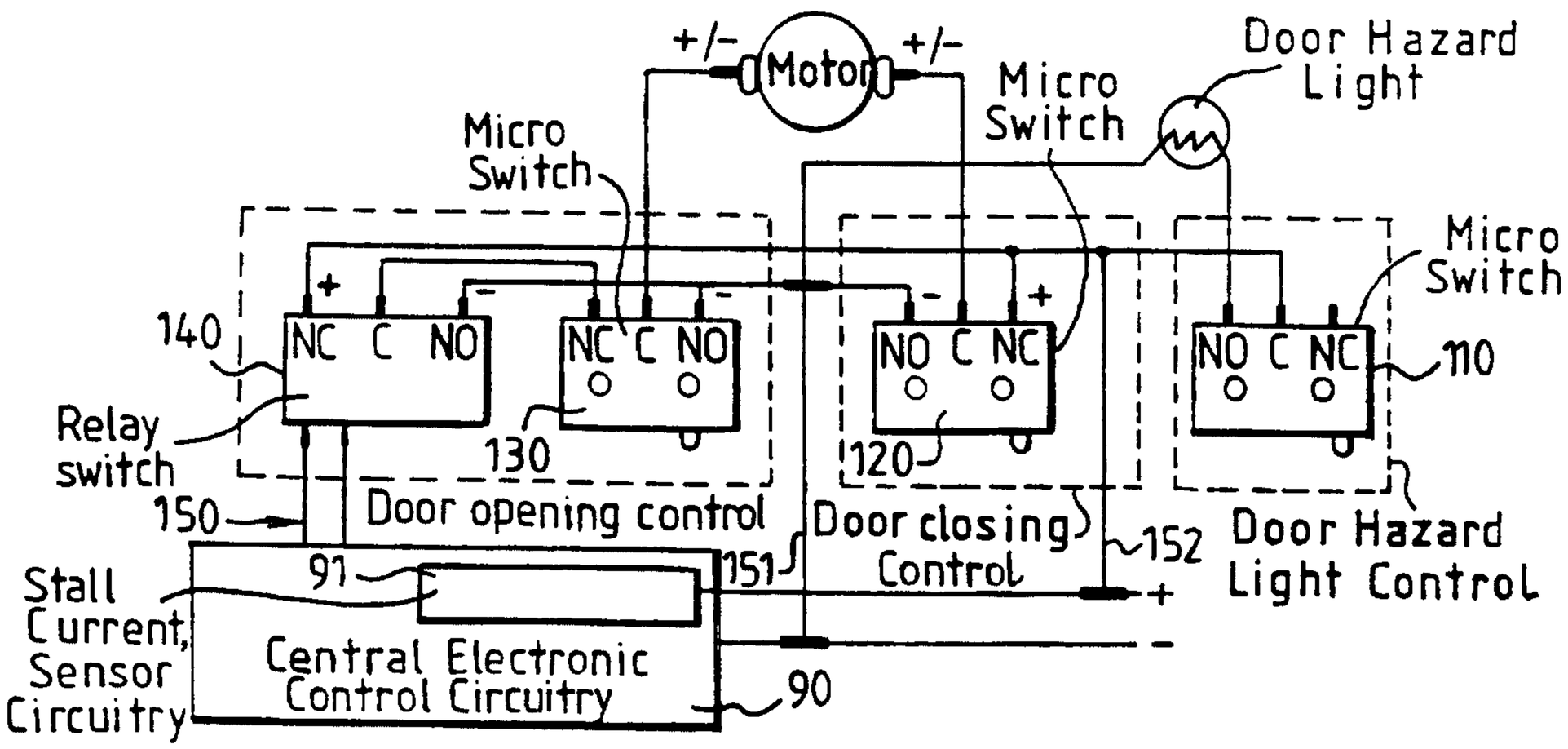

+/-
Motor
+/-
Micro Switch
Micro Switch
Door Hazard Light
Micro Switch
140
NC C NO
NC C NO
NO C NC
NO C NC
110
Relay switch
130
120
150
Door opening control
Door closing Control
152
Door Hazard Light Control
91
151
Stall Current, Sensor Circuitry
Central Electronic Control Circuitry
90

FIG.8

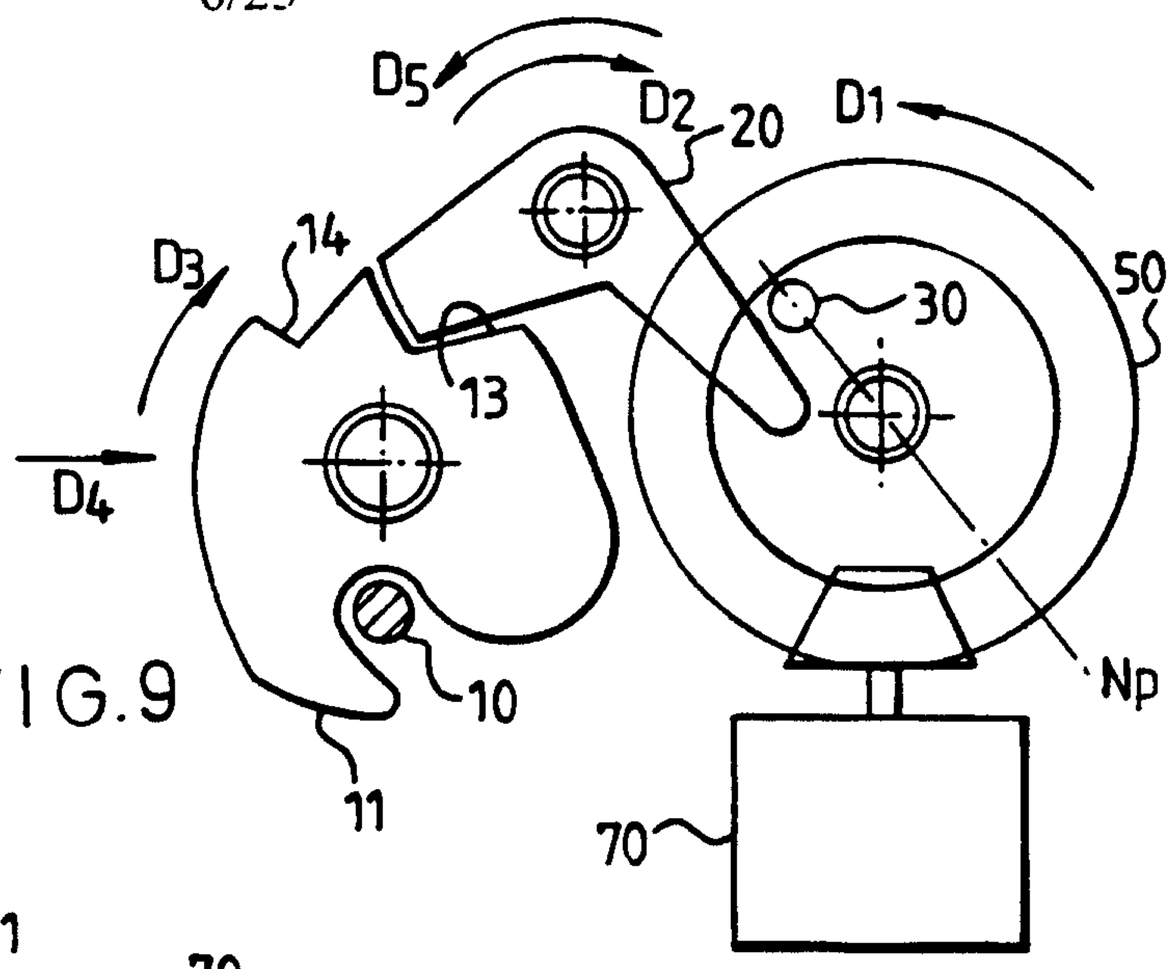


FIG.9

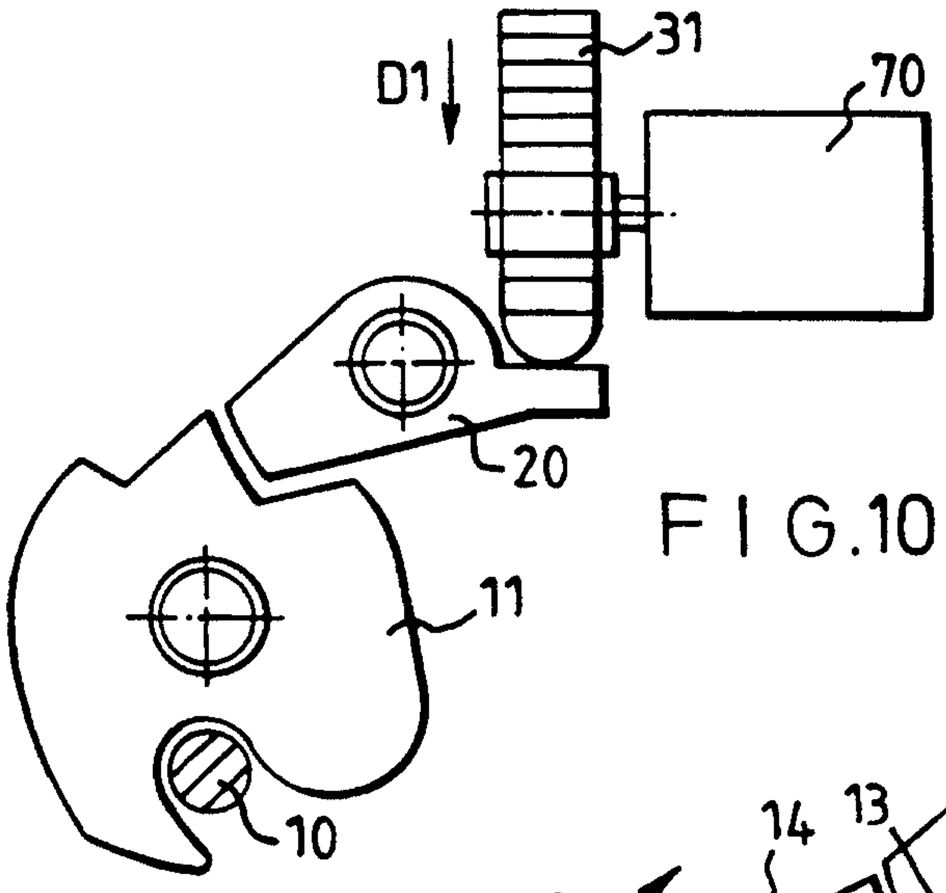


FIG.10

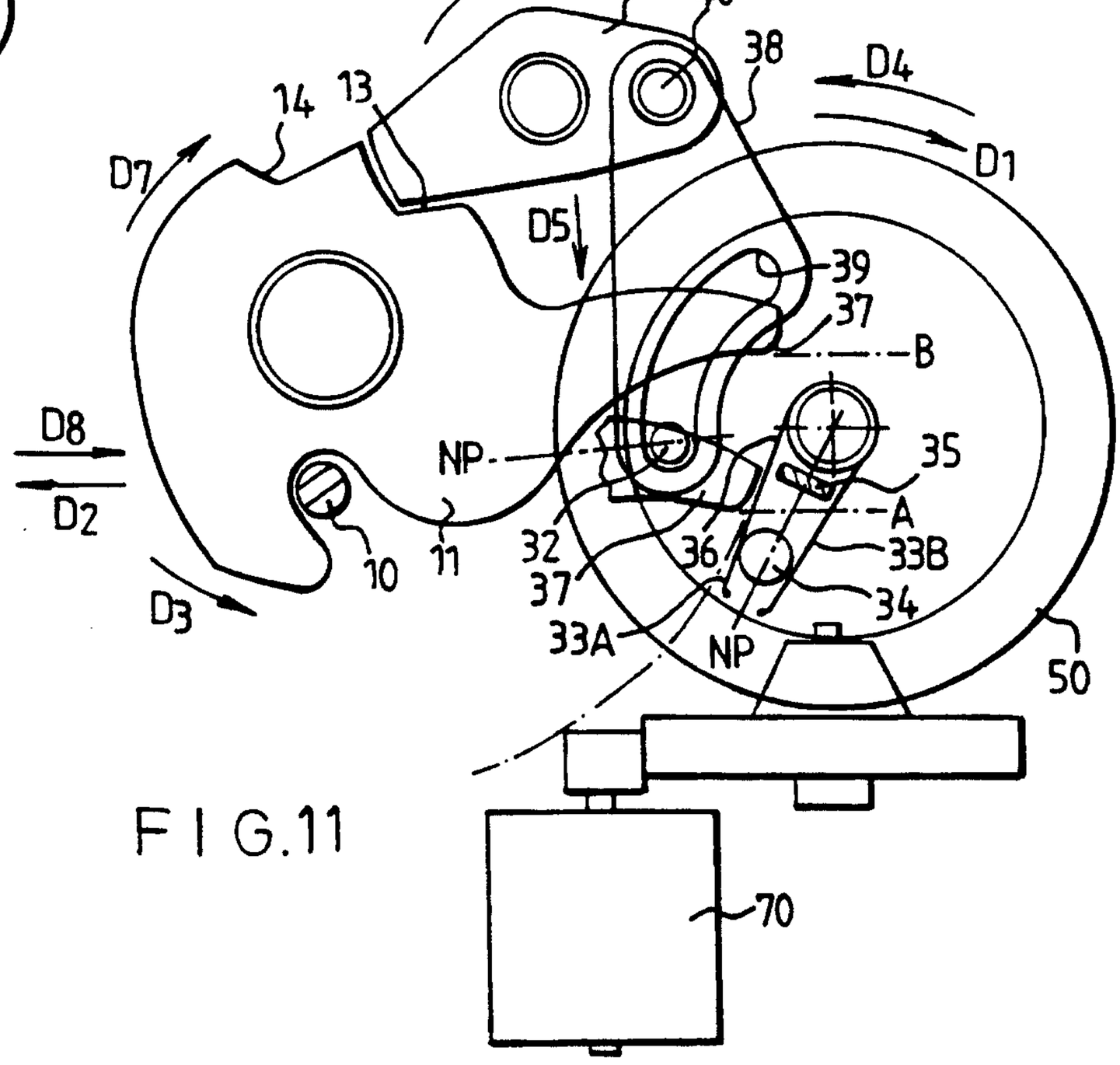


FIG.11

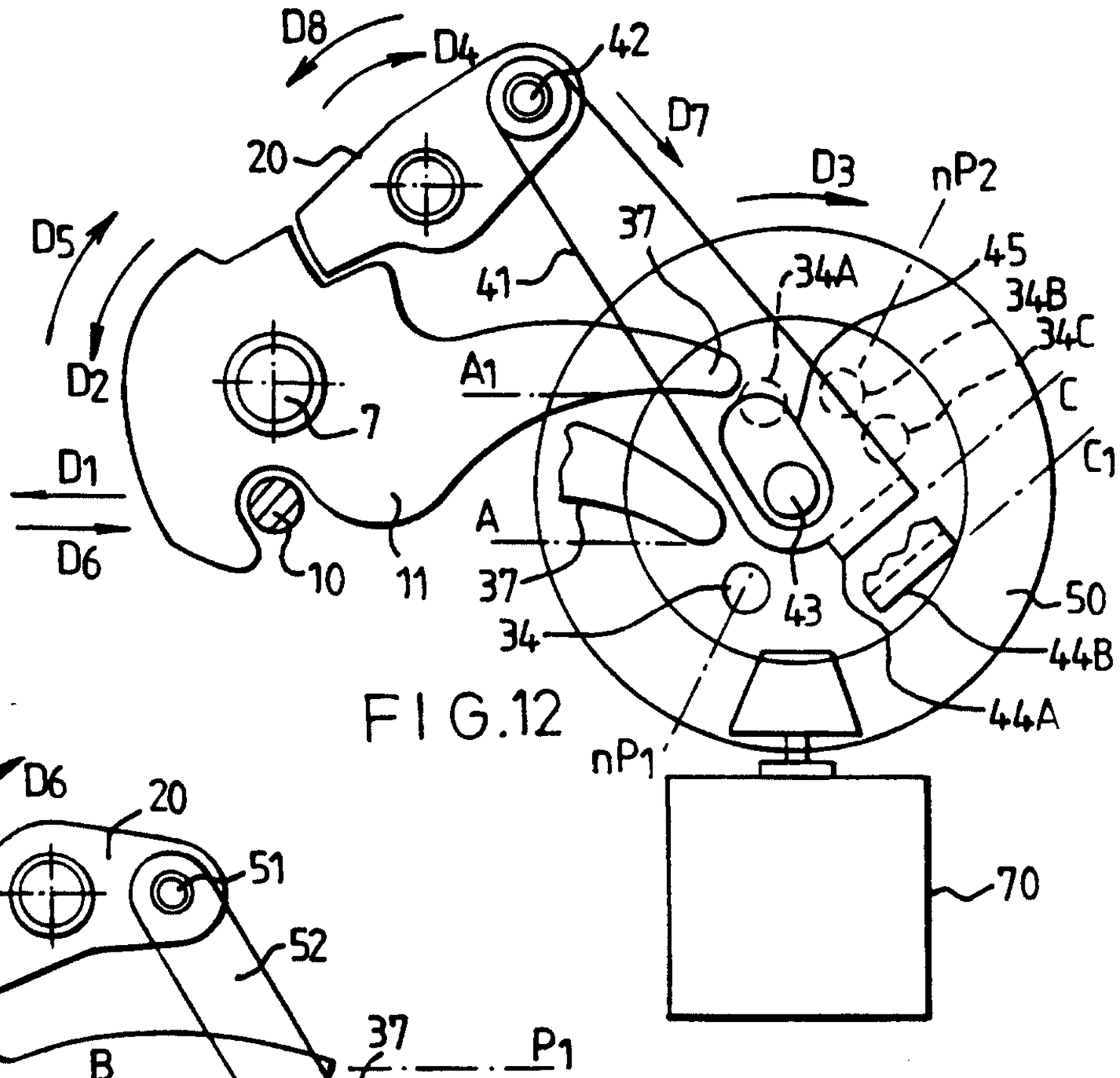

D8
D4
42
D7
20
D3
nP2
D5
37
41
34A
45
34B
34C
A1
C
C1
D2
7
D1
D6
10
11
A
37
43
50
34
44B
44A
nP1
70

FIG.12

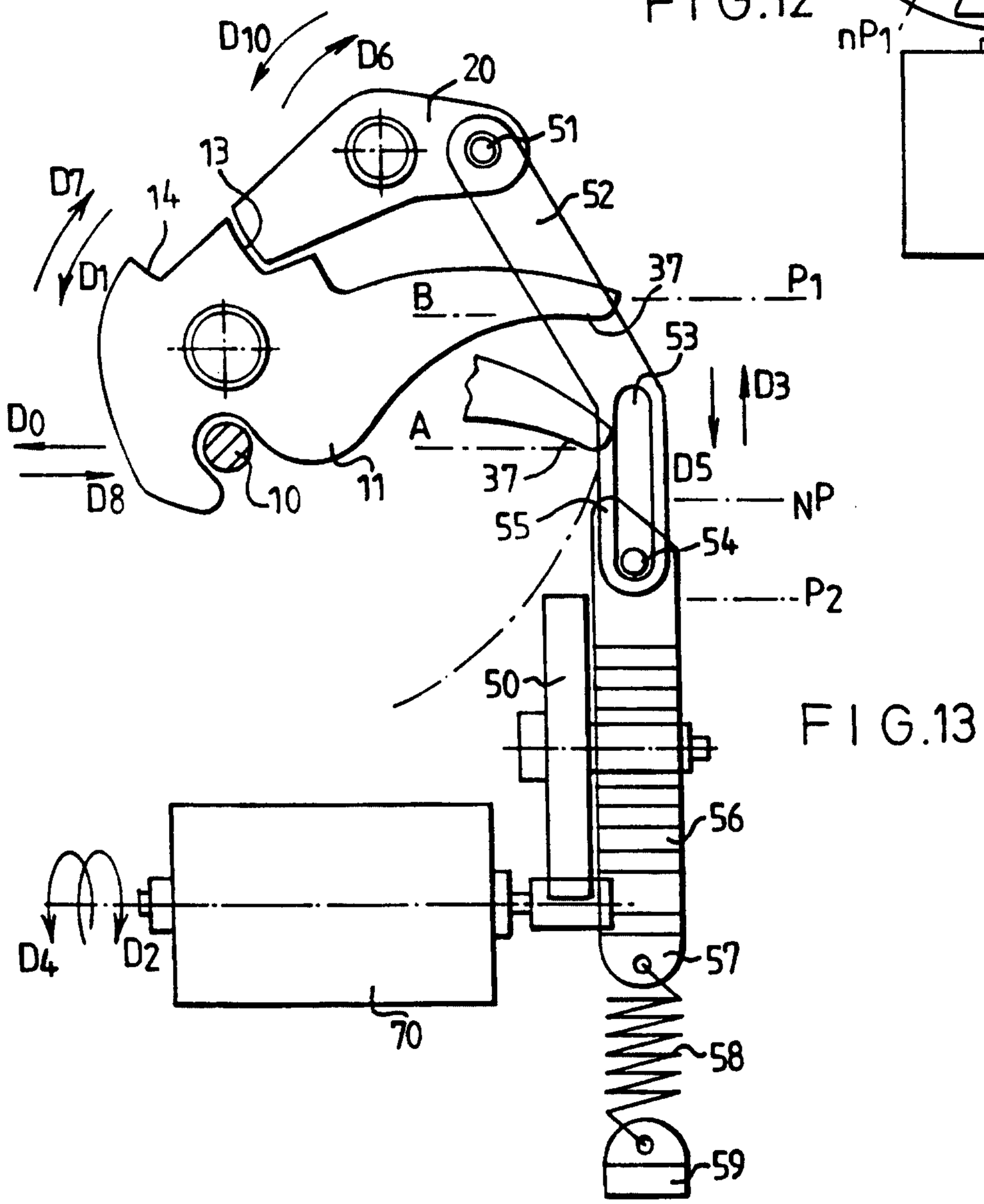

D10
D6
20
51
13
D7
14
52
D1
37
P1
B
53
D3
D0
A
D5
37
NP
D8
10
11
55
54
P2
50
56
D4
D2
57
58
70
59

FIG.13

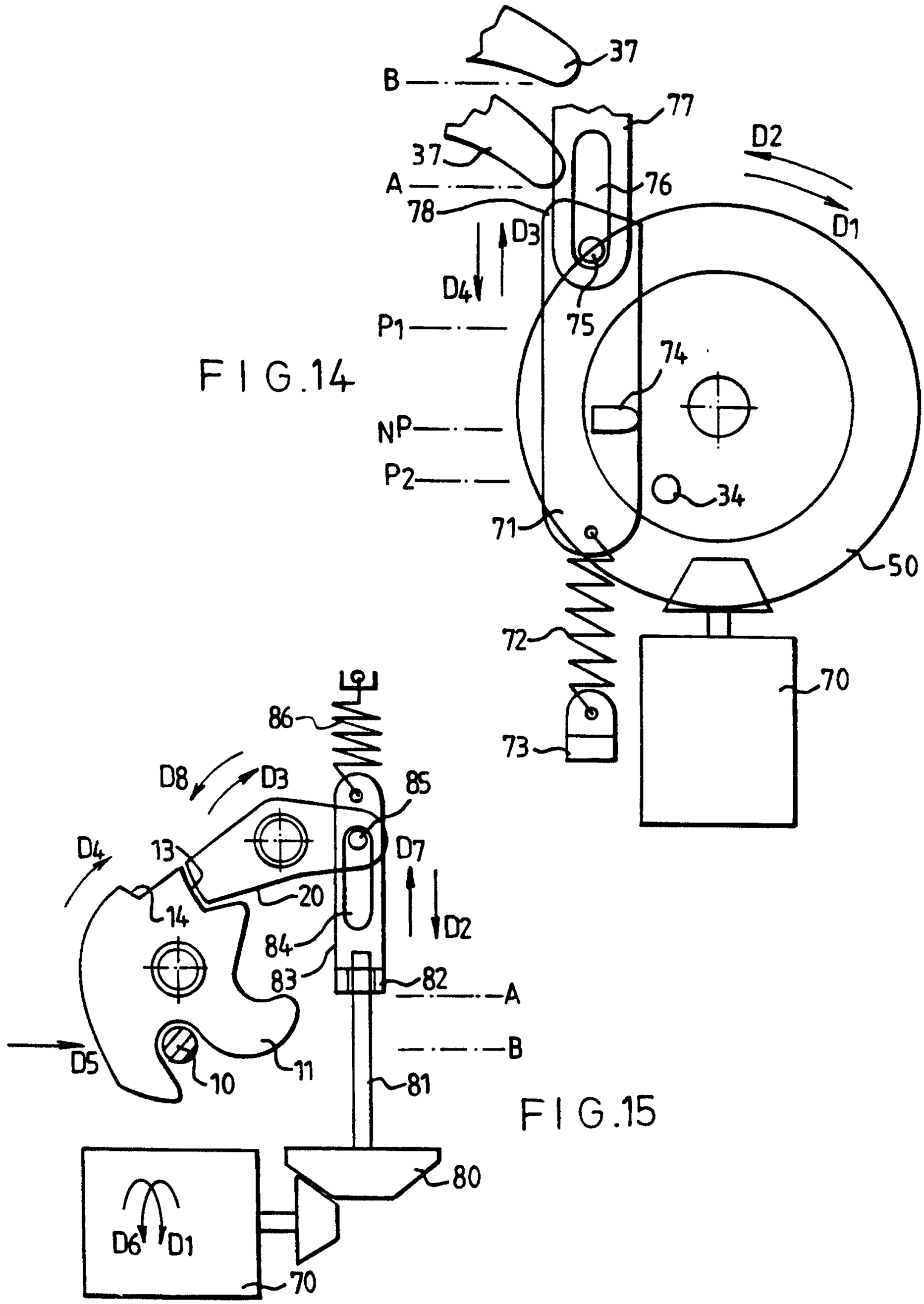

37
B
77
37
D2
A
76
78
D1
D3
D4
P1
75
74
NP
P2
34
71
50
72
70
73
86
D8
D3
85
D4
13
D7
20
14
D2
84
83
82
A
B
D5
10
11
81
80
D6
D1
70

FIG.14

FIG.15

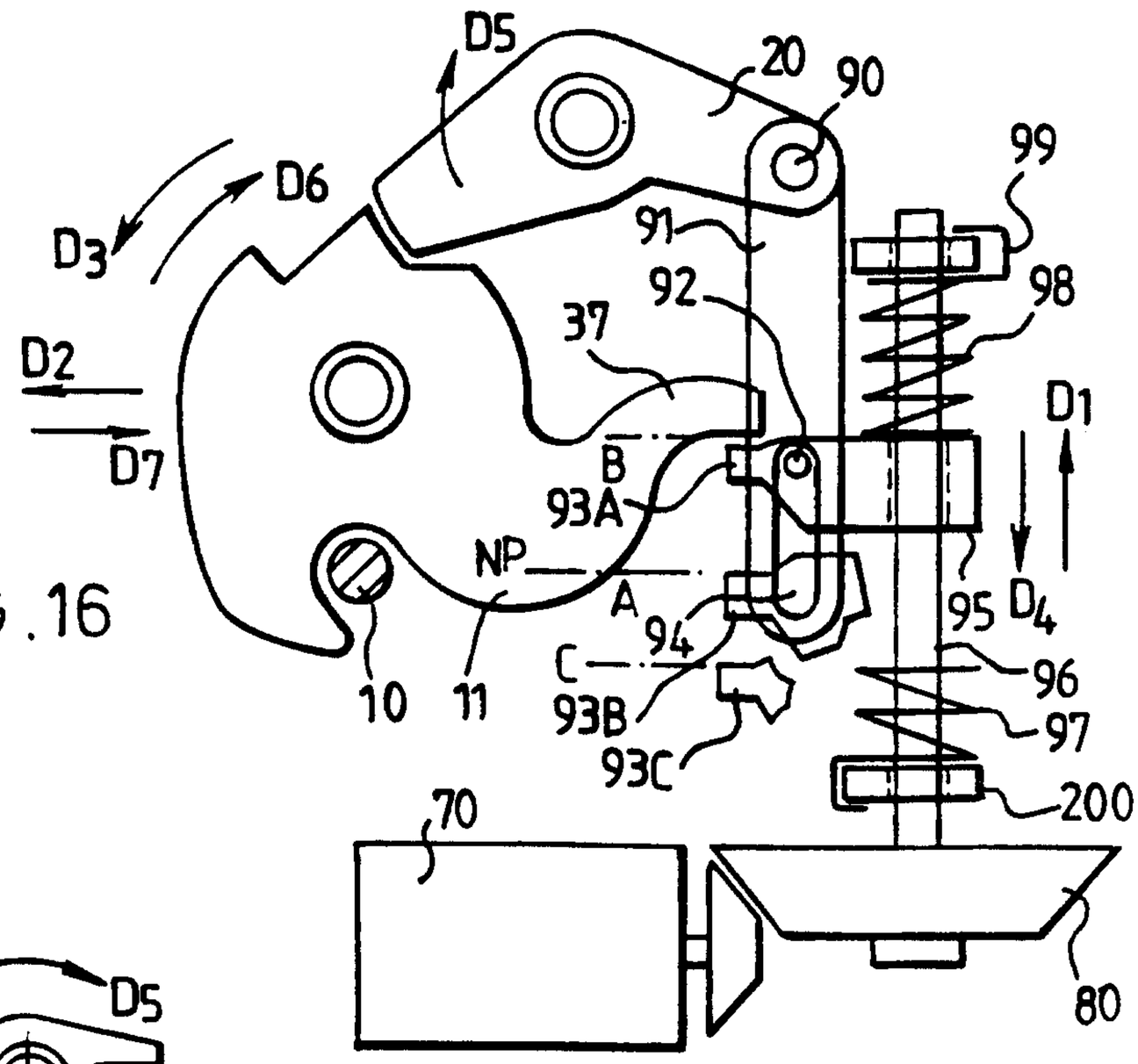

D5
20
90
99
D6
D3
91
92
98
37
D2
D7
B
93A
D1
NP
A
94
95
D4
C
96
93B
97
10
11
93C
200
70
80

FIG.16

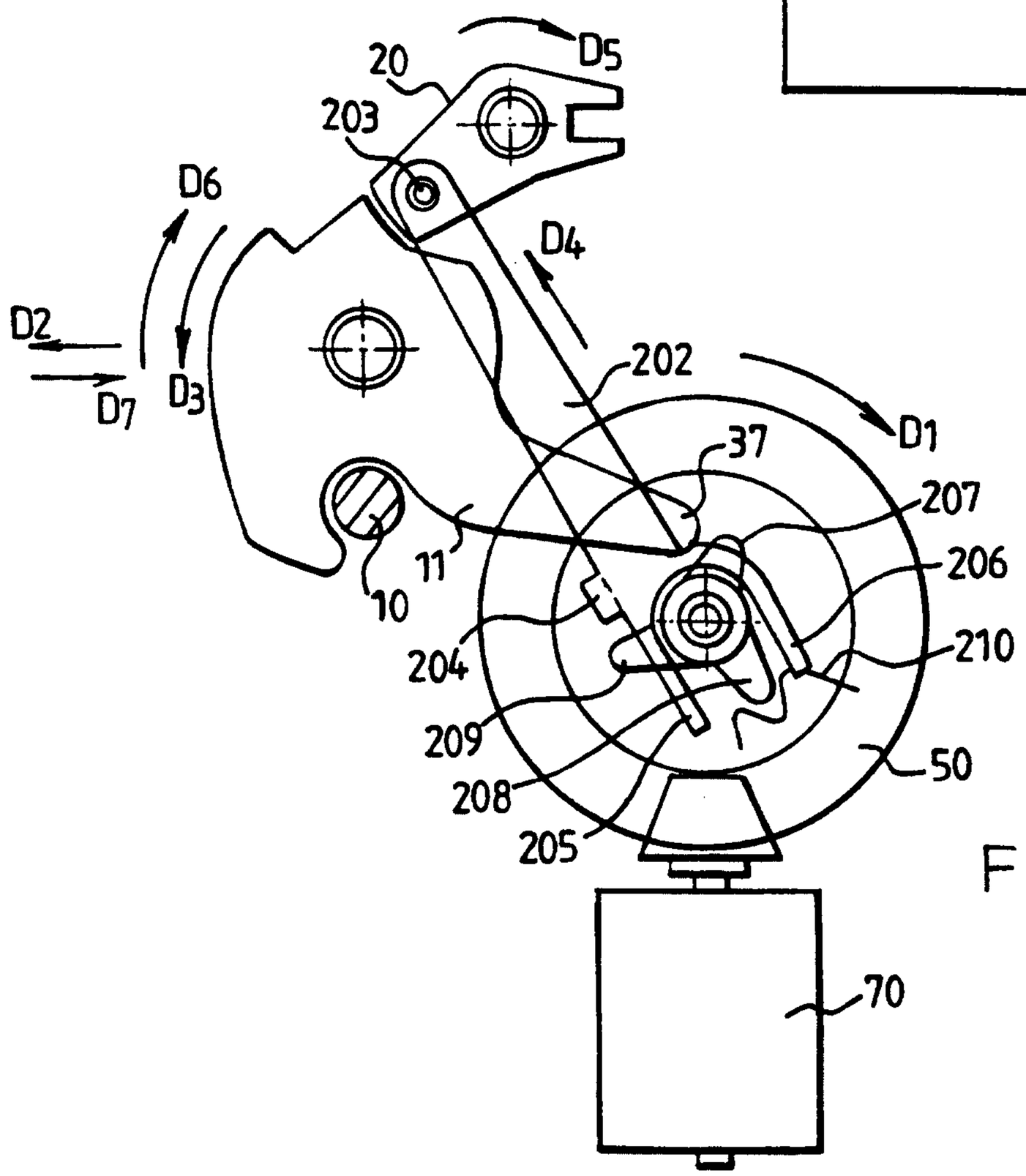

20
D5
203
D6
D4
D2
D7
D3
202
D1
37
207
11
206
10
204
210
209
208
50
205
70

FIG.17

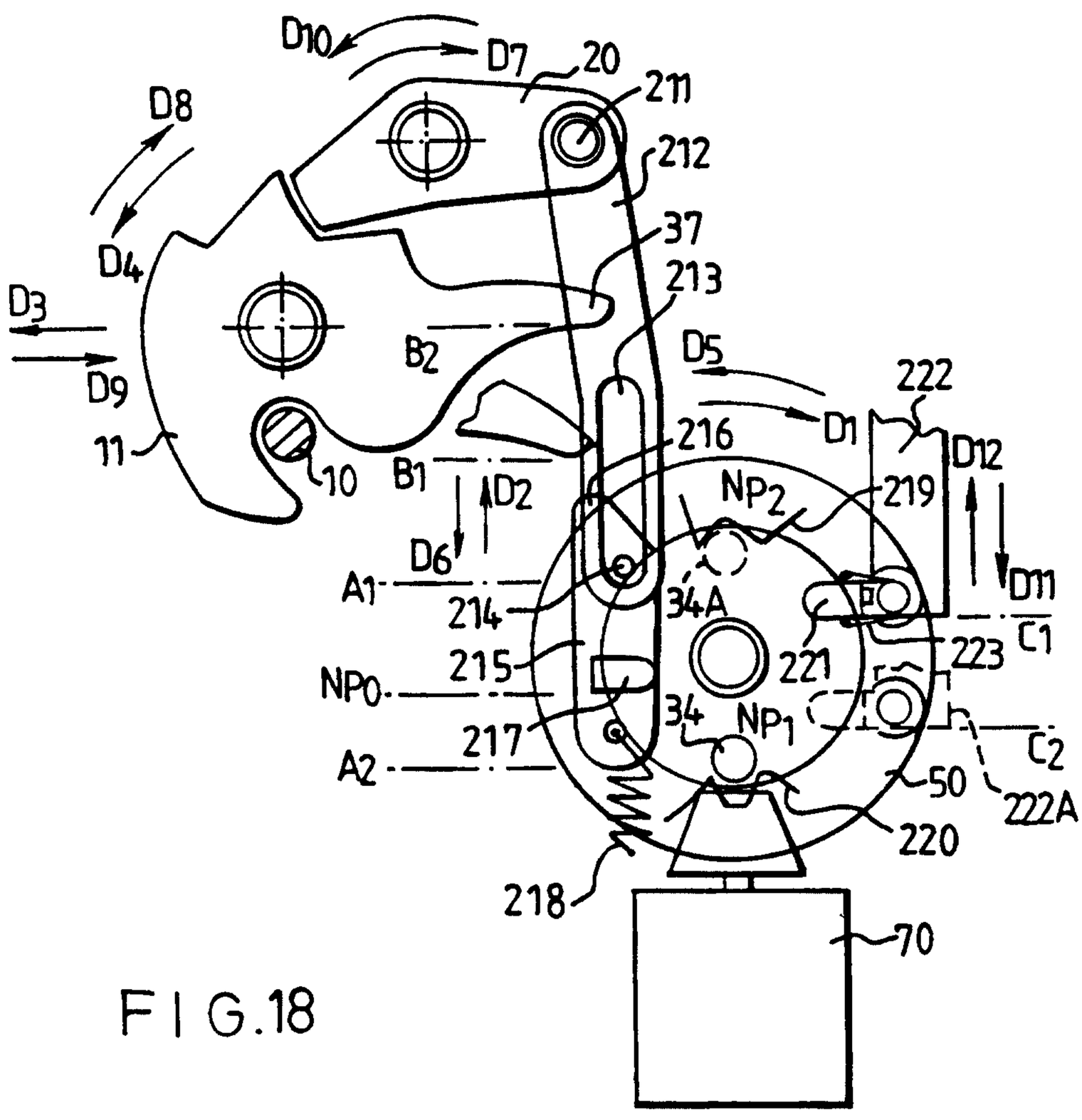

D10
D7
20
211
D8
212
D4
37
D3
213
B2
D5
D9
222
D1
216
11
10
B1
D2
NP2
219
D12
D6
A1
34A
D11
214
C1
215
221
223
NP0
34
NP1
217
C2
A2
50
222A
220
218
70

FIG.18

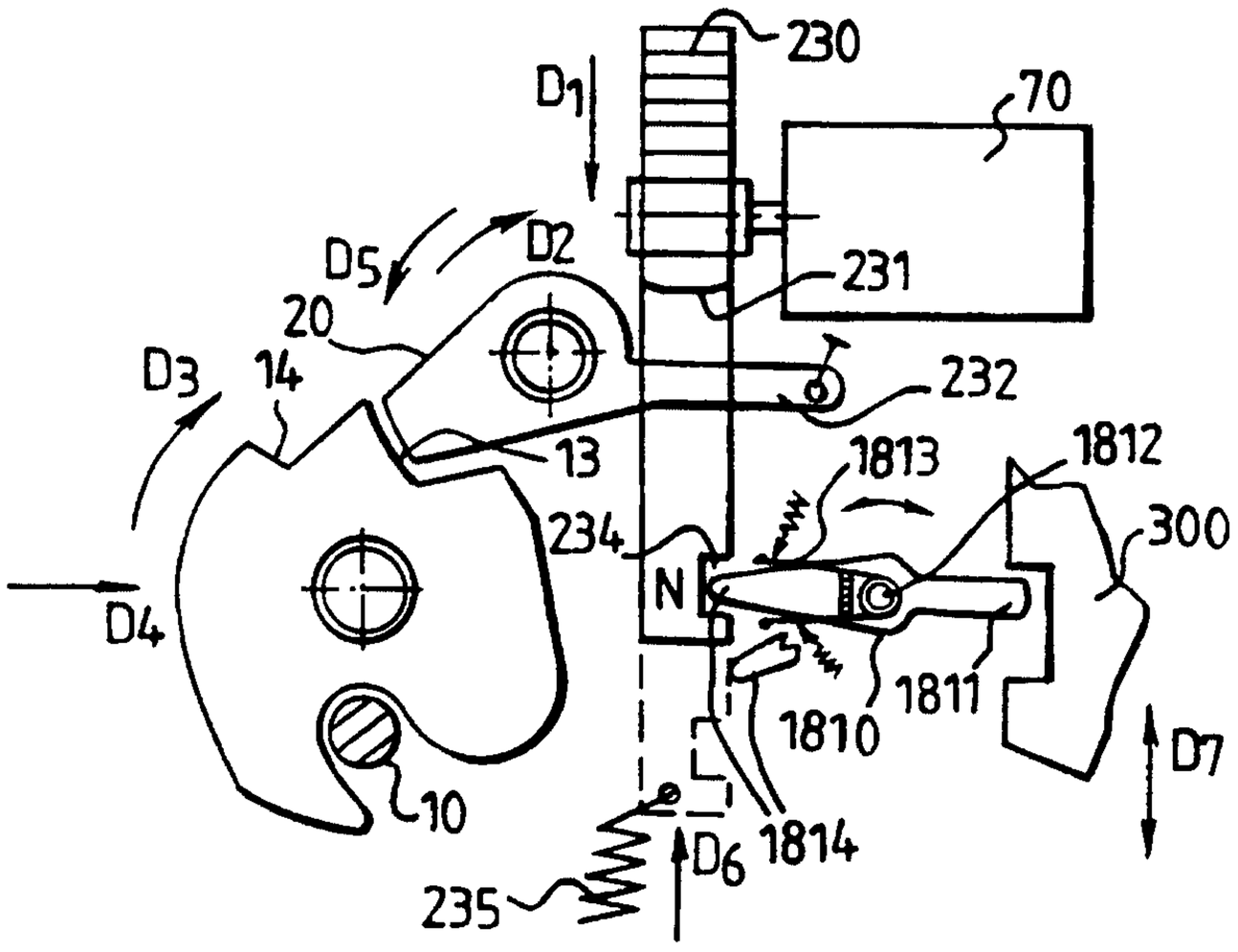


FIG.18A

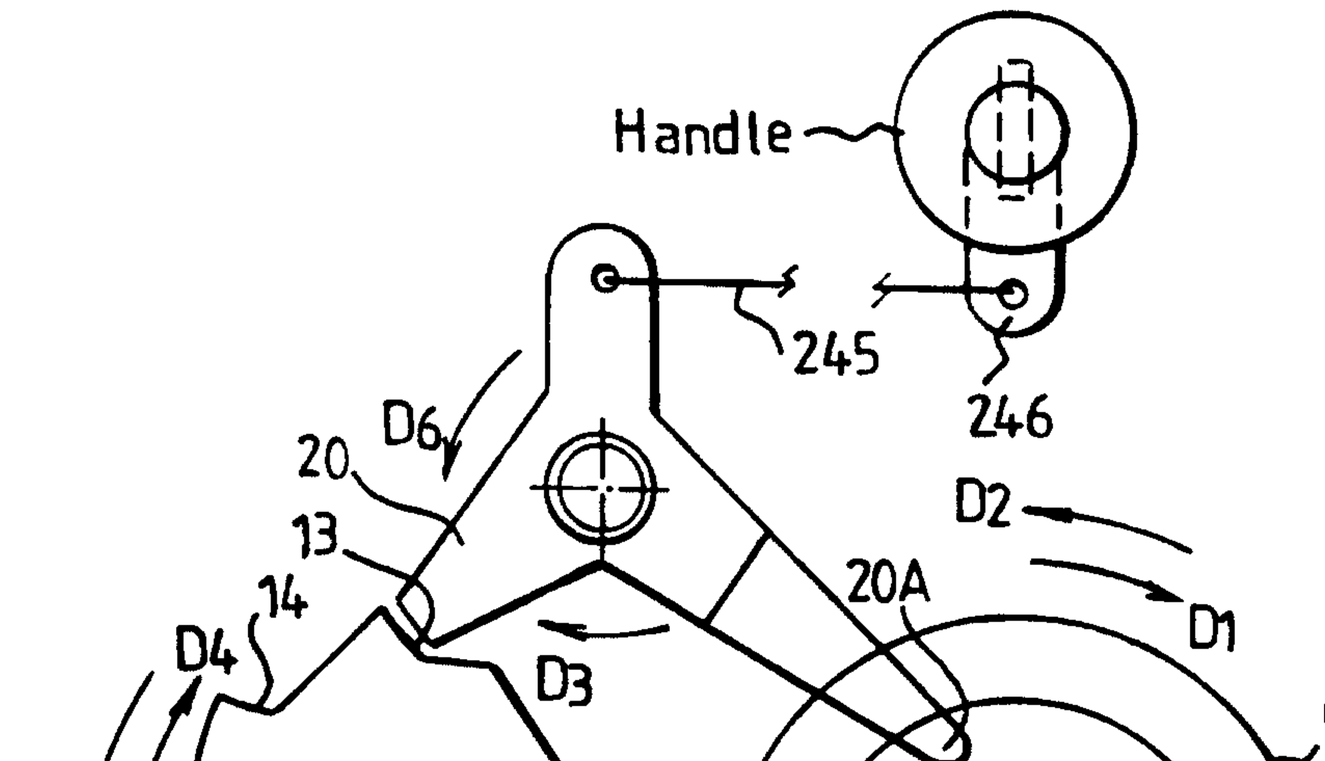


FIG.18B

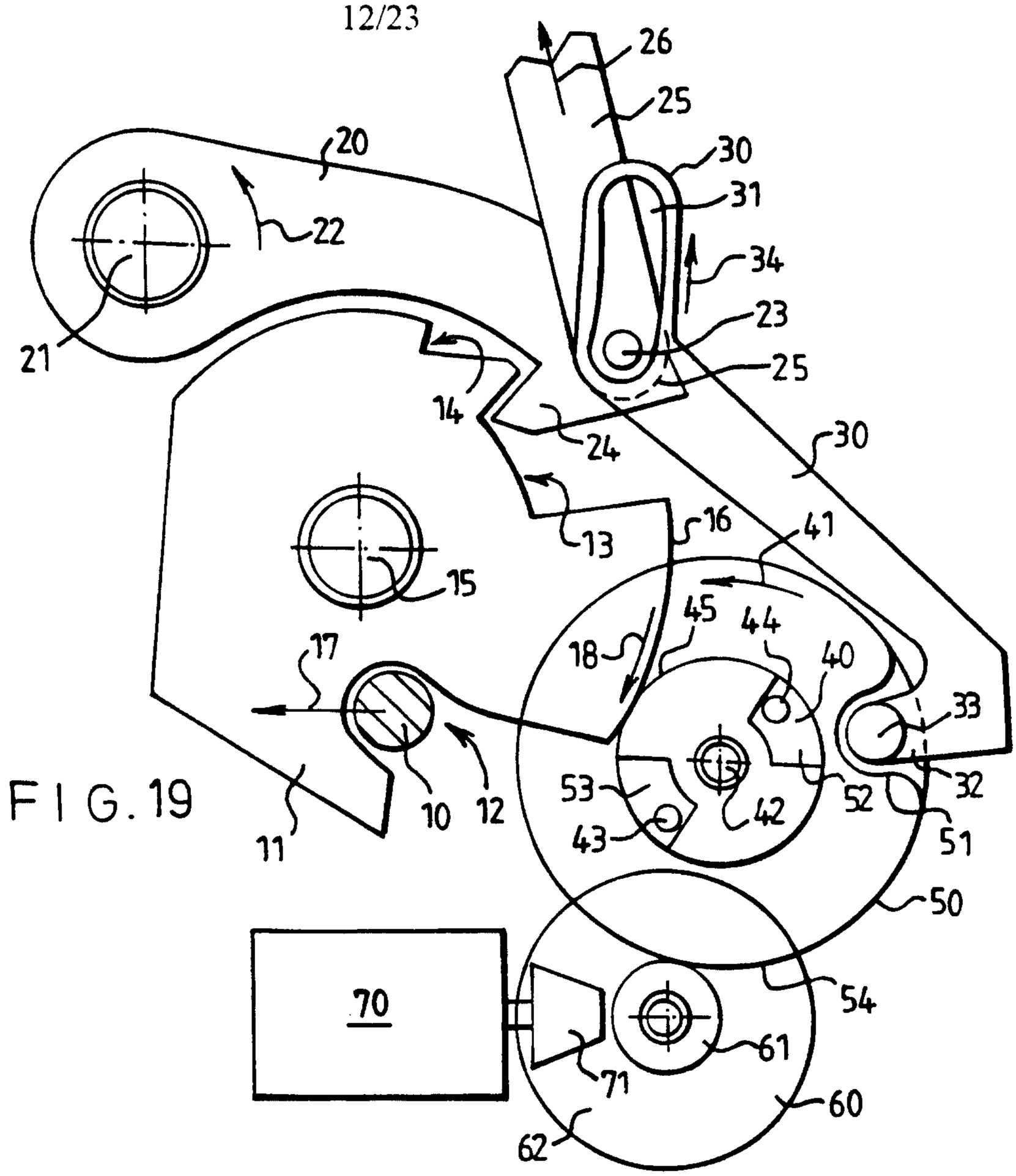


FIG.19

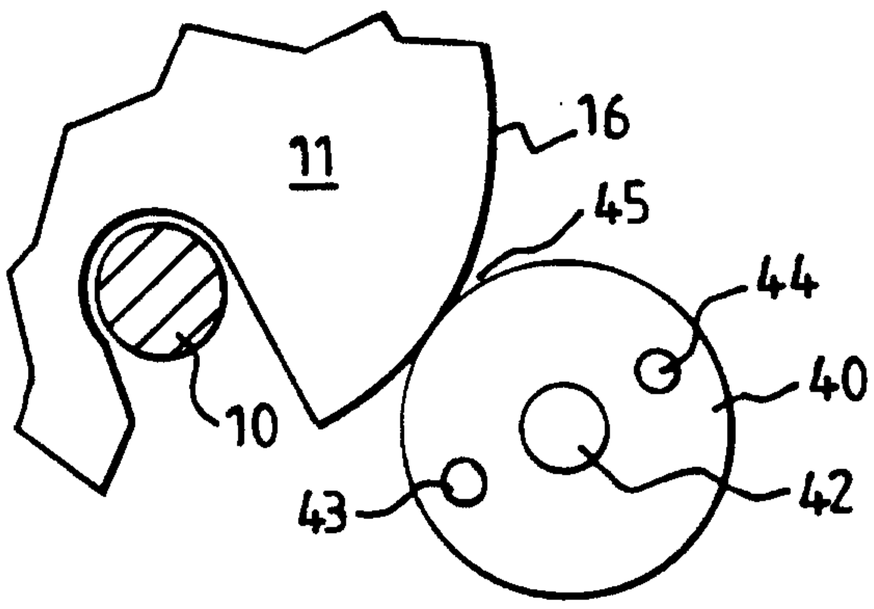


FIG.20

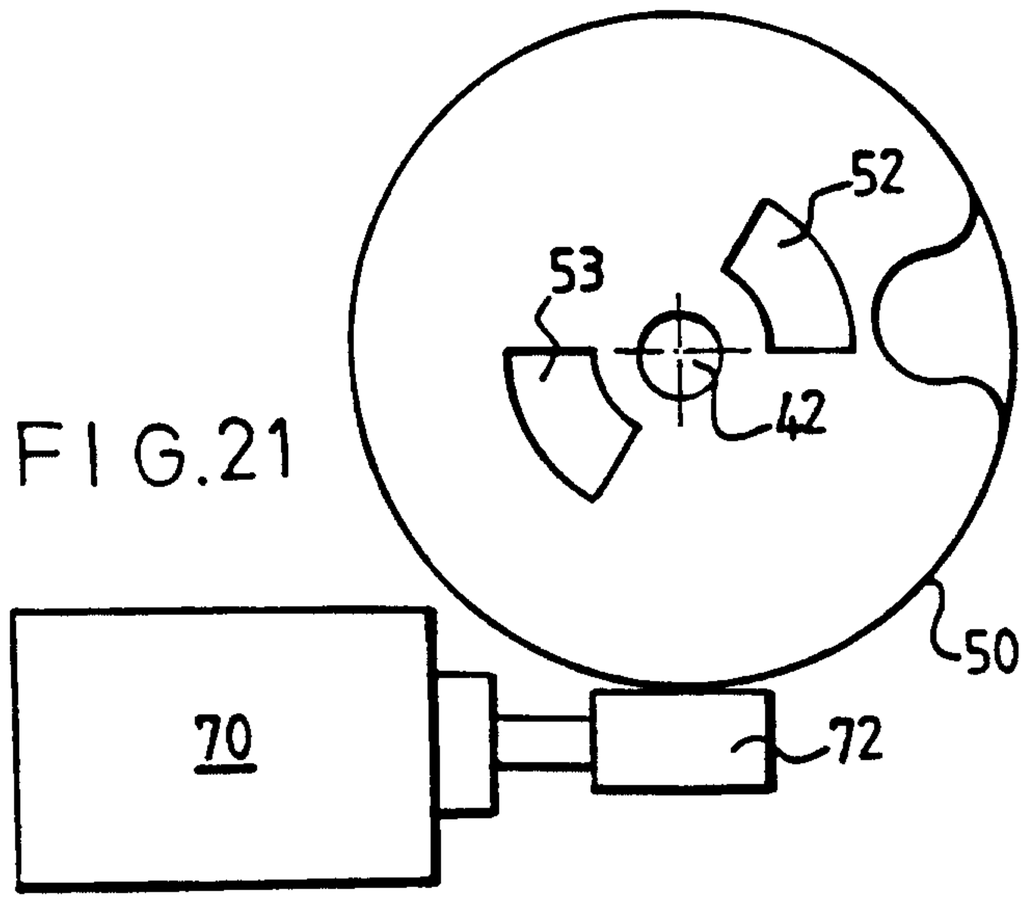


FIG.21

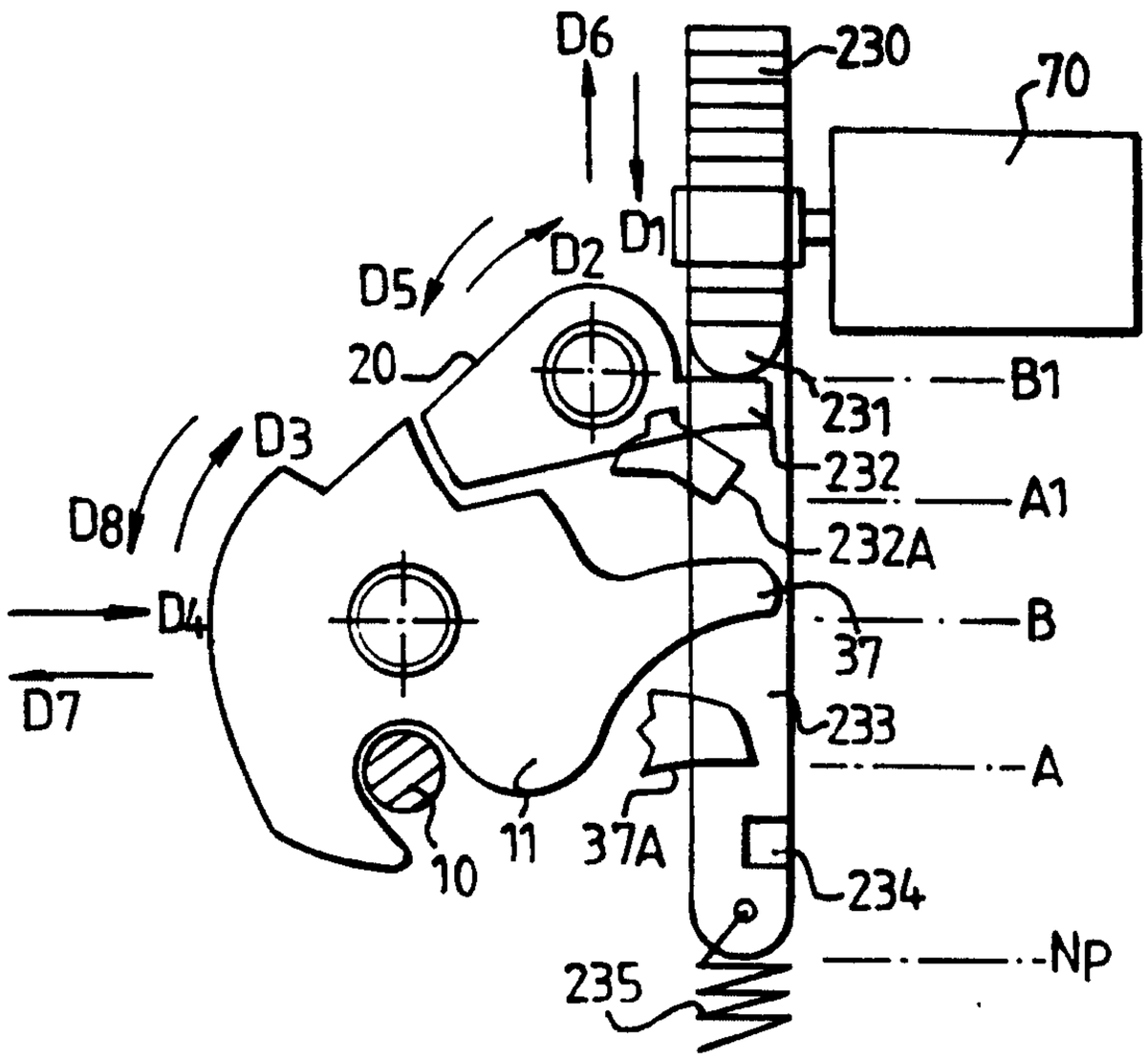

D6
230
70
D1
D5
D2
20
B1
231
D3
232
A1
D8
232A
D4
B
37
D7
233
A
11
37A
10
234
Np
235

FIG.22

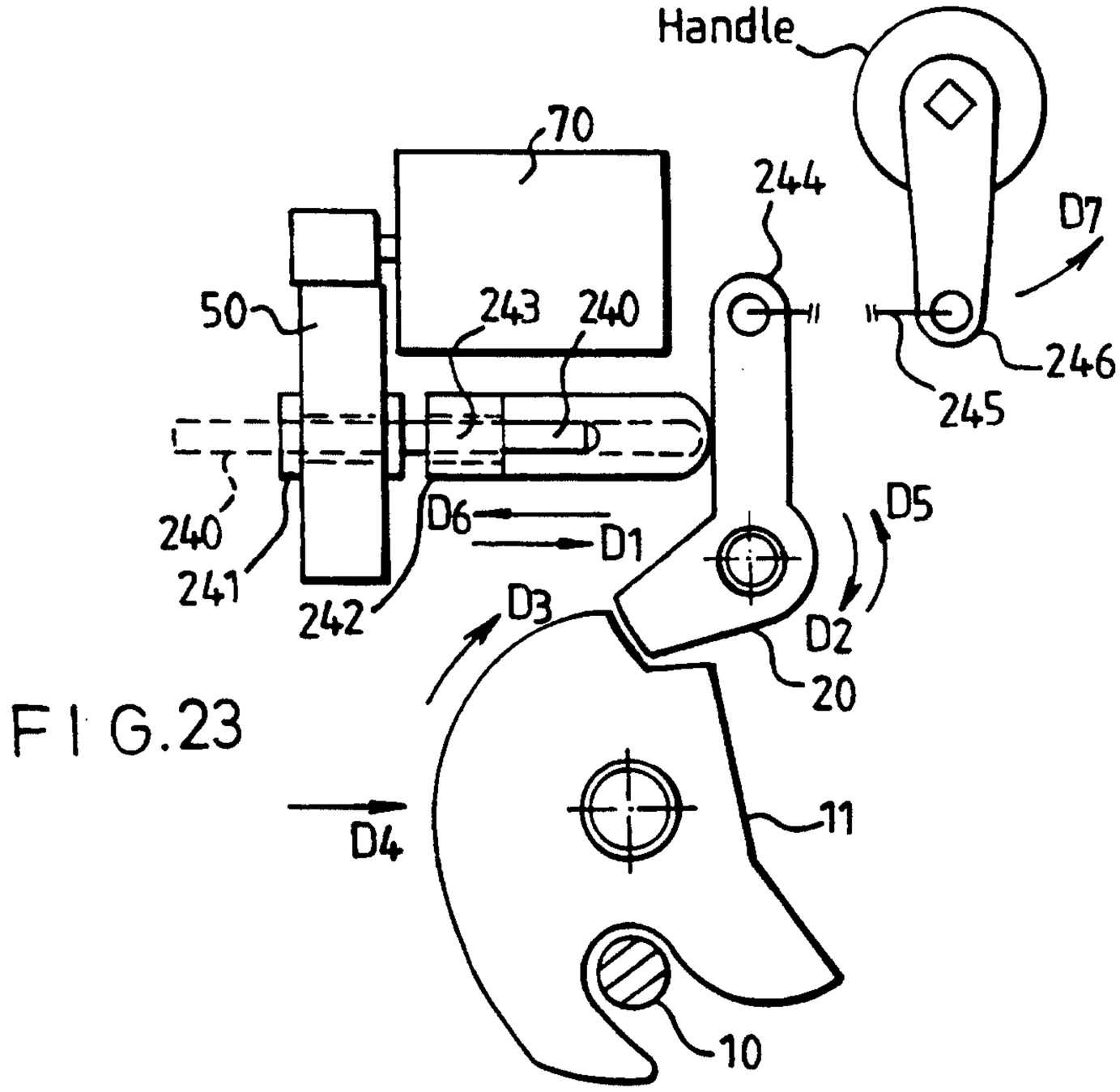

Handle
70
244
D7
50
243
240
246
245
240
241
D6
D1
D5
242
D3
D2
20
D4
11
10

FIG.23

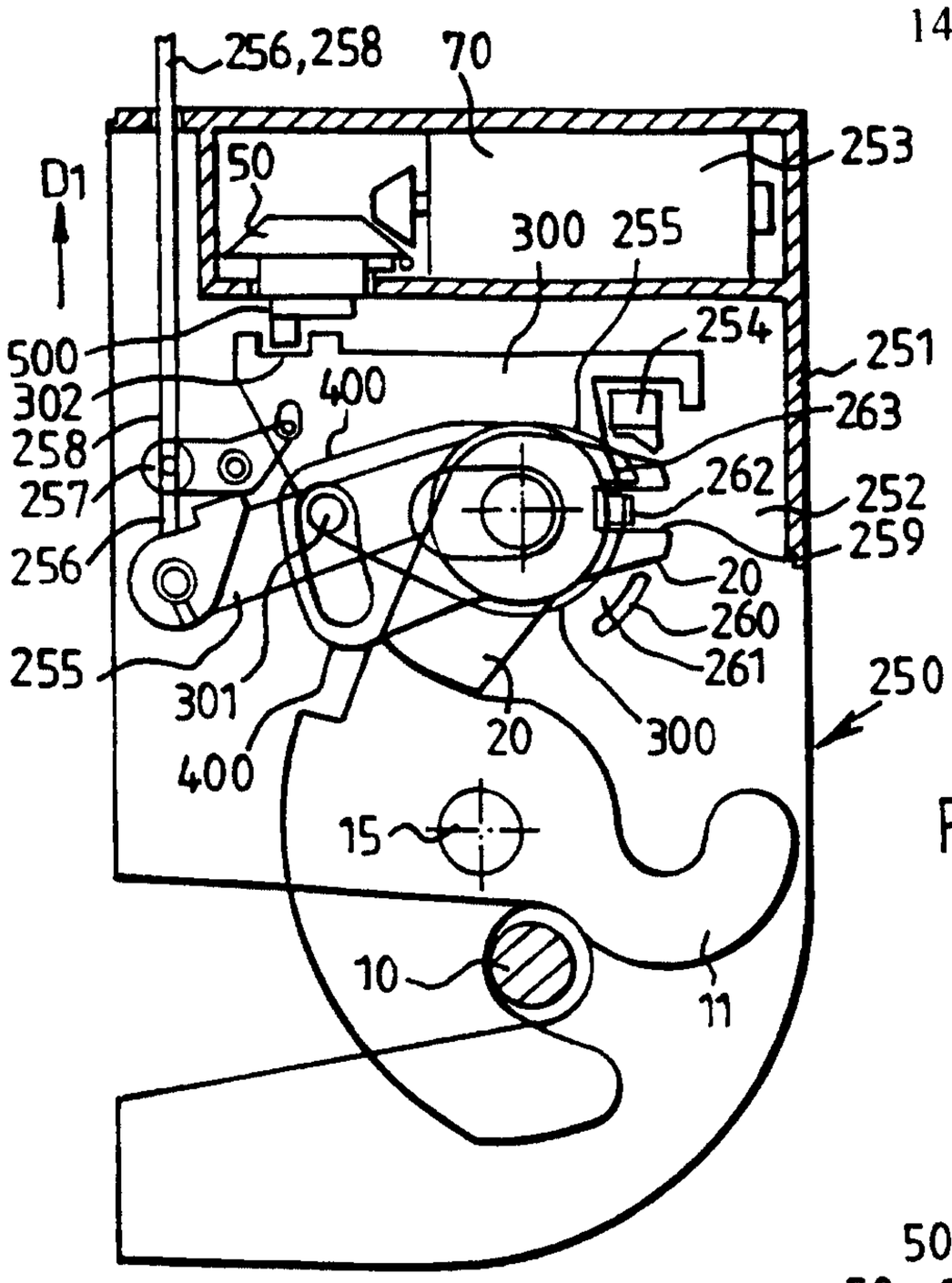

256,258
70
D1
50
253
300 255
500
254
251
302
400
263
258
262
257
252
256
259
20
260
255
261
250
301
300
20
400
15
10
11

FIG.24

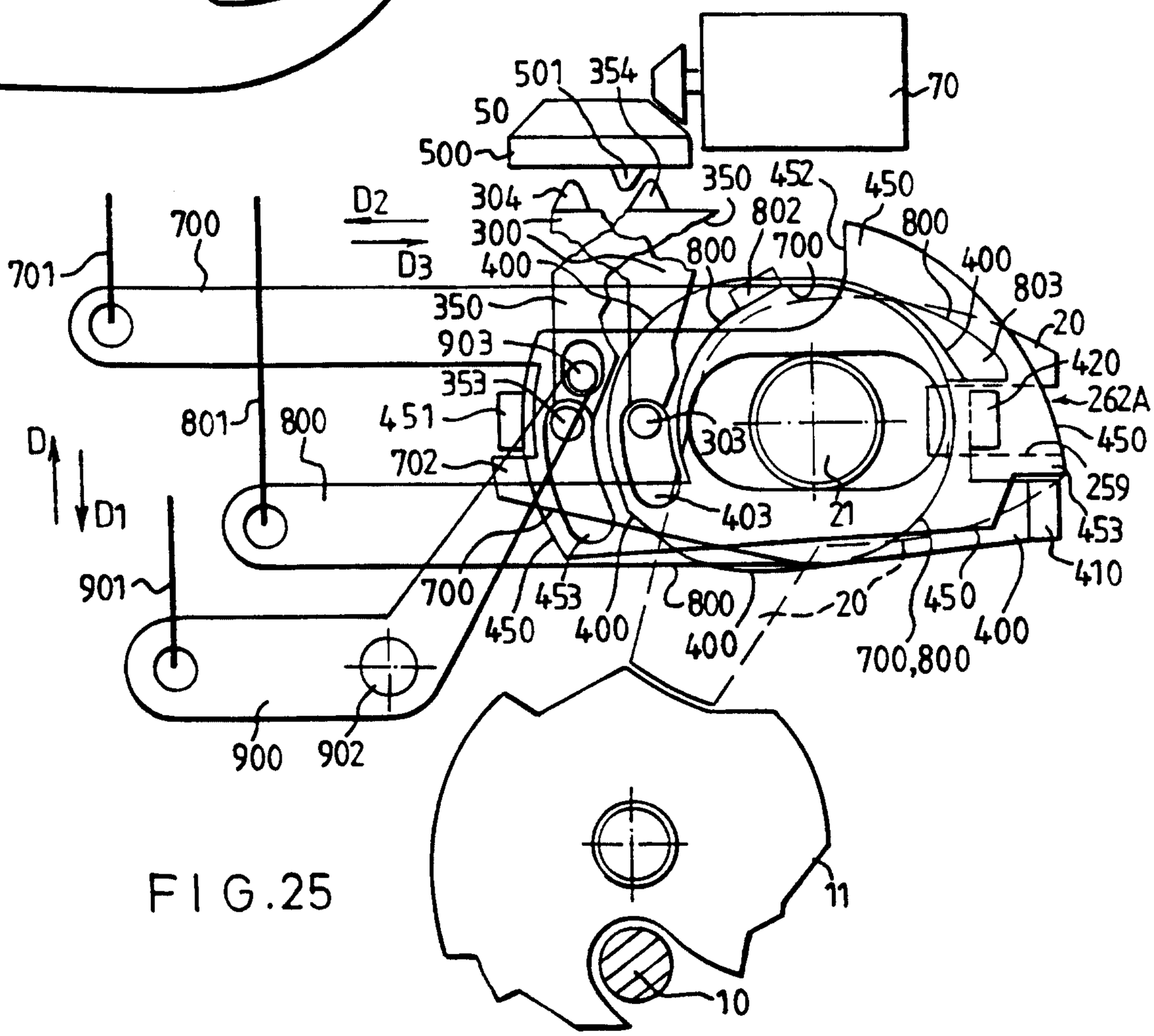

501 354
70
50
500
350 452
450
304
802
800
D2
300
700
800
400
803
700
D3
400
20
350
420
903
262A
353
450
801
800
451
303
D1
702
259
403
21
453
901
700
453
410
450
400
800
20
450
400
400
700,800
900
902
11
10

FIG.25

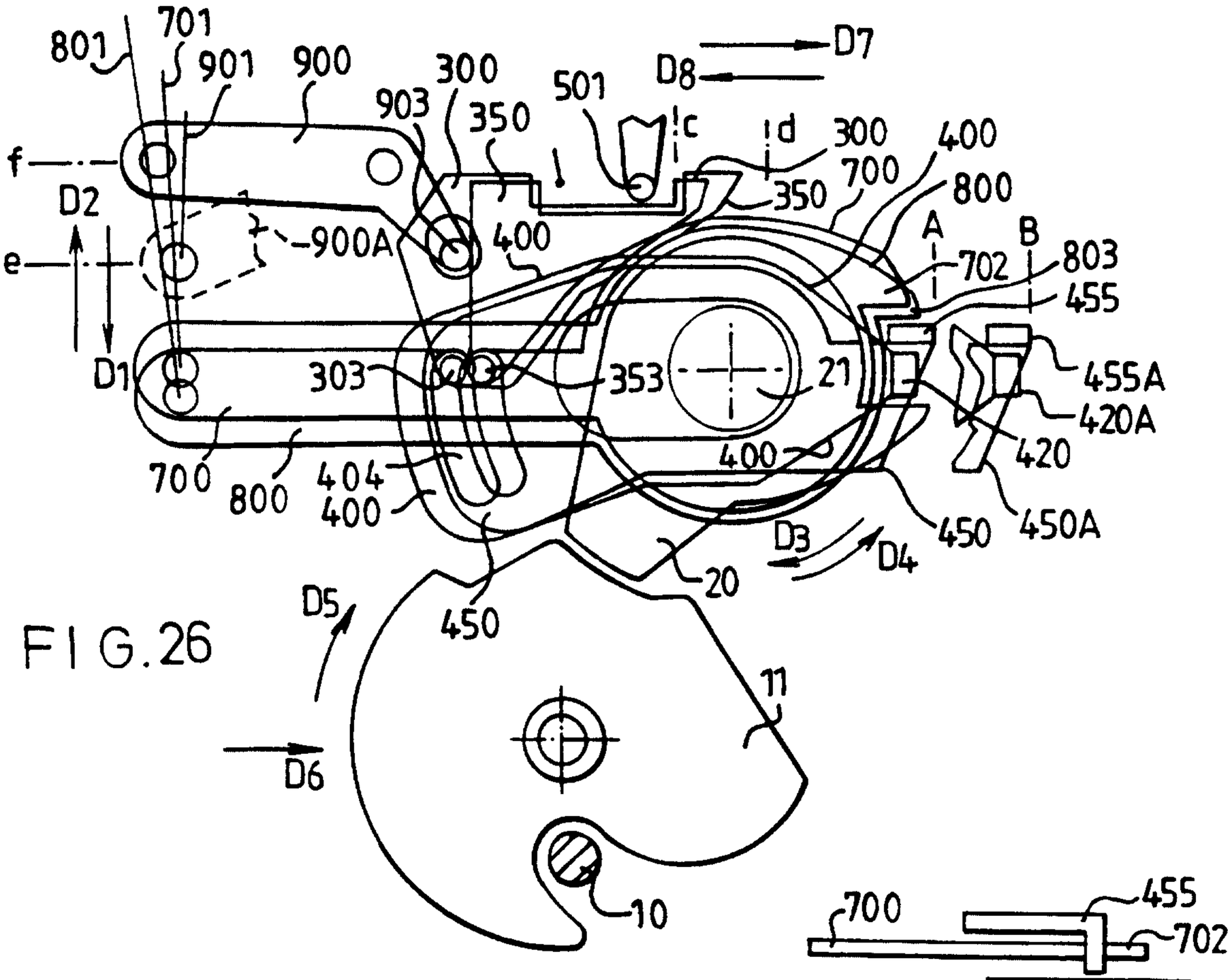


FIG.26

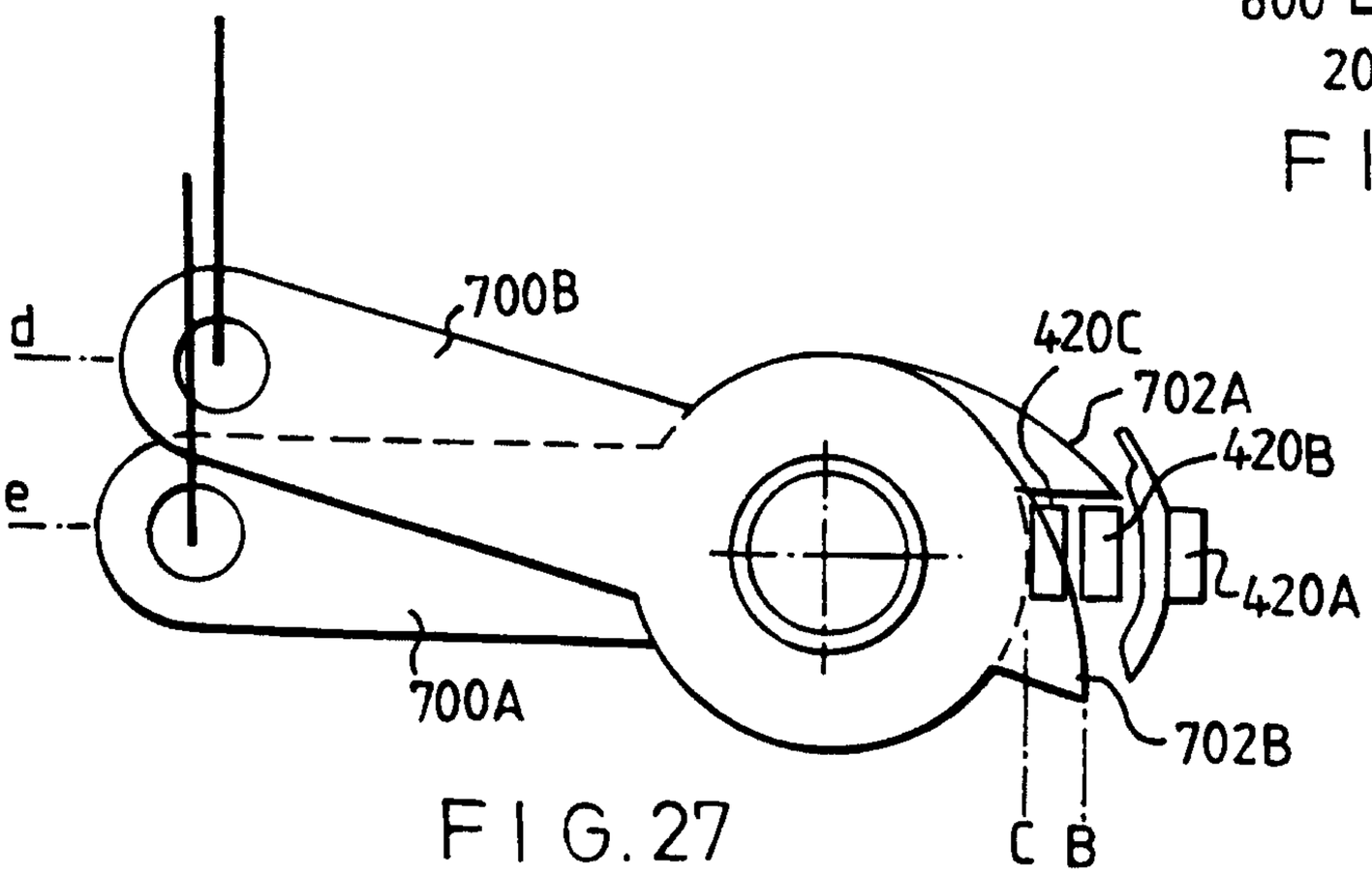


FIG.27

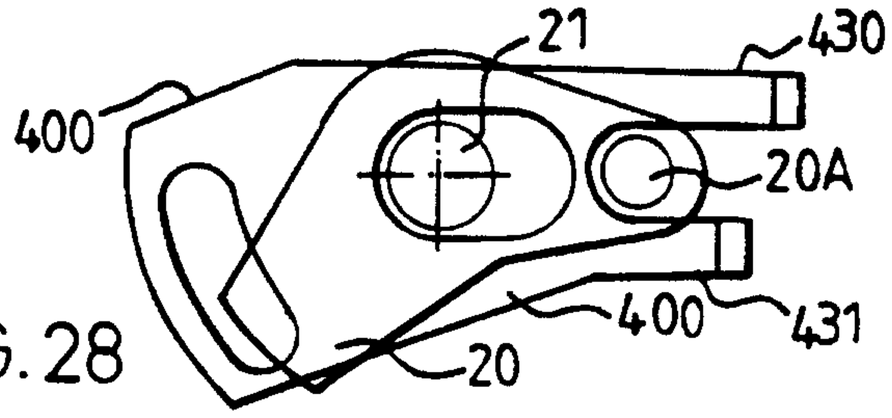


FIG.28

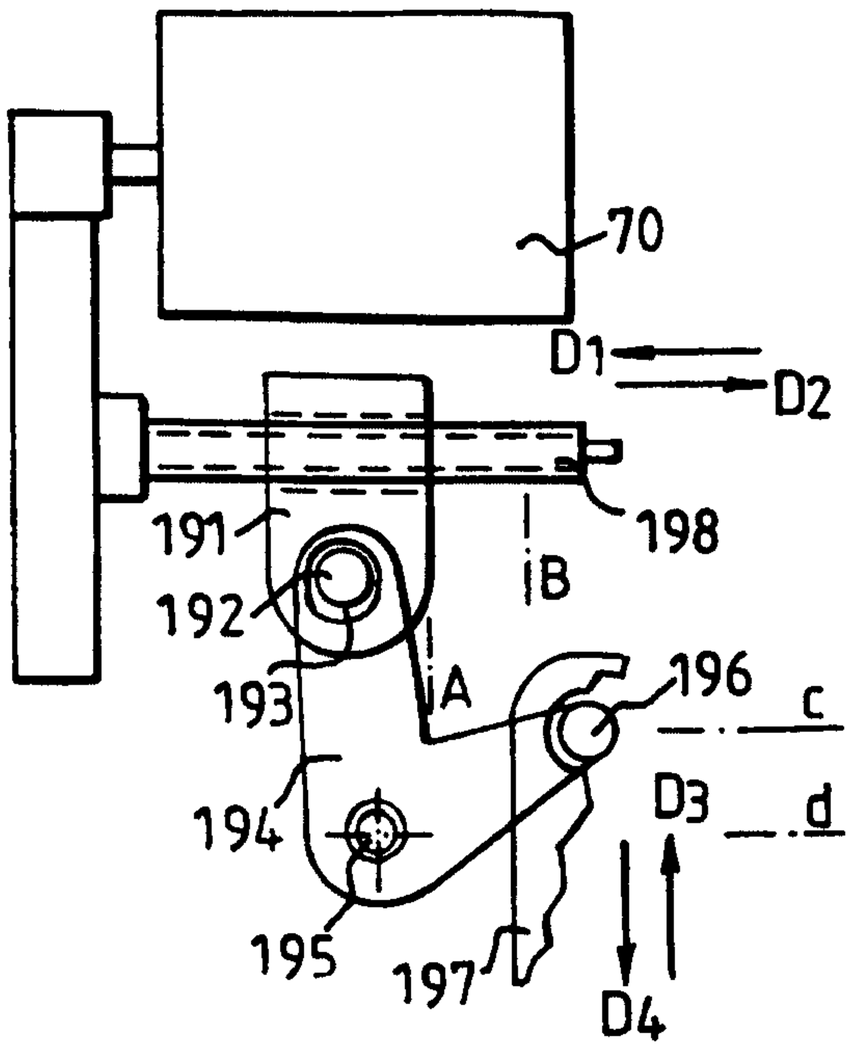

70
D1
D2
191
192
193
194
195
197
198
A
B
196
c
D3
d
D4

FIG.29

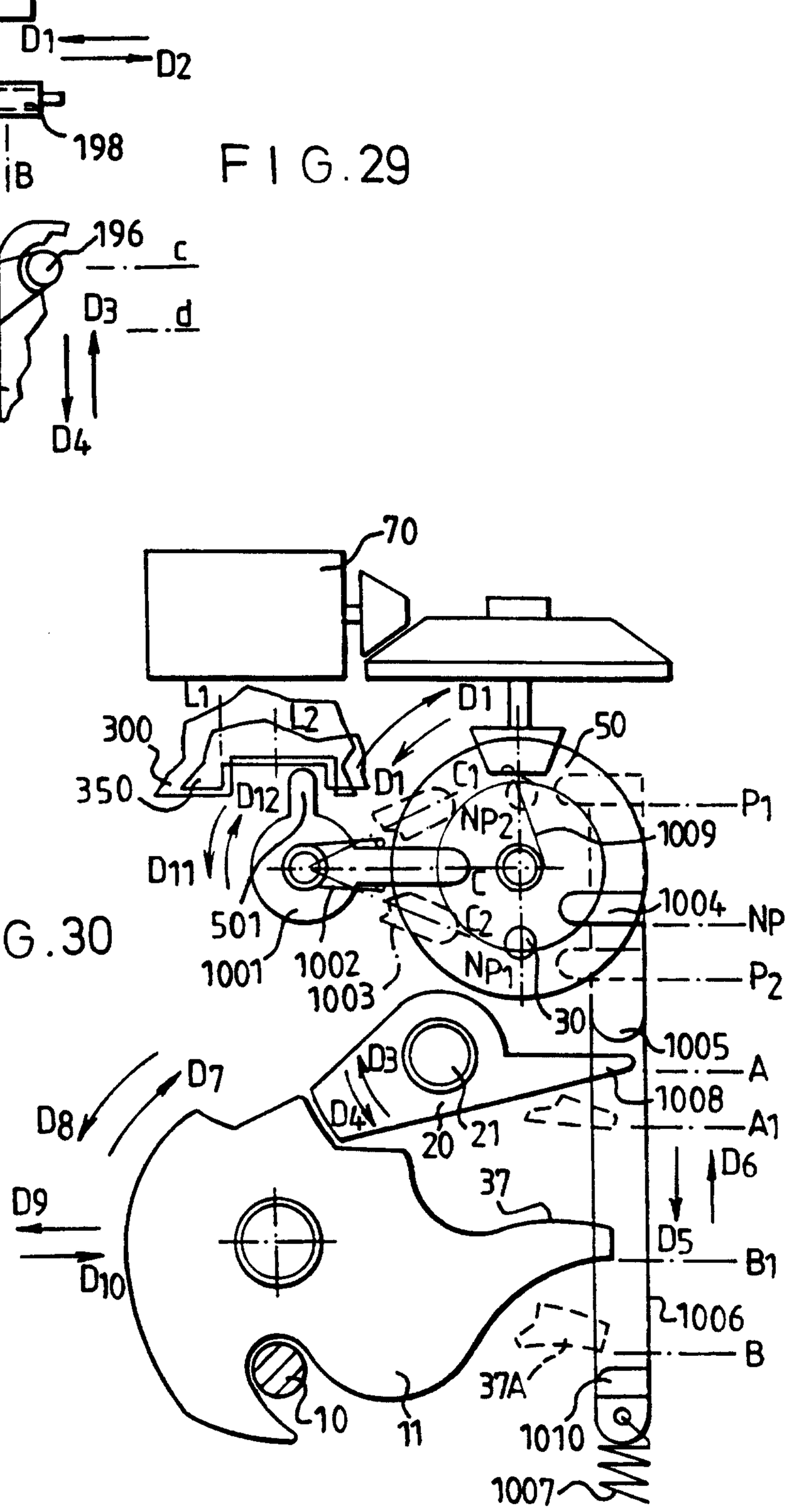

70
L1
L2
300
350
D1
D12
D11
501
1001
1002
1003
50
C1
NP2
C
C2
NP1
P1
1009
1004
NP
P2
30
1005
A
1008
A1
D3
D4
20
21
37
D6
D5
B1
1006
B
37A
1010
1007
D7
D8
D9
D10
10
11

FIG.30

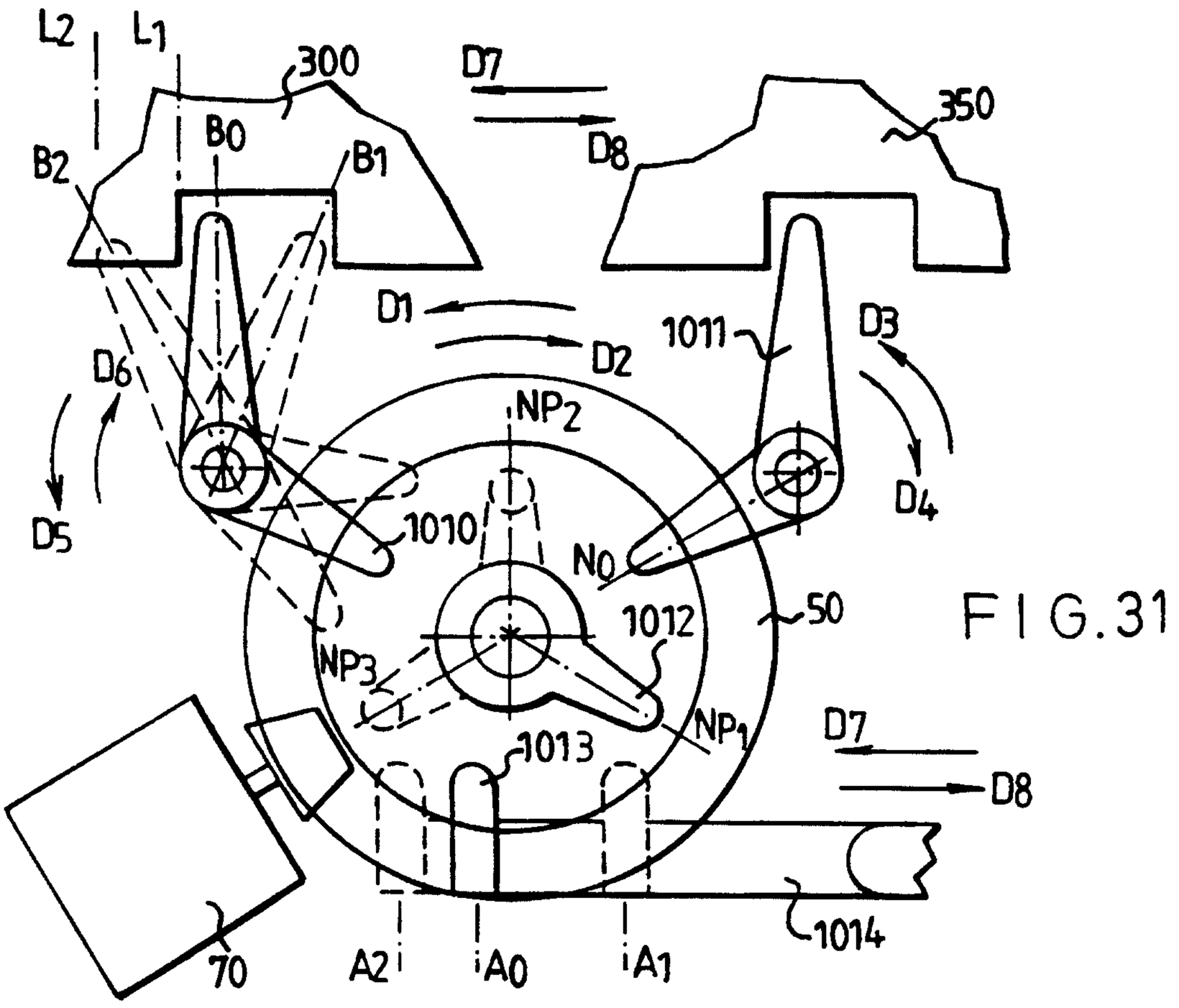

L2
L1
300
B0
B2
B1
D7
D8
350
D1
D2
1011
D3
D6
NP2
D4
D5
1010
N0
50
1012
NP3
NP1
D7
1013
D8
70
A2
A0
A1
1014

FIG.31

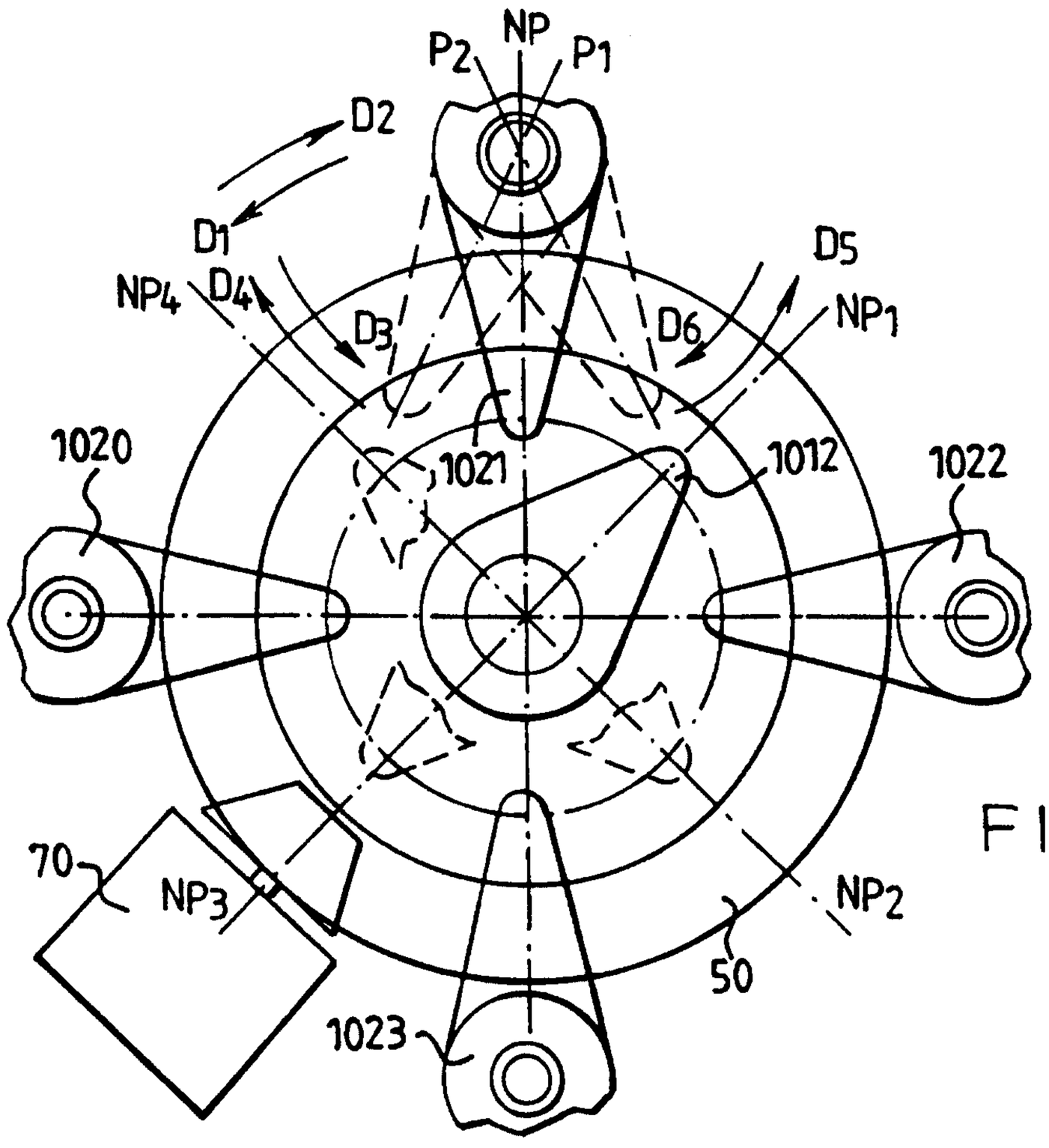
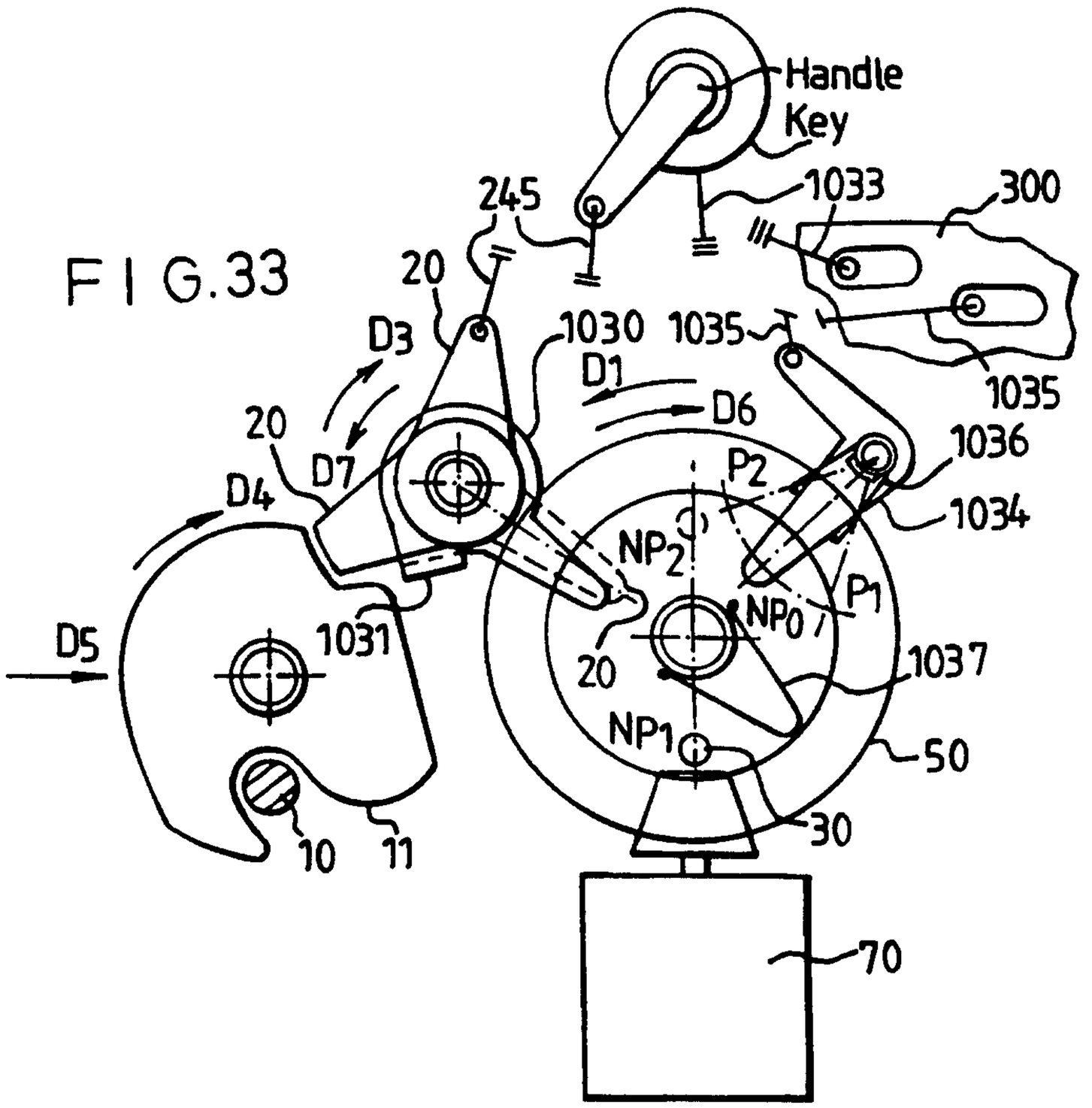

NP
P2
P1
D2
D1
D5
NP4
D4
D3
D6
NP1
1020
1021
1012
1022
70
NP3
NP2
50
1023

FIG.32

FIG.33



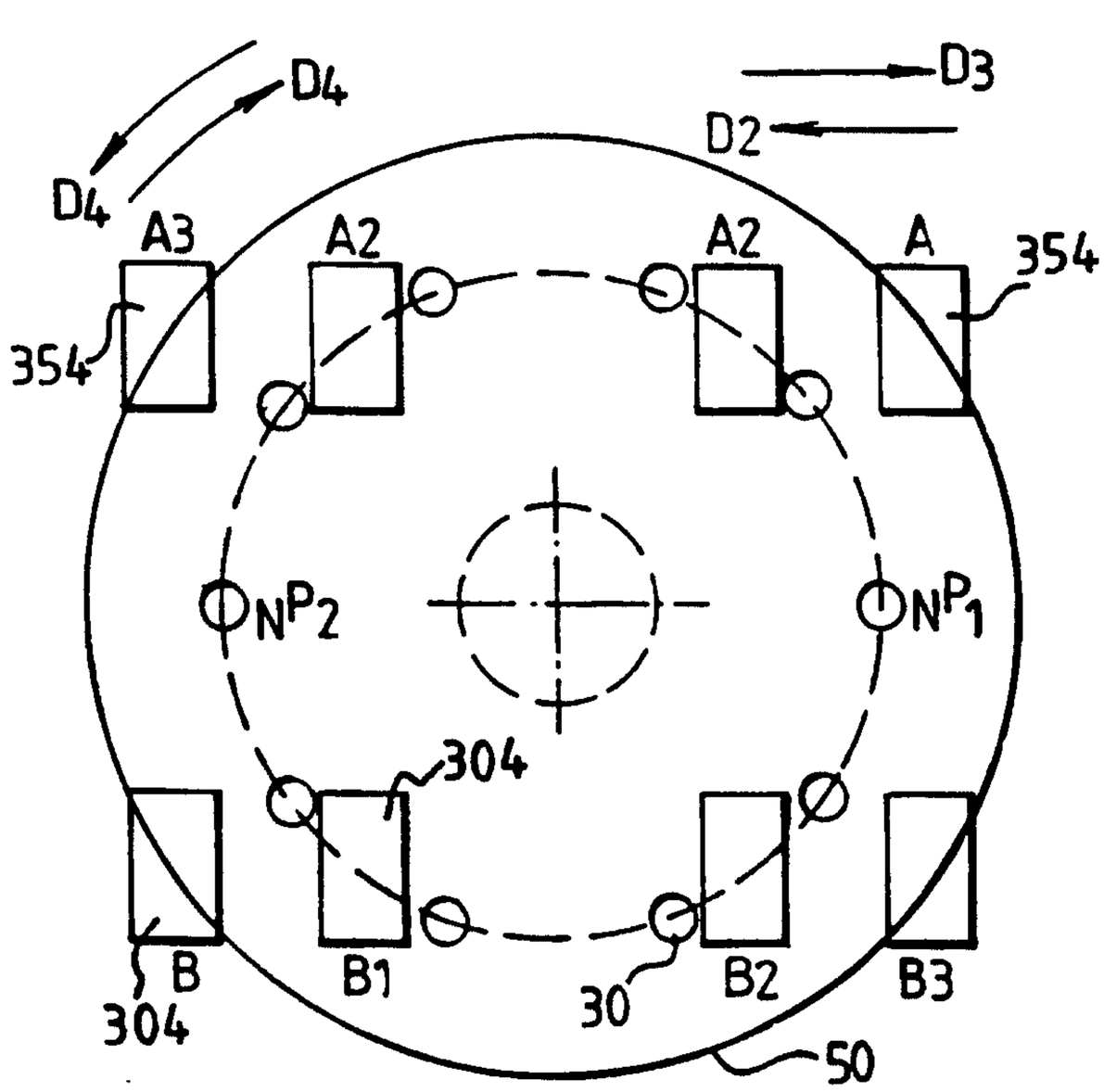


FIG 34

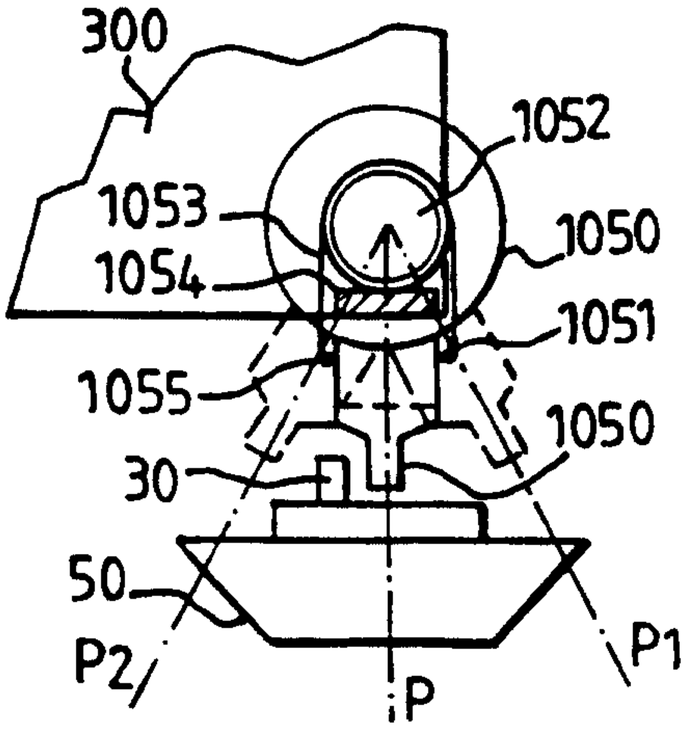


FIG.35

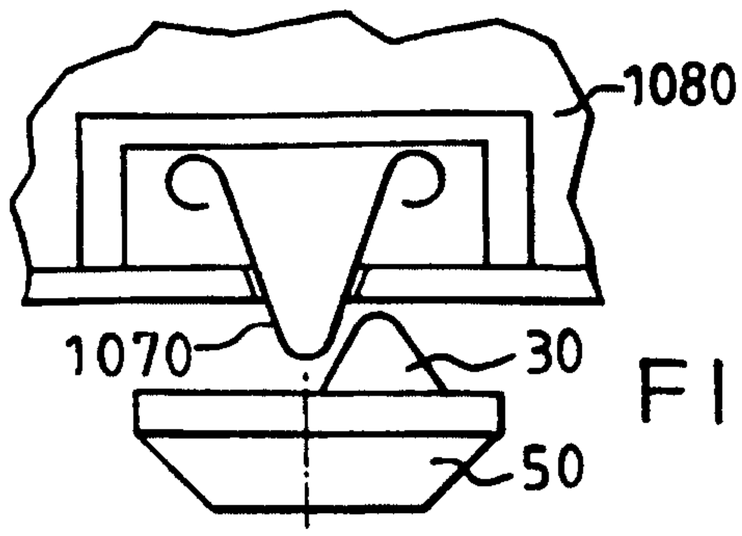


FIG.36

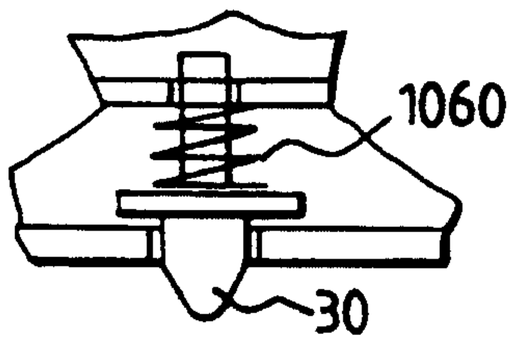


FIG.37

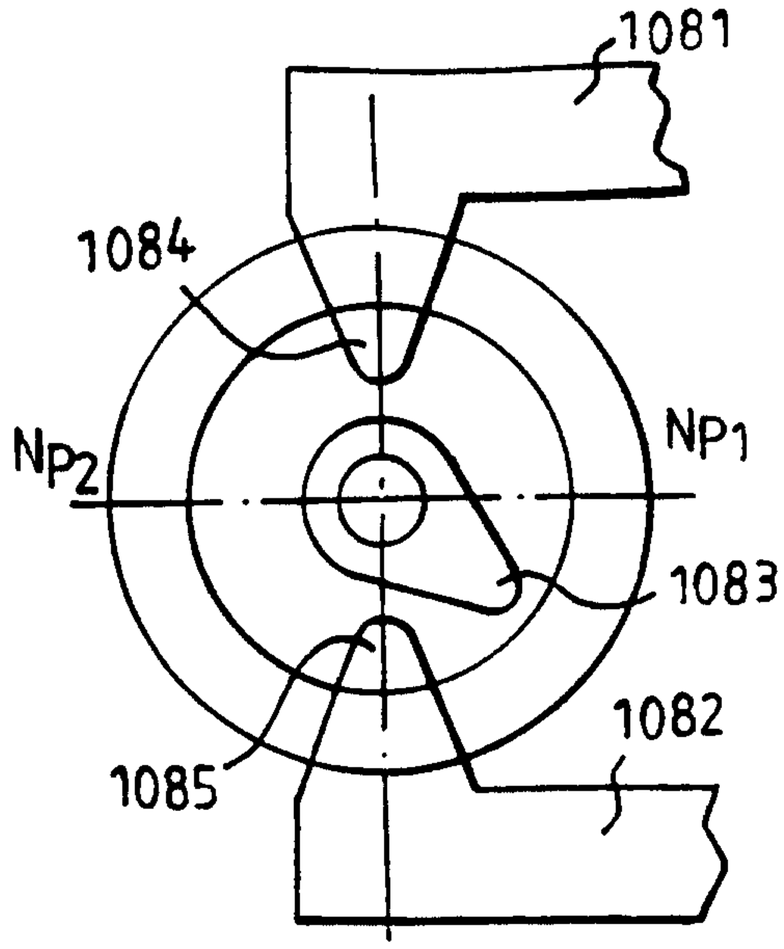


FIG.38

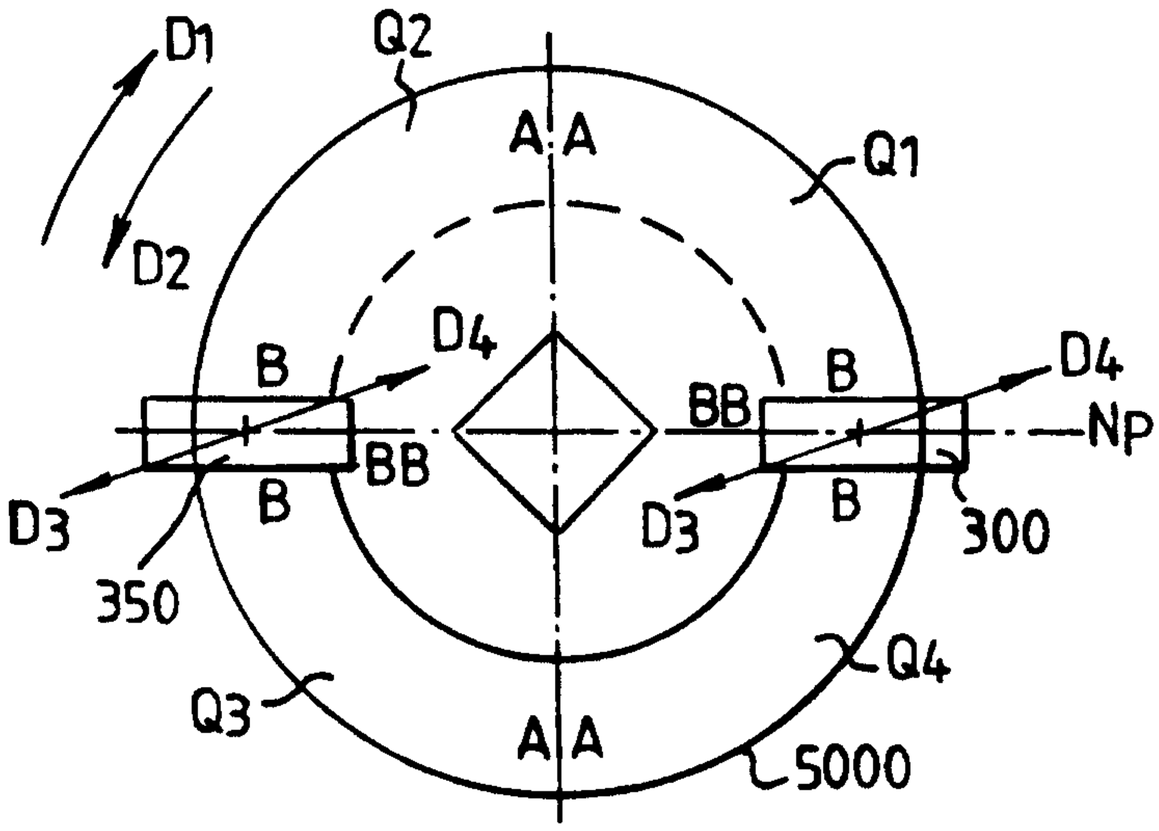


FIG.39

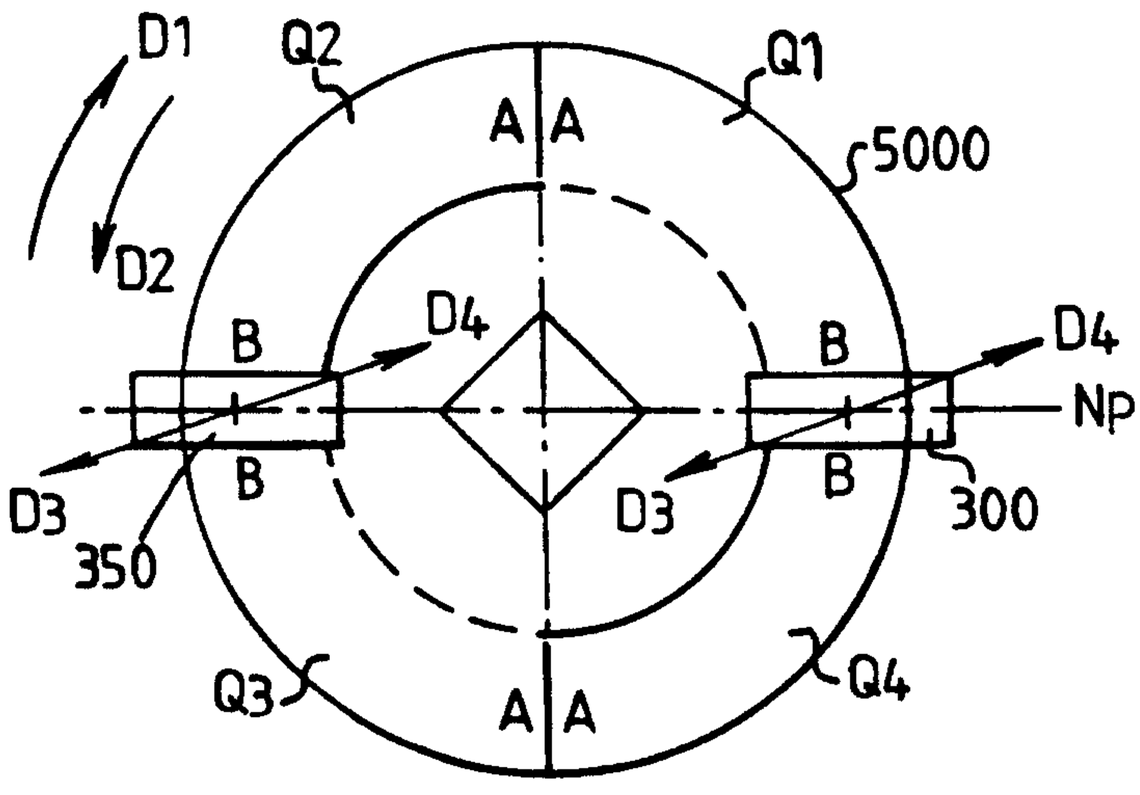


FIG.40

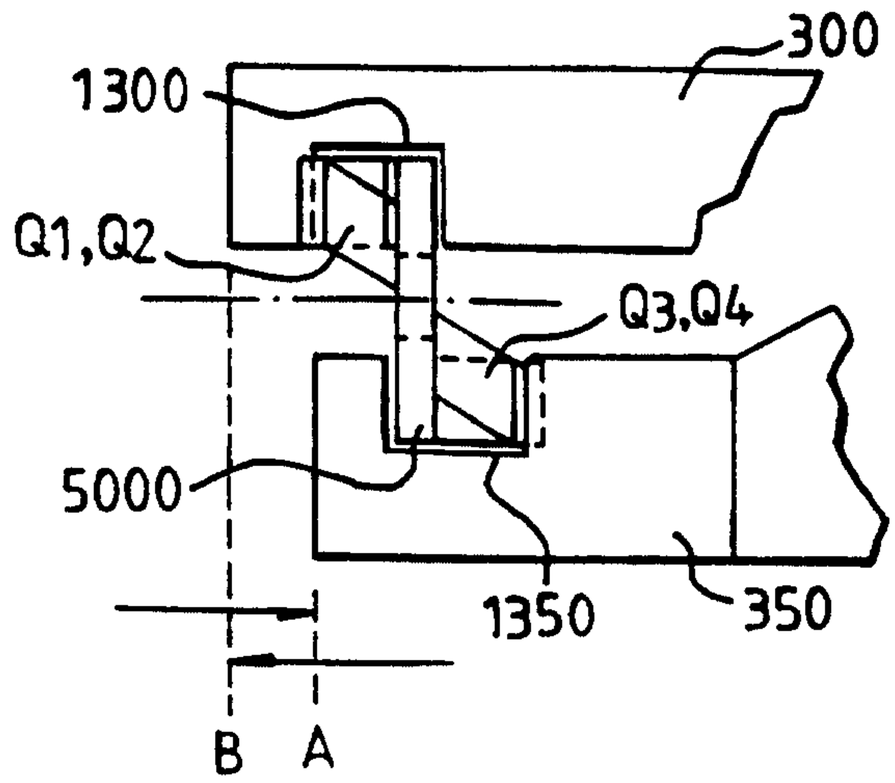


FIG.41

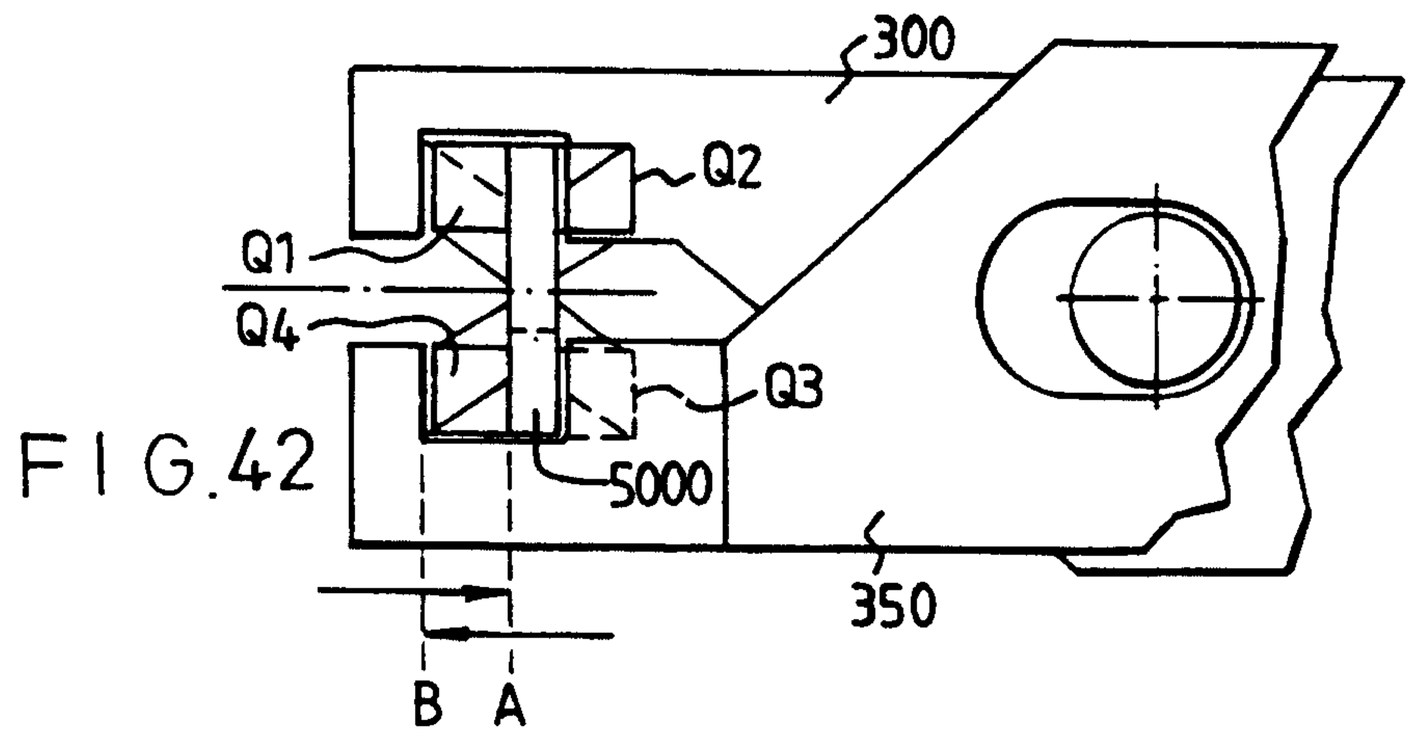


FIG.42

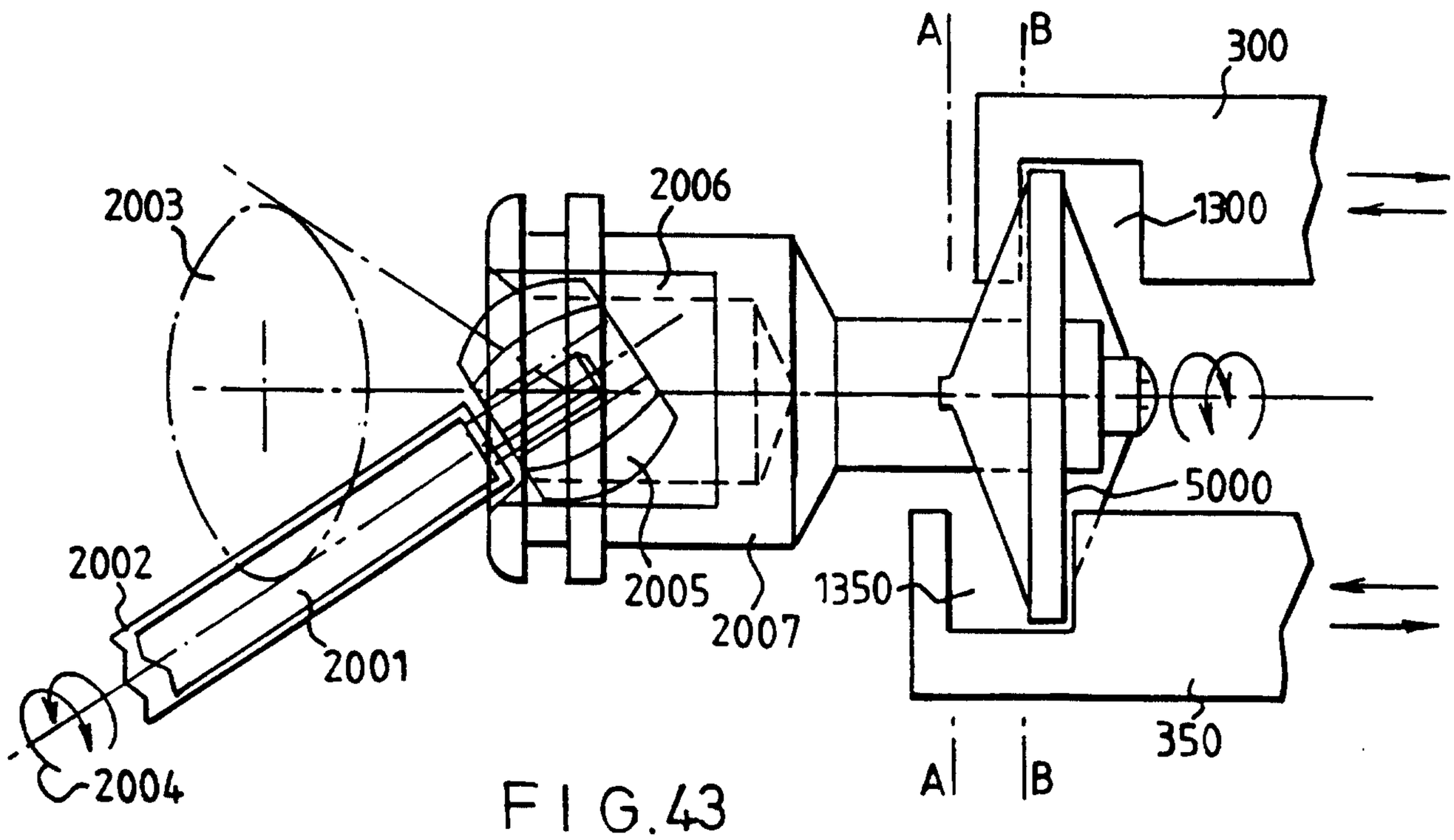


FIG.43

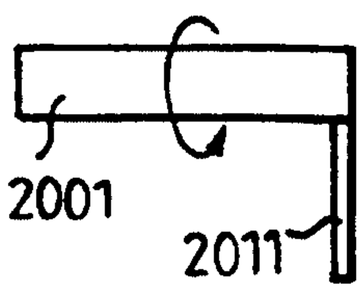


FIG.44

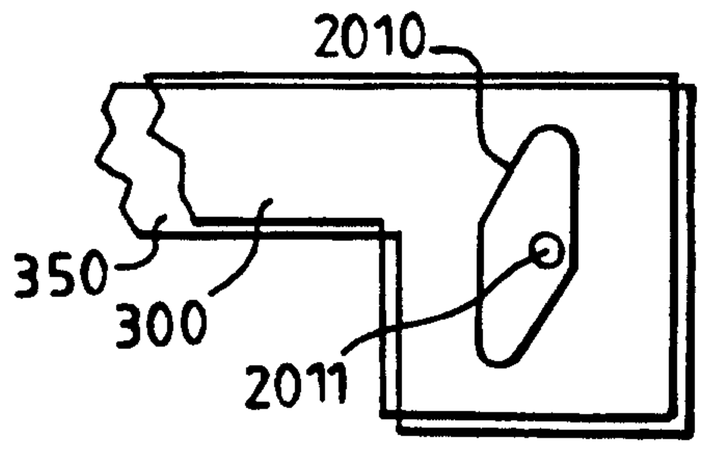


FIG.44A

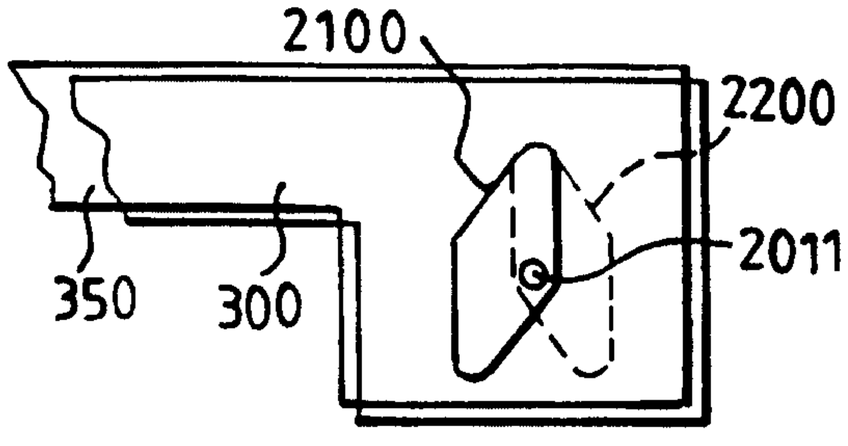


FIG.44B

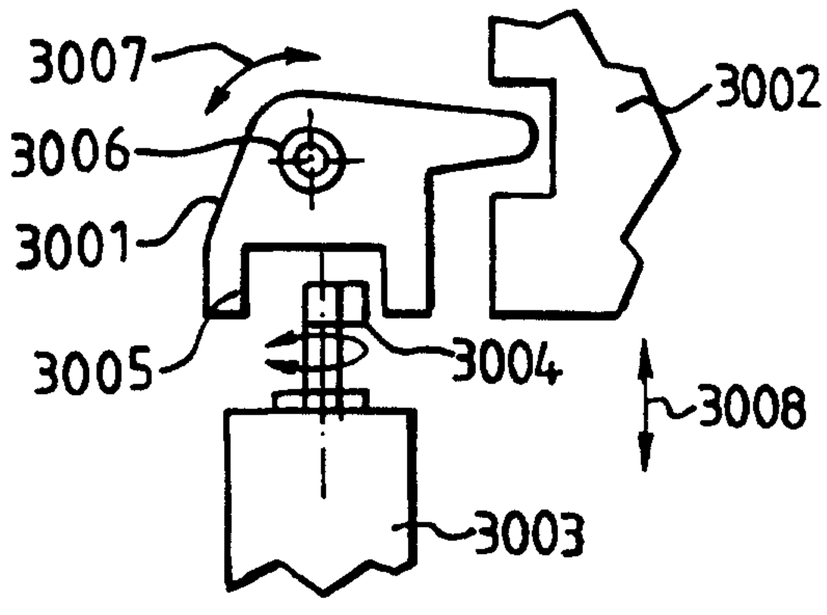


FIG.44C

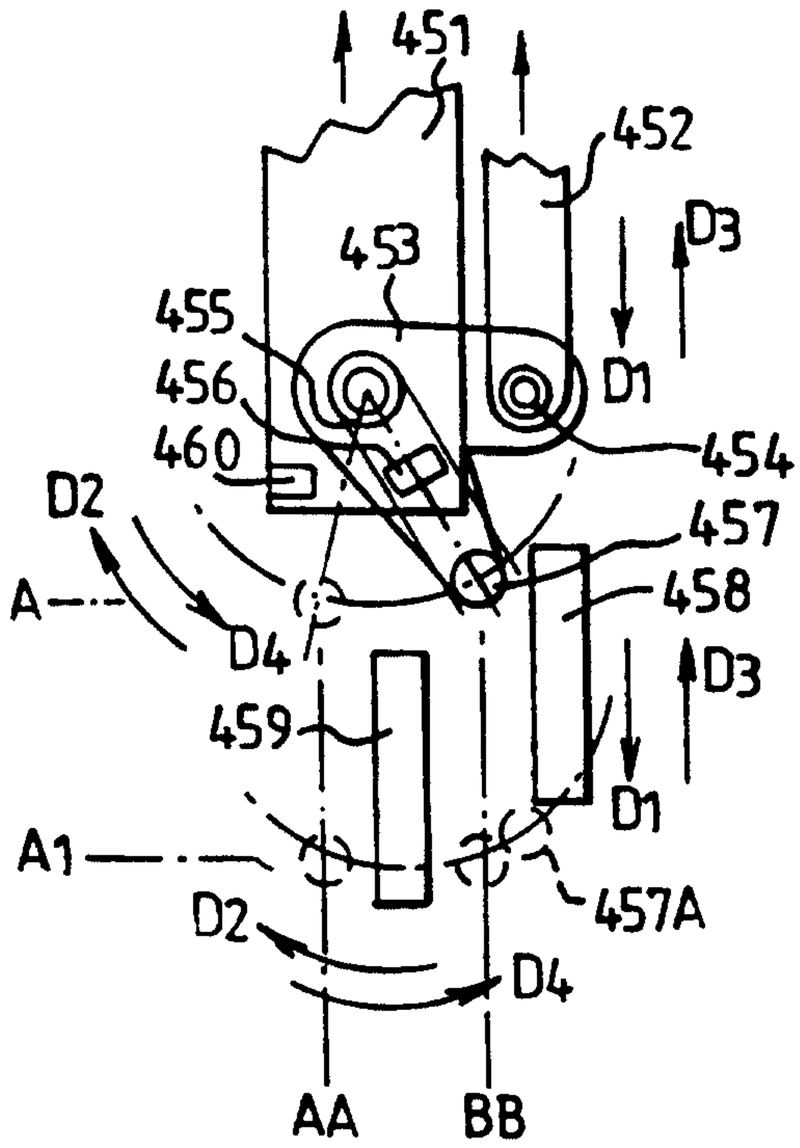


FIG.45

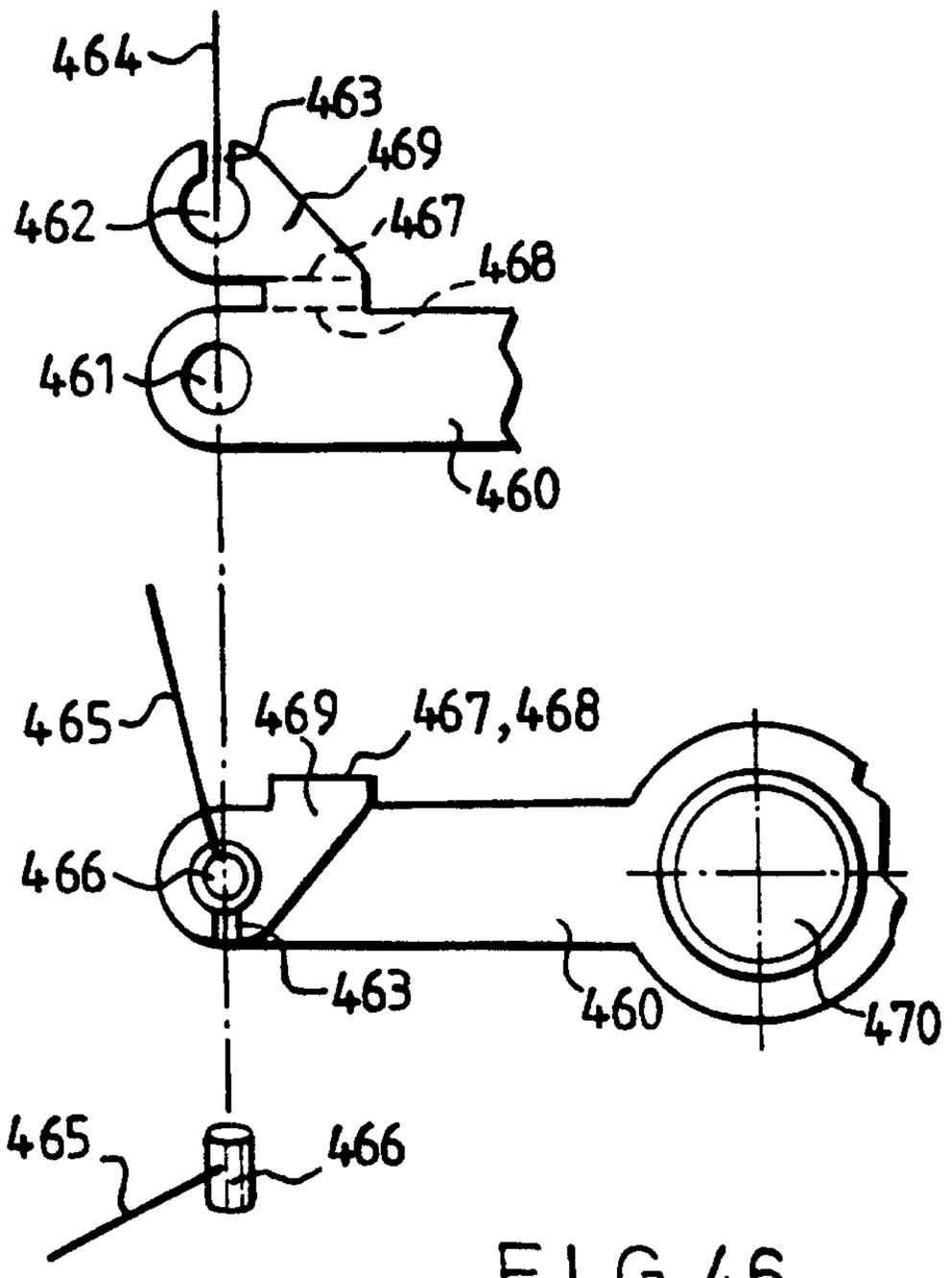


FIG.46

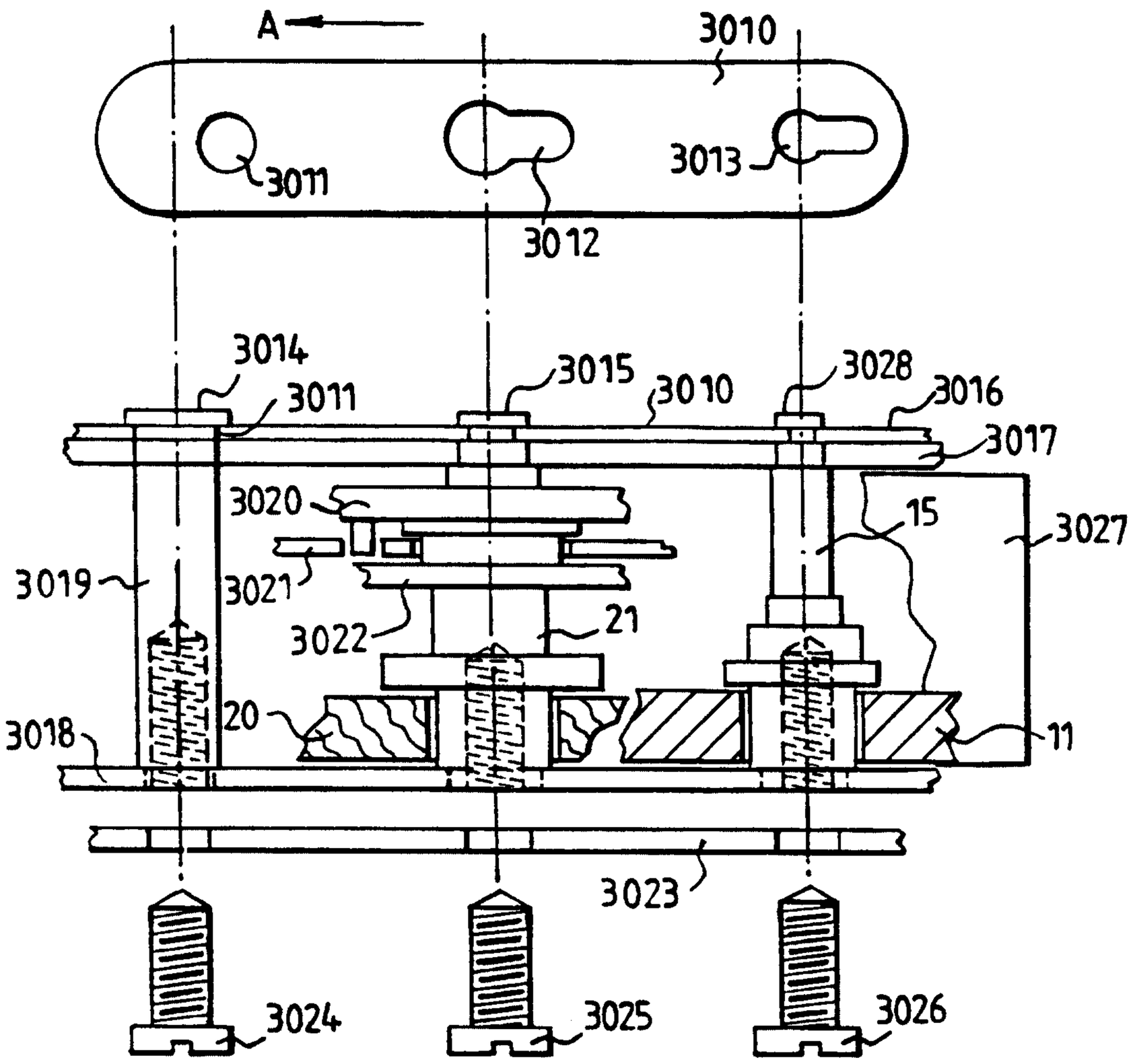

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FIG.47

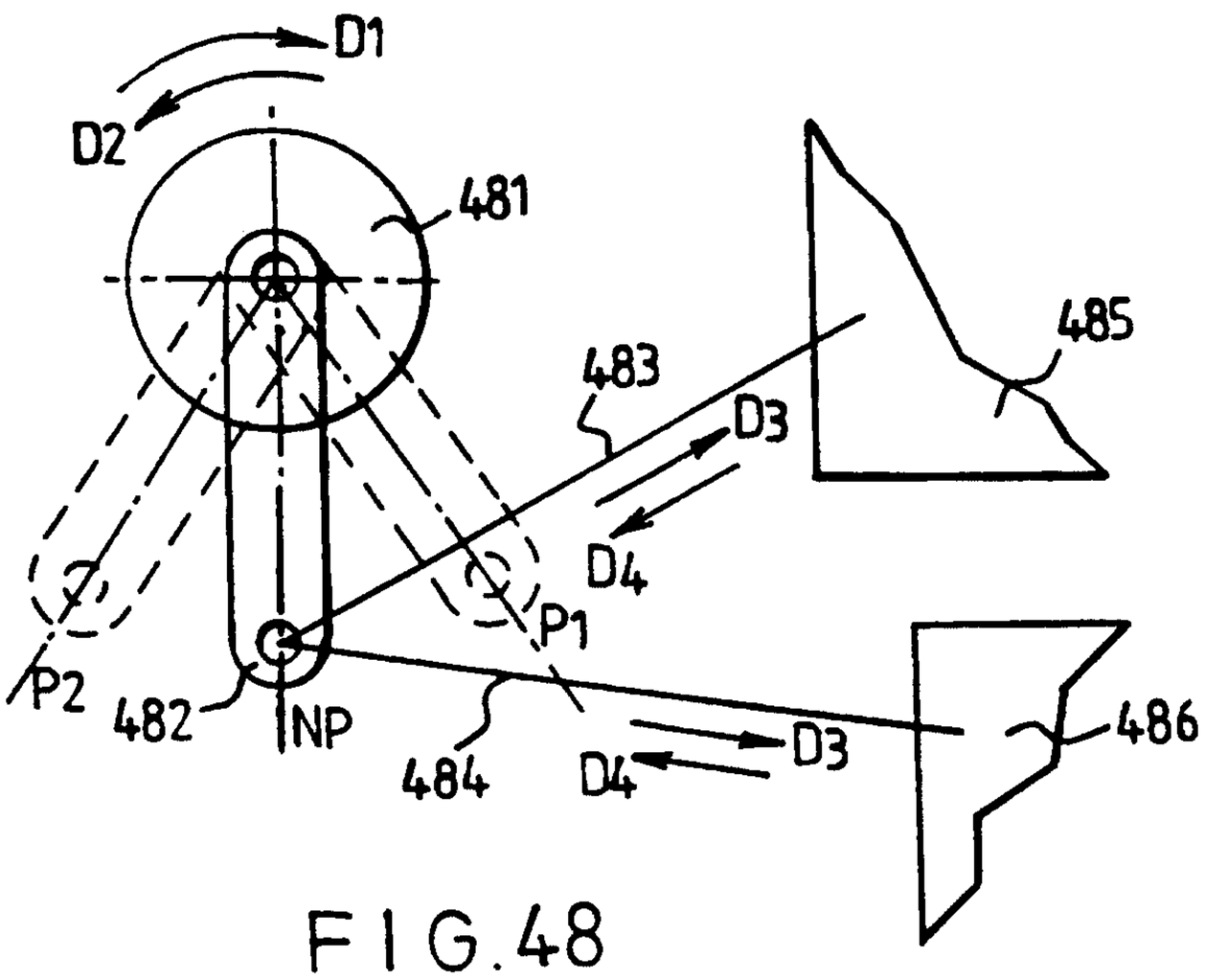

D1
D2
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D3
D4
P1
P2
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NP
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486

FIG.48

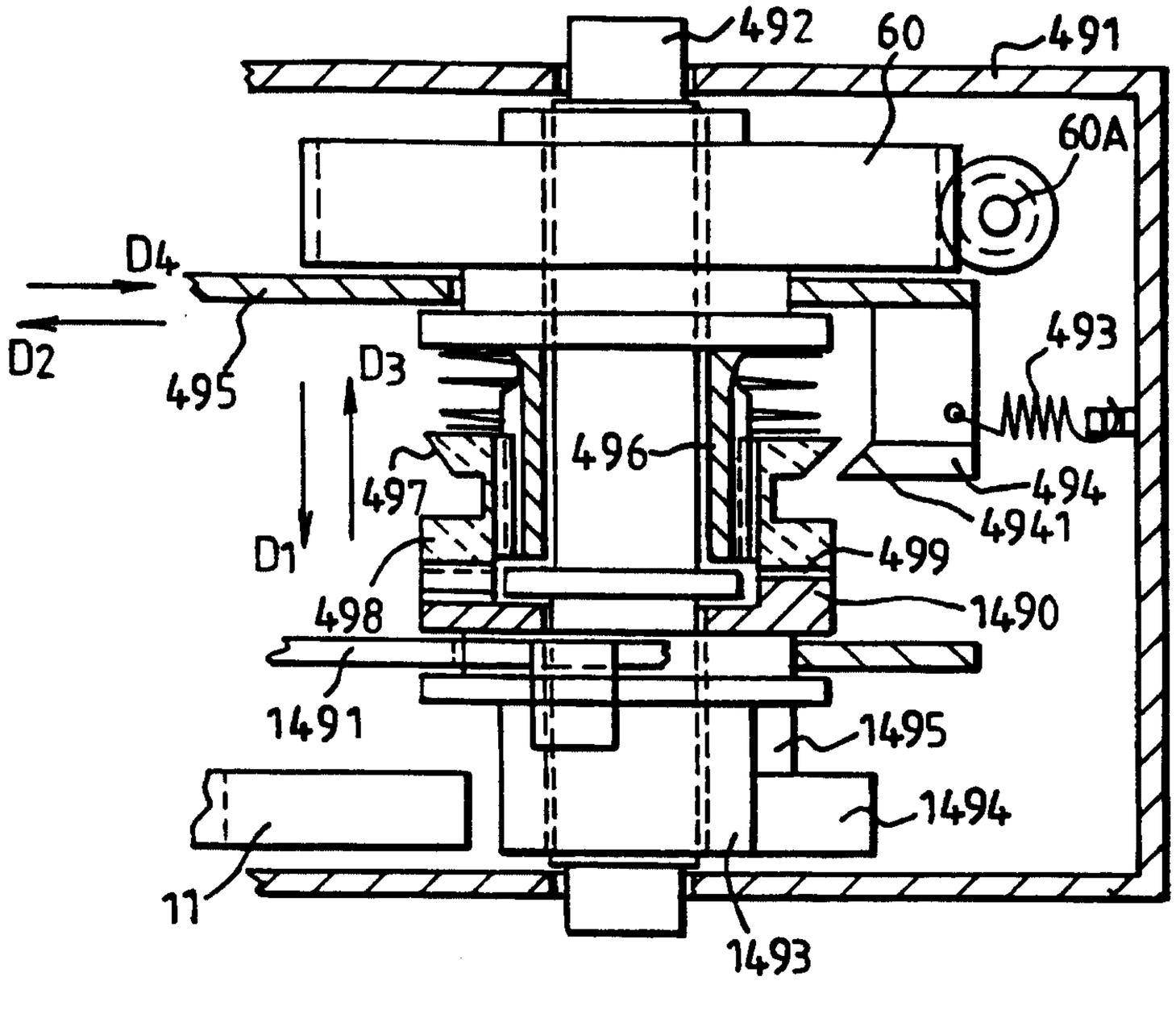

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FIG.49

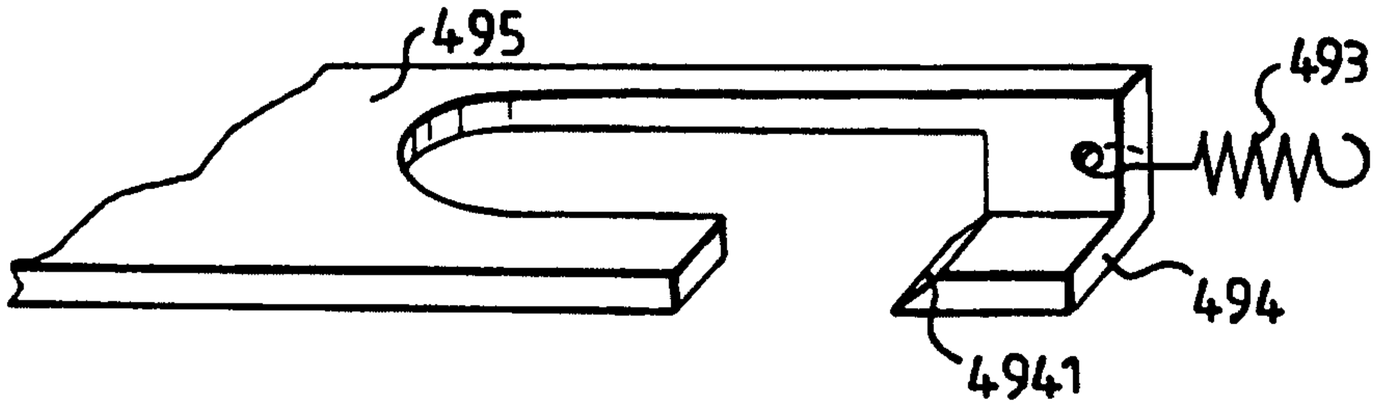

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FIG.50