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## Electromagnetically actuated lens drive

This invention relates generally to focusing apparatus for moving a lens element along its optical axis; it can be advantageously applied to a camera having automated apparatus for moving a camera lens element to focus an image at the film plane.

Automatic lens focusing systems have been discussed and disclosed in the literature for several years. In these systems a rotating motor, controlled by an electrical signal, is mechanically coupled to move a lens element parallel to its axis to focus an image at the film plane of the camera. In prior systems, a continuous feedback interaction is provided to generate for the electronic circuits within the camera an electrical signal representing either the present position of the lens in its path of movement or the quality of the present focus of the image at the film plane. In this manner, further movement of the lens, including the direction of movement, is controlled by the electrical circuits.

Even though often discussed in the literature, automatic focusing systems have not been entirely successful in still or movie cameras. Part of the reason may be that the feedback interaction undesirably introduces an added degree of complexity in the camera system. In addition, even though the electronics packages used in current camera equipment generally take advantage of recent technological innovations to reduce their physical size, similar technological advances have not been adapted to reduce the size of motor drives for automatic focusing mechanism. The motor drives noted in the art used a continuously movable motor, typically an analog-driven D.C. motor, which is mechanically coupled as by a worm drive to move the lens element to the focus position. The mechanical and electrical constraints heretofore placed on this kind of motor operation have retarded its miniaturization.

It is an object of this invention to provide motorised focusing apparatus, suitable for application to a camera, without unduly increasing its size.

Focusing apparatus according to the invention comprises a lens element movable along its optical axis, a lens holder in which the lens element is mounted, a lens holder support mounted concentrically to the axis of the lens element and coupled to the lens holder so that the lens holder is moved axially in response to relative rotation of the lens holder and support, and an electric motor arranged to effect the said relative rotation at a speed less than the speed of rotation of the motor, characterised in that the motor is an epicyclic motor having a stator with pole pieces concentrically disposed with respect to the optical axis of the lens element and an armature which is eccentrically disposed around the said axis between the stator and the

lens holder and which, when the pole pieces are sequentially energised, rotates eccentrically about the said axis, and in that coupling means are provided whereby the said eccentric rotation of the armature effects relative rotation of the lens holder at the said reduced speed.

The use of a stepping motor to focus a lens, particularly a lens for a microscope, has been proposed in German DAS 2234448, although in this specification the mechanical arrangement of the stepping motor in relation to the optical elements was not dealt with in detail. In addition, U.S. specification No. 3917394 has proposed the use of a linear stepping motor for moving a lens mount in the direction of the optical axis of the lens. However, as stepping motors are typically larger in size and weight than continuously movable analogue motors, they have not generally been used for moving lenses to a focussed position where the space available is critical, for example in photographic cameras. Also, the increment of rotational movement of rotary stepping motors is often large and cumbersome gearing would be required to reduce the step size for precision focusing.

In the preferred apparatus embodying the invention, the apparatus includes means for energising the pole pieces of the stator in a pulsed manner to impart the said eccentric rotation to the armature in a step-by-step manner, the number of pulses supplied to the motor being indicative of the position of the lens along the said axis.

In this embodiment, the armature has two rings of teeth by means of which it simultaneously engages teeth on a fixed armature support, centrally mounted in the stator, and teeth on the lens holder. The pulses applied to the stator poles cause the armature to roll around the armature support.

Such a construction permits an automatic focusing mechanism to be arranged co-axially around a lens system and hence packaged compactly in a relatively small space. The pulsed drive permits the mechanism to move the lens element in precise incremental steps to provide accurate focusing without continuously interactive feedback.

Epicyclic motors are of course known in themselves; examples are described in U.S. specification Re27446 and German DAS 2004343.

In order that the invention may be better understood, one example of a photographic camera embodying the invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of a camera having an automatic focus drive apparatus embodying the invention;

Figure 2 is a schematic plan view of an epicyclic

motor embodying the invention which shows the position of the lens and lens holder relative to the rotating armature;

Figure 3 is a cross section along lines 3—3 of Figure 2, showing the relationship between the various fixed and movable lens mounts, the armature, and other elements of the epicyclic motor;

Figure 4 is a 90° cut-away perspective view of the epicyclic focusing mechanism of the camera as seen along lines 4—4 of Figure 2 and showing the epicyclic motor modified to embody the invention; and

Figure 5 is a block schematic diagram of electrical equipment for driving the incrementally driven motor.

Referring to Figure 1, a camera 10 includes a lens mount 12 in which a lens holder 14 is positioned for rotating motion. Lens holder 14, which mounts a focusing lens element 16, is supported to move also in a direction parallel to the axis of the lens to focus an image at a camera film plane 22.

Lens element 16 and lens holder 14 are supported and encompassed by, and are coaxial with, an incrementally driven rotating device 28 in the form of an epicyclic motor secured within and to camera 10. The epicyclic motor is mechanically coupled to the lens holder 14 so that the driven rotational motion of an eccentrically mounted rotating armature 36 of the epicyclic motor (Figures 2, 3 and 4) rotates the lens holder 14 and the lens element 16 as a unit. The lens holder 14 is threaded on and thus is secured to a fixed support element 40 (fixed with respect to the stator of the epicyclic motor 28) so that rotation of the lens holder 14 moves it, with lens element 16, in a direction parallel to the lens axis, which coincides with the optical axis of the camera.

The illustrated camera also has an automatic range determining device 88, for example the sonic system described in U.S. patent no. 3,522,764. The sonic ranging system disclosed in U.S. patent no. 3,522,764 provides an electrical signal which can operate drive circuits for motor 28 to focus the lens elements 16.

The switch 100 shown in Figure 1 is a lever or button the operator depresses, just prior to taking a picture, to turn on the automatic focusing mechanism and thereby automatically bring into focus the image viewed in the camera viewfinder.

Referring now to Figures 2—4, the rotating armature 36 includes a magnetically soft iron sleeve member 41 carried on a central ring gear member 42. A stack of thin laminations 43 is carried on sleeve member 41. The armature thus assembled with sleeve member 41, gear member 42, and laminations 43 is disposed eccentrically within a stator 46 of the motor 28. The stator 46 has circumferentially-spaced and radially-extending pole pieces 48 of thin laminations and a yoke member 49. The stator

may have any number of pole pieces 48, each with a coil 50 wound around it. The coils are illustrated in Figure 2 connected electrically in series; the connection point between each pair of adjacent coils is brought out to a terminal diagrammatically illustrated in Figure 2 as a commutator 51.

In the illustrated embodiment, the stator 46 has eight pole pieces 48 concentrically disposed about a fixed center axis A which coincides with the optical axis of the lens element 16. Electrical drive signals are applied to the coils so that one circumferentially-adjacent half of the coils effectively has a first magnetic polarity and the other circumferentially-adjacent half has the opposite magnetic polarity. With the connections shown in Figure 2, where a rotatable pair of brushes 52 are illustrated in electrical contact with diametrically opposite commutators to provide power to the coils 50 of the epicyclic motor 28, the coils and corresponding pole pieces of the left half of the stator have one magnetic polarity while the coils and corresponding poles of the right half of the stator have the opposite polarity. The resultant magnetic field pulls the eccentric armature against lens holder 14 and a fixed support element 54 (Figures 3 and 4) at a circumferential site 55 (Figure 2). As the brushes rotate, making contact with each successive pair of oppositely-positioned commutators, the respective coils are energized in such a manner that the magnetic field between the stator pole pieces rotates synchronously with the brushes. It will be understood that the brushes and commutators, and the series connection of the coils, are shown only in Figure 2 for illustrative purposes. Any of various configurations of electronic circuits preferably is provided in place of the brush commutator structure. For example, solid-state components known in the art can provide the same rotating magnetic field.

The armature 36 of the motor 28 moves, in response to the rotating magnetic field, around the fixed support element 54 with a rolling motion synchronized to the magnetic field. Since the inside surface of the armature which faces element 54 has a diameter greater than the supporting surface of element 54, the armature will also rotate about its own center as it rolls about element 54. In this manner, the center axis of the armature 36 rotates concentrically about the fixed axis A. The epicyclic motor described thus far is known in the art, and is available, for example, from The Bendix Corporation. Further information concerning it is available in the art.

In the camera system shown the epicyclic motor is adapted to move a lens to focus an image at the camera film plane, as follows. Referring to Figures 3 and 4, the epicyclic focusing motor includes the armature 36 assembled with elements 41, 42 and 43, the stator 46 with pole pieces 48, coil windings 50 and yoke 49, and the fixed support element 54.

The lens holder 14, the movable focusing lens element 16, and a lens holder support or wall element 40 are arranged to cooperate with motor, together with annular sliding support mounts 64 and 66. These mounts axially position the armature 36 within a support housing 68 of magnetically soft material that typically is secured to the body of camera 10.

The optical light path from an image to the camera film plane 22 passes through the center of the motor, where the movable lens system is located. In this manner, the bulk of the motor is conveniently placed around the outside of the lens system and hence is compactly "absorbed" by the camera body. In this context, fixed support elements 40 and 54 can also mount optical elements of the camera lens system.

As shown in Figures 3 and 4, the armature 36, along the cylindrical circumference where it contacts fixed support element 54, is provided with a first set of internal gear teeth 70 which mesh with corresponding external gear teeth 72 around a circumference of fixed support element 54. The outside diameter of that portion of the armature support 54 which is within the armature is sufficiently less than the armature inside diameter to provide annular spacing between these elements sufficient to accommodate the eccentric motion of the armature. The armature gears mesh with the support gears only along part of the opposed toothed surfaces, due to the eccentric location of the armature about the support. Further, the pitches of the gear teeth 70 and 72, i.e., the number of gear teeth per inch, are approximately the same, i.e., they can be equal or differ slightly, so that as the armature 36 rolls around fixed support element 54, it will rotate slowly about its own center.

The armature 36 has a second set of internal gear teeth 78 positioned around a second internal circumference and which mesh with a set of external gear teeth 80 formed around an outside circumference of lens holder 14. The diameters of opposed surfaces of the armature and of the holder 14 differ to provide space between these surfaces as just described for the armature and the support element 54. Similarly, the pitches of gear teeth 78 and 80 are approximately the same, and the gears mesh only along a portion of the opposed surfaces. As noted above, the illustrated lens holder 14 is secured to the fixed lens-holder support element 40 by mating helical threads 86. By properly selecting the diameters of the mechanical components and the pitches of gear teeth 78 and 80 according to known practices, the armature 36 can apply large rotational torques as it rotates the lens holder 14. In this manner a substantial reduction in speed may be provided between the speed of the motor and the speed at which the lens is displaced. This rotational torque can rotate lens holder 14 in either direction and, through its helically arranged threaded connection to fixed support element 40, provides

for reciprocal translation of the holder 14 along the optical axis. By appropriate choice of pitch diameters of threads 86 and of the gears, the increment of axial rotation of the lens holder 14 produced by an increment of armature rotation produced by one increment of sequential energisation of the stator pole pieces can be made very small, e.g. in one instance less than 15 minutes of arc.

Referring now to Figure 5, the illustrated electrical system 88 (Figure 1) for generating drive signals to rotate the motor 28 through arcuate increments includes a reset circuit 90, an increment-determining circuit 92, a range-determining circuit 94, and a motor drive circuit 96. The illustrated electrical system is one of several that can be used. The selection of a specific system and the construction of the circuits for it, including those illustrated, can employ conventional skills known in the art. The reset circuit 90 is independently responsive to closures of switches 100 and 102 to operate circuits 92 and 96 to reset the lens element 16 to an initial predetermined focus position; for example, to either minimum or maximum focus. The operation of the reset circuit 90 is initiated by the closure of the contacts of switch 100, which as noted can be a manual lever-actuated switch located on the camera. Actuation of switch 100 by the operator closes the switch contacts and thereby actuates the reset circuit 90 to apply an "increment" signal level on line 104 to the increment determining circuit. This signal on line 104 serves two functions. First, it actuates the increment determining circuit to produce pulses, on a line 106, which actuate the motor drive circuit 96 to generate signals that reset motor 28 to an initial starting position. Each pulse on line 106 represents one increment of movement, and the pulses are spaced no closer than the minimum time required to increment the motor. Simultaneously, the increment determining circuit actuates the range determining circuitry 94, with signals on a line 108, to produce a signal, on a line 110, indicative of the range from the camera to the image. This latter signal can be provided as described in the above-noted U.S. patent no. 3,522,764 or by other apparatus known in the art. The signal on line 110 is processed as described below.

When the lens holder carries the focusing lens element 16 to the predetermined reset position, switch 102 closes to signal the reset circuit that the motor is at its initial reset position. The illustrated switch 102 is a micro-switch fixed on the support housing 68 actuated by a pawl 103 carried on the lens holder 14. The reset circuit thereupon provides a "reset complete" signal level over a line 112 to the increment determining circuit. (The "increment" signal level on line 104 is removed at or prior to the time the "reset complete" signal appears, depending on details of the circuit 92.) Upon receipt of the "reset complete" signal on

line 112, the increment determining circuit terminates the stream of pulses on line 106 to the motor drive circuit, so that further reset-incrementing of the motor ceases.

Simultaneously, the increment determining circuit 92 converts the range determination signal on line 110, using for example a read-only memory or a non-linear analog-to-digital converter, to a binary number which represents the number of increments which the motor must turn to position the focusing lens element at the specified focus position. The increment determining circuit stores this number, e.g., in a register, and provides a number of pulses on line 114 to the motor drive circuit to rotate the motor armature, and hence the lens holder and lens element, to the correct position. After the number of pulses provided over line 114 equals the binary number stored in the increment determining circuit, the circuit 92 ceases transmitting pulses to the motor drive circuit, which in turn terminates incrementing motor 28 over a plurality of lines 116. The circuits 92 and 96 constitute a pulse generating means for generating and applying to the motor the required number of pulses.

The illustrated motor drive circuit 96 simulates the brush 52 and commutator 51 arrangement shown schematically in Figure 2 by using known solid state devices to arcuately increment the motor 28 more reliably and to reduce the motor size. In the illustrated embodiment, the coils 50 are arranged in a circuit for individual actuation, Figure 5. Thus drive circuit 96 is connected over lines 116 to actuate each coil 50 independently, i.e., there is a separate line 116 to each coil, and there also is a common (e.g., ground) return.

When the motor 28 has reached its correct "in focus" position, the illustrated increment determining circuit provides a signal level over a line 120 which can, for example, signal the user, with an indication in the viewfinder of the camera, that the camera is in focus. At this juncture, a picture is taken. Where desired, an interlock can be provided between the focusing and the picture-taking operations so that a picture is not taken until the camera has reached the focus condition.

As noted above, the range determining circuit 94 can be constructed in the manner disclosed in U.S. patent no. 3,522,764, or it can be provided by other known automatic manual control systems. Thus, for example, a manually controlled rangefinder could be used to determine the distance from the camera to the image, and upon closing of switch 100, the increment determining circuit can use that manual setting to effect movement of lens element 16.

In other embodiments, the position of the focusing lens element 16 can be stored in the increment determining circuit by using an up-down digital counter to count the pulses provided over lines 106, 114. In that case, the

reset at the beginning of each focus determination can be eliminated. The system instead is reset after electric power is removed, to provide the up-down counter with a known initial starting position.

#### Example

In a particular embodiment of the invention as illustrated, the epicyclic motor has eight stator pole pieces 48 and eight stator coil windings 50. The armature is provided with one hundred and twelve gear teeth 70 at a pitch diameter of 29.634 mm, and the fixed support element 54 is provided with one hundred and eight gear teeth 72 at a pitch diameter of 28.575 mm. The portion of the armature which meshes with the lens holder is provided with one hundred and four gear teeth 78 at a pitch diameter of 27.516 mm, and the lens holder itself is provided with one hundred gear teeth 80 at a pitch diameter of 26.459 mm. This construction produces rotational movement of the lens, in an opposite direction from rotational movement of the armature, of 0.989 degrees per complete cycle of the armature (eight incremental steps), so that after three hundred and sixty-four cycles (2912 increments) the lens element rotates a full 360 degrees; this is the maximum rotation to transport the focusing element over the full focus range. Where the threads 86 have a 6.35 mm lead so that one complete rotation of the lens element 16 advances it by 6.35 mm, then each increment of motor rotation corresponds to an axial movement of the lens element of about 0.00203 mm.

Although the focusing apparatus of this invention is described in relation to a camera structure, it will be understood that the invention has broader application and may be used in conjunction with other devices such as a microscope.

#### Claims

1. Focusing apparatus comprising a lens element movable along its optical axis, a lens holder in which the lens element is mounted, a lens holder support mounted concentrically to the axis of the lens element and coupled to the lens holder so that the lens holder is moved axially in response to relative rotation of the lens holder and support, and an electric motor arranged to effect the said relative rotation at a speed less than the speed of rotation of the motor, characterised in that the motor is an epicyclic motor having a stator with pole pieces concentrically disposed with respect to the optical axis of the lens element and an armature which is eccentrically disposed around the said axis between the stator and the lens holder and which, when the pole pieces are sequentially energised, rotates eccentrically about the said axis, and in that coupling means are provided whereby the said eccentric rotation of the

armature effects relative rotation of the lens holder at the said reduced speed.

2. Focusing apparatus in accordance with claim 1, including means for energising the pole pieces of the stator in a pulsed manner to impart the said eccentric rotation to the armature in a step-by-step manner, the number of pulses supplied to the motor being indicative of the position of the lens along the said axis.

3. Focusing apparatus in accordance with claim 2, in which the said coupling means includes a fixed armature support centrally mounted within the stator for engaging the armature when the armature is driven in eccentric rotation.

4. Focusing apparatus in accordance with claim 3, in which the coupling means comprises gear teeth on the lens holder for engagement with gear teeth formed on the inner surface of the armature, whereby the armature rotates the lens holder about the optical axis of the lens element as the armature is caused to roll around the said fixed armature support in response to pulses applied to sequentially energise the motor pole pieces.

5. Focusing apparatus in accordance with claim 4, wherein another portion of the inner surface of the armature has gear teeth engaging further gear teeth provided on the said fixed armature support.

6. Focusing apparatus in accordance with claim 3, 4, or 5, wherein the lens holder is formed on one part of its surface with a helical thread for engaging a complementary thread on the lens holder support.

7. Focusing apparatus in accordance with any one of the preceding claims, further comprising means for resetting the epicyclic motor to an initial starting position corresponding to a predetermined position of the lens element along its optical axis.

8. Focusing apparatus in accordance with any one of the preceding claims, comprising a range-determining circuit for providing an electrical output signal representative of the number of arcuate increments required to move the lens element from an initial condition to a position corresponding to a required focused condition, and pulse-generating means responsive to the range-determining circuit for generating and applying to the motor the required number of pulses.

9. A photographic camera comprising means automatically ascertaining the range of an object to be photographed and generating an electric signal containing a number of pulses indicative of the said range, and focusing apparatus in accordance with any one of the preceding claims in which the motor is responsive to the said pulses to move the lens element along its optical axis to a focused condition.

10. Focusing apparatus comprising a lens element movable along its optical axis, a lens holder in which the lens element is mounted, a lens holder support mounted concentrically to

the axis of the lens element and coupled to the lens holder so that the lens holder is moved axially in response to relative rotation of the lens holder and support, and an electric motor arranged to effect the said relative rotation at a speed less than the speed of rotation of the motor, characterised in that the motor is an epicyclic stepping motor having a stator with pole pieces concentrically disposed with respect to the optical axis of the lens element, means for sequentially energising the pole pieces of the stator in a pulsed manner, and an armature eccentrically disposed around the said axis between the stator and the lens holder, the energisation of the pole pieces causing eccentric rotation of the armature about the said axis, and in that gear teeth are provided on the lens holder for engagement with gear teeth formed on the inner surface of the armature such that the eccentric rotation of the armature effects relative rotation of the lens holder at the said reduced speed.

#### Patentansprüche

1. Scharfeinstellvorrichtung mit einem Linsenelement, das längs seiner optischen Achse beweglich ist, mit einem Linsenhalter, in dem das Linsenelement eingebaut ist, mit einem Linsenhalterträger, der konzentrisch zur Achse des Linsenelementes gelagert und so mit dem Linsenhalter gekuppelt ist, daß der Linsenhalter axial gemäß einer Relativdrehung zwischen Linsenhalter und Linsenhalterträger verschoben wird und mit einem Elektromotor, der diese Relativdrehung mit einer Drehzahl bewirkt, die kleiner ist als die Drehzahl des Motors, dadurch gekennzeichnet, daß der Motor ein epizyklischer Motor ist, der einen Stator aufweist, dessen Polschuhe konzentrisch zur optischen Achse des Linsenelementes angeordnet sind, und der einen Anker aufweist, der exzentrisch zu dieser Achse zwischen dem Stator und dem Linsenhalter angeordnet ist und der sich bei aufeinanderfolgender Erregung der Polschuhe exzentrisch um diese Achse dreht, und daß eine Kupplung vorgesehen ist, wodurch die exzentrische Drehung des Ankers eine Relativdrehung des Linsenhalters mit der verminderten Drehzahl bewirkt.

2. Scharfeinstellvorrichtung gemäß Anspruch 1, welche Mittel aufweist, um die Polschuhe des Stators gepulst zu erregen um die exzentrische Drehung des Ankers schrittweise zu bewirken, wobei die Zahl der dem Motor zugeführten Impulse maßgeblich ist für die Lage des Linsenelementes längs der optischen Achse.

3. Scharfeinstellvorrichtung gemäß Anspruch 2, bei welcher die Kupplung einen festen Ankerträger aufweist, der zentral innerhalb des Stators gelagert ist, um am Anker anzugreifen wenn der Anker exzentrisch gedreht wird.

4. Scharfeinstellvorrichtung gemäß Anspruch 3, bei welchem die Kupplung einen Zahnkranz am Linsenhalter aufweist, der mit einer Ver-

zahnung kämmt, die auf der inneren Oberfläche des Ankers angebracht ist, so daß der Anker den Linsenhalter um die optische Achse des Linsenelementes dreht, wenn der Anker gemäß den Impulsen, die aufeinanderfolgend die Polschuhe erregen, veranlaßt wird um den festen Ankerträger abzurufen.

5. Scharfeinstellvorrichtung gemäß Anspruch 4, wobei ein weiterer Abschnitt der inneren Oberfläche des Ankers eine Verzahnung aufweist, die in eine weitere Verzahnung eingreift, die am festen Ankerträger angebracht ist.

6. Scharfeinstellvorrichtung gemäß Anspruch 3, 4 oder 5, wobei der Linsenhalter auf einem Teil seiner Oberfläche mit einem Schraubgewinde versehen ist, welches mit einem komplementären Schraubgewinde des Linsenhalterträgers zusammenwirkt.

7. Scharfeinstellvorrichtung gemäß einem der vorhergehenden Ansprüche, welche außerdem Mittel aufweist, um den epizyklischen Motor in eine anfängliche Ausgangsstellung zu überführen, die einer vorbestimmten Lage des Linsenelementes längs der optischen Achse entspricht.

8. Scharfeinstellvorrichtung gemäß einem der vorhergehenden Ansprüche, welche eine Entfernungsmeßschaltung aufweist, um ein elektrisches Ausgangssignal zu liefern, das der Zahl von Winkelschritten entspricht, die erforderlich sind, um das Linsenelement von der Ausgangsstellung in eine Stellung zu überführen, die der gewünschten Scharfeinstellung entspricht, wobei ein Impulsgenerator auf die Entfernungsmeßschaltung anspricht, um die erforderliche Zahl von Impulsen zu erzeugen und dem Motor zuzuführen.

9. Fotografische Kamera mit Mitteln, die automatisch die Gegenstandsweite eines Aufnahmegegenstandes bestimmen und ein elektrisches Signal erzeugen, das eine Zahl von Impulsen enthält, die für diese Gegenstandsweite maßgeblich sind, wobei eine Scharfeinstellvorrichtung gemäß einem der vorhergehenden Ansprüche vorgesehen ist, bei welcher der Motor auf die Impulse anspricht, um das Linsenelement längs der optischen Achse in die für die Scharfeinstellung richtige Stellung zu überführen.

10. Scharfeinstellvorrichtung mit einem Linsenelement, welches längs seiner optischen Achse beweglich ist, mit einem Linsenhalter, in den das Linsenelement eingebaut ist, mit einem Linsenhalterträger, der konzentrisch zur Achse des Linsenelementes gelagert und mit dem Linsenhalter so gekuppelt ist, daß der Linsenhalter axial bewegt wird, wenn Linsenhalter und Träger relativ zueinander verdreht werden, und mit einem Elektromotor, der die Relativdrehung mit einer Drehzahl bewirkt, die kleiner ist als die Drehzahl des Motors, dadurch gekennzeichnet, daß der Motor als epizyklischer Schrittmotor ausgebildet ist, dessen Stator Polschuhe aufweist, die konzentrisch zur optischen Achse des Linsenelementes angeordnet sind, wobei Mittel

vorgesehen sind um aufeinanderfolgend die Polschuhe des Stators mit Impulsen zu erregen, und wobei ein Anker exzentrisch um die Achse zwischen Stator und Linsenhalter angeordnet ist und wobei die Erregung der Polschuhe eine exzentrische Drehung des Ankers um die optische Achse bewirkt, und daß eine Verzahnung am Linsenhalter vorgesehen ist, die in Eingriff mit einer Verzahnung steht, die auf der inneren Oberfläche des Ankers derart ausgebildet ist, daß die exzentrische Drehung des Ankers eine Relativdrehung des Linsenhalters mit der verminderten Drehzahl bewirkt.

## Revendications

1. Dispositif de mise au point comprenant un élément d'objectif mobile le long de son axe optique, une monture d'objectif dans laquelle l'élément d'objectif est monté, un support de monture d'objectif monté concentriquement à l'axe de l'élément d'objectif et accouplé à la monture d'objectif de sorte que la monture d'objectif soit déplacée axialement en réponse à une rotation relative de la monture d'objectif et du support et un moteur électrique agencé pour réaliser ladite rotation relative à une vitesse inférieure à la vitesse de rotation du moteur, caractérisé par le fait que le moteur est un moteur épicycloïdal possédant un stator avec des pièces polaires disposées concentriquement par rapport à l'axe optique de l'élément d'objectif et une armature qui est disposée excentriquement autour dudit axe entre le stator et la monture d'objectif et qui, lorsque les pièces polaires sont excitées séquentiellement, tourne excentriquement autour dudit axe, et en ce que des moyens d'accouplement sont prévus de sorte que ladite rotation excentrique de l'armature provoque une rotation relative de la monture d'objectif à ladite vitesse réduite.

2. Dispositif de mise au point selon la revendication 1, caractérisé par le fait qu'il comprend des moyens pour exciter les pièces polaires du stator par impulsion pour impartir à l'armature une rotation excentrique pas à pas le nombre d'impulsions fournies au moteur indiquant la position de l'objectif le long dudit axe.

3. Dispositif de mise au point selon la revendication 2, caractérisé par le fait que lesdits moyens d'accouplement comprennent un support d'armature fixe monté centralement dans le stator pour venir en contact avec l'armature lorsque l'armature est entraînée en rotation excentrique.

4. Dispositif de mise au point selon la revendication 3, caractérisé par le fait que les moyens d'accouplement comprennent des dents d'engrenage sur la monture d'objectif pour coopérer avec des dents d'engrenage formées à la surface interne de l'armature de sorte que l'armature fasse tourner la monture d'objectif autour de l'axe optique de l'élément d'objectif lorsque l'armature est amenée à rouler autour

dudit support d'armature fixe en réponse à l'application des impulsions qui excitent séquentiellement les pièces polaires.

5. Dispositif de mise au point selon la revendication 4, caractérisé par le fait qu'une autre partie de la surface interne de l'armature possède des dents d'engrenage coopérant avec d'autres dents d'engrenage prévues sur ledit support d'armature fixe.

6. Dispositif de mise au point selon l'une quelconque des revendications 3 à 5, caractérisé par le fait que la monture d'objectif est munie, sur une partie de sa surface, d'un filet hélicoïdal pour coopérer avec un filet complémentaire sur le support de monture d'objectif.

7. Dispositif de mise au point selon l'une quelconque des revendications précédentes, caractérisé par le fait qu'il comprend en outre des moyens pour rétablir le moteur épicycloïdal à une position de départ initiale correspondant à une position prédéterminée de l'élément d'objectif le long de son axe optique.

8. Dispositif de mise au point selon l'une quelconque des revendications précédentes, caractérisé par le fait qu'il comprend un circuit de télémétrie pour fournir un signal de sortie électrique représentant le nombre d'incréments d'arc nécessaires pour amener l'élément d'objectif d'une condition initiale à une position correspondant à la condition de mise au point requise et des moyens de génération d'impulsions répondant au circuit de télémétrie pour engendrer et appliquer au moteur le nombre requis d'impulsions.

9. Appareil de prise de vues photographique, caractérisé par le fait qu'il comprend des moyens déterminant automatiquement la

distance d'un objet à photographier et engendrant un signal électrique contenant un nombre d'impulsions indiquant cette distance et un dispositif de mise au point selon l'une quelconque des revendications précédentes, le moteur étant sensible auxdites impulsions pour déplacer l'élément d'objectif le long de son axe optique jusqu'à la position de mise au point.

10. Dispositif de mise au point comprenant un élément d'objectif mobile le long de son axe optique, une monture d'objectif dans laquelle l'élément d'objectif est monté, un support de monture d'objectif monté concentriquement à l'axe de l'élément d'objectif et accouplé à la monture d'objectif de sorte que la monture d'objectif soit déplacée axialement en réponse à une rotation relative de la monture d'objectif et du support et un moteur électrique agencé pour effectuer ladite rotation relative à une vitesse inférieure à la vitesse de rotation du moteur, caractérisé par le fait que le moteur est un moteur pas à pas épicycloïdal possédant un stator avec des pièces polaires disposées concentriquement par rapport à l'axe optique de l'élément d'objectif, des moyens pour exciter séquentiellement les pièces polaires du stator au moyen d'impulsions et une armature disposée excentriquement autour dudit axe entre le stator et la monture d'objectif, l'excitation des pièces polaires provoquant une rotation excentrique de l'armature autour dudit axe et par le fait que des dents d'engrenage sont prévues sur la monture d'objectif pour coopérer avec des dents d'engrenage formées à la surface interne de l'armature de sorte que la rotation excentrique de l'armature effectue une rotation relative de la monture d'objectif à ladite vitesse réduite.

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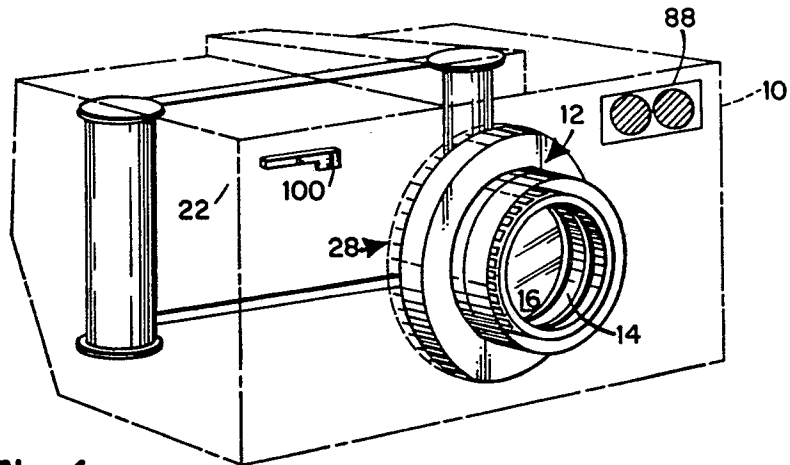


Fig. 1.

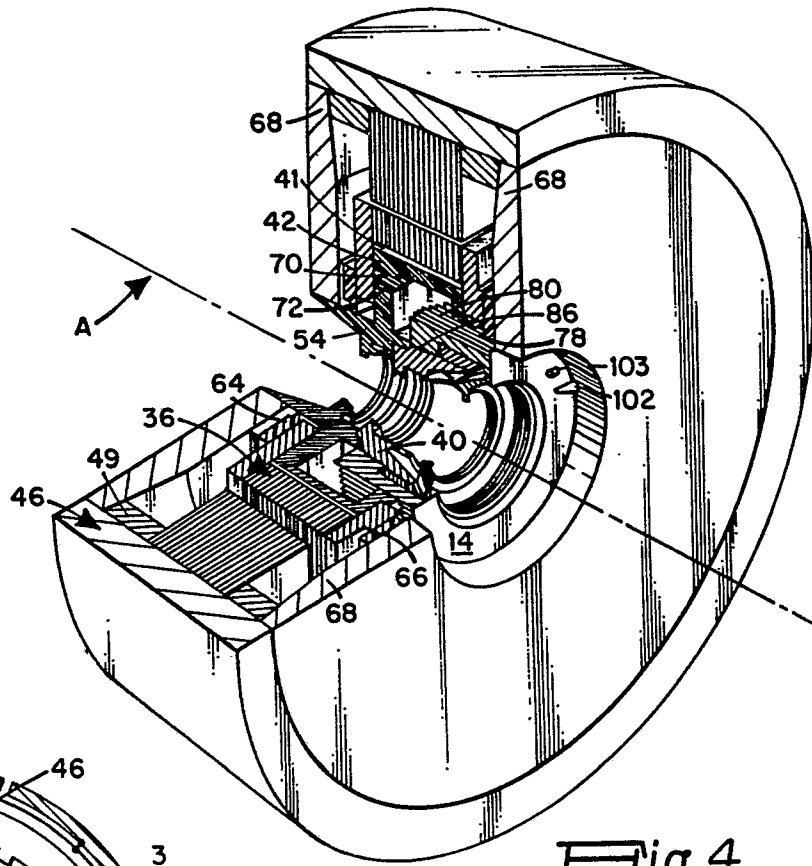


Fig. 4.

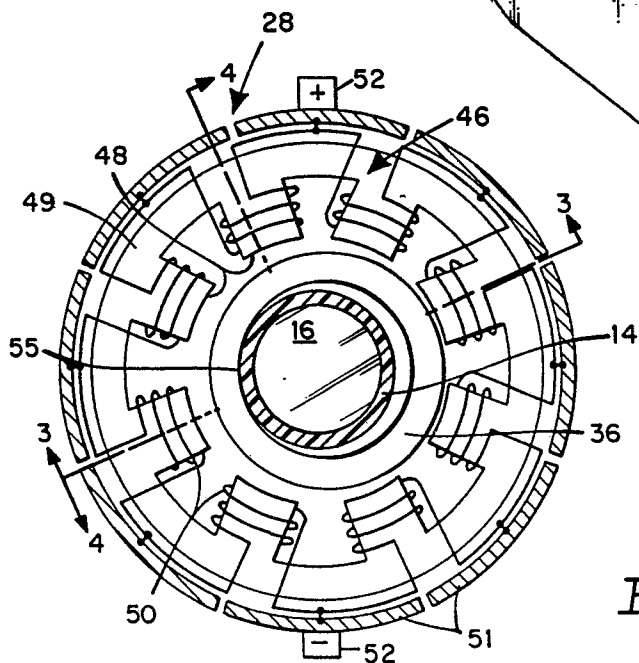


Fig. 2.

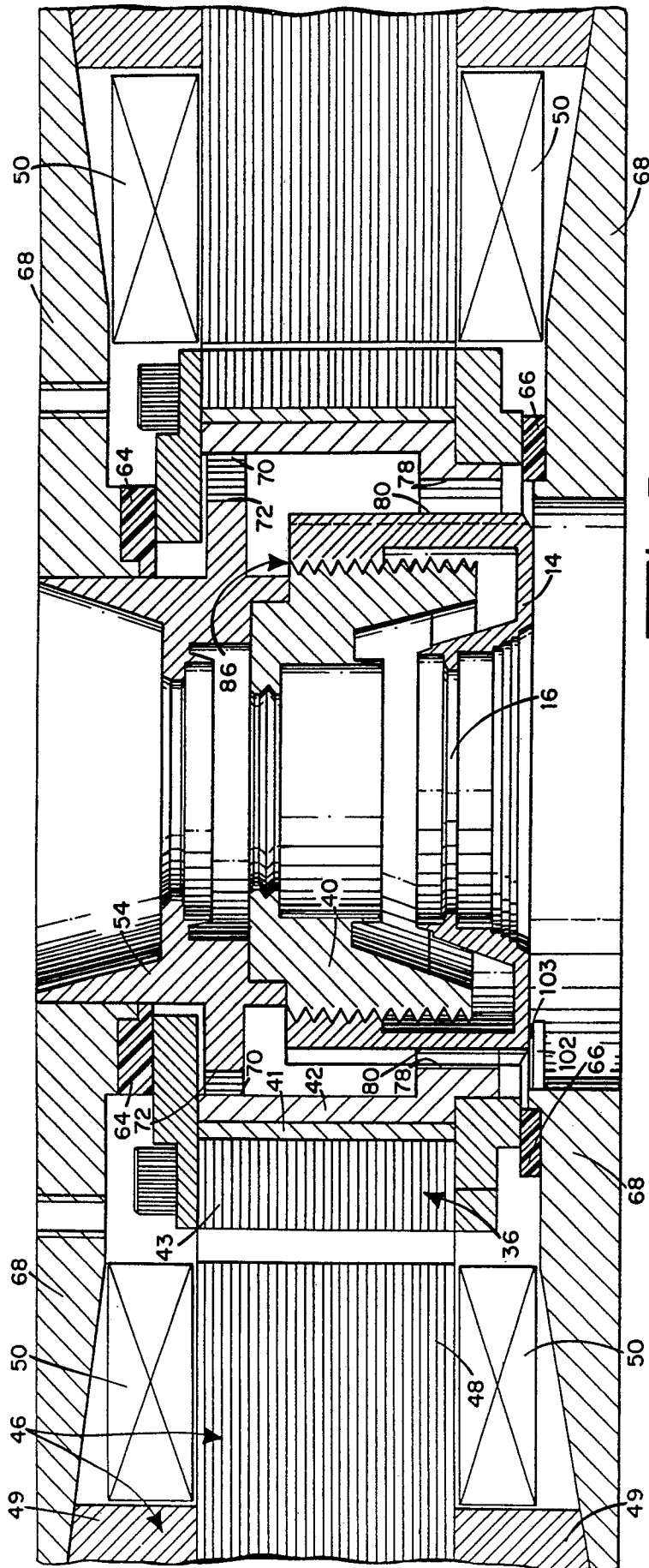


Fig. 3.

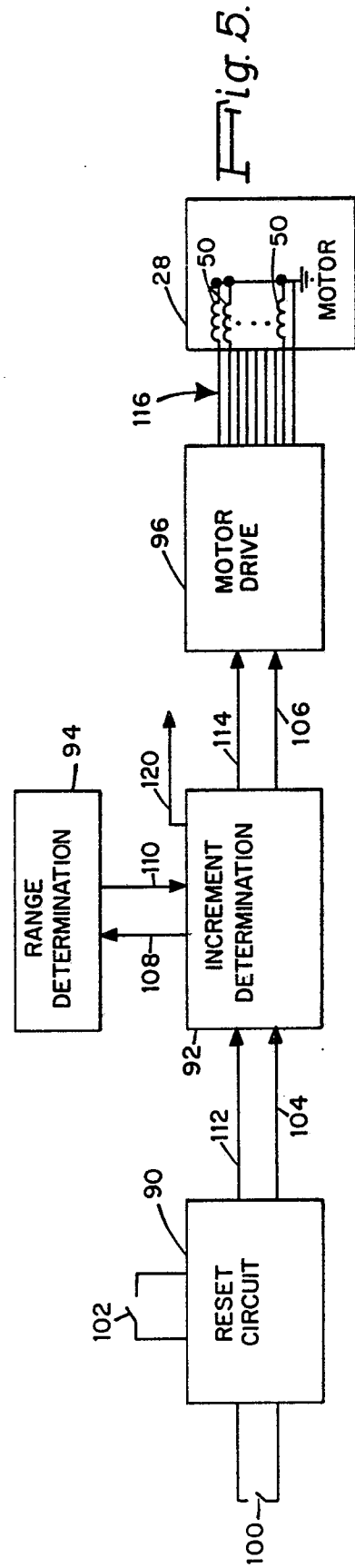


Fig. 5.