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(54) IMPROVEMENTS IN OR RELATING TO FOCAL PLANE SHUTTERS

(71) We, OLYMPUS OPTICAL COMPANY LTD., a Japanese Corporation, of 43-2, 2-Chome, Hatagaya, Shibuya-Ku, Tokyo, Japan,

do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to focal plane shutters.

In a focal plane shutter, the shutter blinds which have run are wound or charged subsequent to the completion of an exposure, by utilizing shutter blind winding gears which are interlocked with a film winding operation, for example, to drive pinions which are associated with shutter blind winding drums. A conventional winding apparatus comprises pinions and gears which are normally maintained in meshing engagement with each other. However, this may present a problem in providing a high speed shutter operation because the gears represent a load on the shutter blinds as they run. A type of winding apparatus is available in which both the first and the second pinions are simultaneously driven. With this construction, if there happens to be an opening between the two blinds when the shutter blinds have come to a stop, the winding procedure is performed with the opening maintained between the two blinds, thus disadvantageously opening a taking lens path.

There is another problem involved with the conventional construction of the prior art focal plane shutters. A focal plane shutter is constructed such that an exposure value is determined by both a diaphragm aperture and by a time delay between the running of the first and second shutter blinds which is determined by a photometric device. With a high speed operation or when the exposure period is very brief, the second blind starts to run soon after the first blind has started to run, thereby forming a slit of a width which is substantially reduced relative to the width of an image field. Light from an object being photographed is made to impinge upon a film surface while the slit travels across the film field. Consequently, the slit width must be maintained constant during the shutter operation in order to assure a uniform exposure. However, a conventional focal plane shutter is generally designed such that the second blind runs slightly faster than the first blind in order to improve the accuracy of the exposure period. In extreme instances, the second blind which started to run with a certain delay after the first blind has started to run may catch up with the first blind, thus resulting in a closed shutter condition while the two blinds travel across the film field. In such instance, there will be no or insufficient exposure.

According to the present invention there is provided a focal plane shutter including a first blind and a second blind, a take-up drum and a winding drum supporting the opposite ends of the first blind, a take-up drum and a winding drum supporting the opposite ends of the second blind, a pair of winding pinions each connected to a respective one of the winding drums for rotation therewith, and means for driving the two winding pinions to rotate the respective winding drums in synchronism during part of a shutter charging operation, said drive means comprising a pair of shutter winding gears each having a gap to maintain the respective gear out of meshing engagement with the corresponding pinion during operation of the shutter to effect an exposure and being adapted to rotate into meshing engagement with the respective winding pinion during a shutter charging operation, the gaps being arranged to be positioned at the start of a shutter charging operation such that rotation of the first blind winding pinion to rotate the first winding drum precedes rotation of the second blind winding pinion

to rotate the second winding drum.

The invention will be further described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a perspective view of a focal plane shutter constructed in accordance with one embodiment of the invention,

Fig. 2 is a fragmentary perspective view of part of the focal plane shutter of Fig. 1,

Figs. 3 to 7 are schematic plan views illustrating the various phases of operation of the focal plane shutter of Fig. 1,

Figs. 8 and 9 show graphically respectively the operation of shutter blinds of a conventional focal plane shutter and of the focal plane shutter of Fig. 1,

Figs. 10 and 11 are fragmentary plan views of a braking release device, and

Fig. 12 is a plan view showing the relationship between the first and second blind winding gears and the first and second blind winding pinions.

Referring to Fig. 1, there is shown a first blind 1 of a shutter which has its right-hand end wrapped around a first blind take-up drum 2. An end member 3 is fixedly attached to the left-hand end of the first blind 1, and has its upper and lower ends connected with one end of an upper string 4 and a lower string 5 which are utilized for pulling the first blind. The two strings 4, 5 are passed around pulleys 6, 7, respectively, and are wound around a first blind winding drum 8. A second blind 9 of the shutter has its left-hand end wrapped around a second blind winding drum 10, and has an end member 11 fixedly mounted on its right-hand end. A pair of upper and lower strings 12, 13 are secured to the upper and lower portions of the end member 11 for pulling the second blind. The two strings 12, 13 pass around pulleys 14, 15, respectively, and are wrapped around a second blind take-up drum 16.

The two take-up drums 2, 16 are mounted on respective shafts 17, 18 with coiled, winding springs (not shown) interposed therebetween, these coiled springs normally operating to strongly urge the drums 2, 16 to rotate in the direction indicated by an arrow *a* or in the shutter blind take-up direction. The both winding drums 8, 10 are fixedly mounted on respective shafts 19, 20, which have a first blind winding pinion 21 and a second blind winding pinion 22 fixedly mounted thereon, respectively, at a position below the respective drums. The pulleys 6, 7 and 14, 15 are rotatably mounted on the shafts 20, 17 at the opposite ends of the drums 10, 2, respectively. However, these pulleys may be mounted on separate shafts from the support shafts 20, 17 for the drums 10, 2.

First and second blind winding gears 24 and 25 are fixedly mounted on a shutter winding shaft 23, and are located adjacent to the pinions 21, 22, respectively. Each of the gears 24, 25 is provided with a gap 24a, 25a, respectively, and in the position shown in Fig. 1, the gaps 24a, 25a face toward the pinions 21, 22 respectively, thus interrupting the meshing engagement between these gears and the pinions.

At positions below the pinions 21, 22, the shafts 19, 20 have fixedly mounted thereon a first blind locking cam disc 26 and a second blind locking cam disc 27, respectively, each having a peripheral notch 26a, 27a, which are in turn engaged by an end 28a, 29a of a first blind locking lever 28 and a second blind locking lever 29, respectively. A force tending to rotate the both shutter winding shafts 19, 20 is transmitted from the two take-up drums 2, 16 through the two blinds 1, 9 and the two shutter winding drums 8, 10, but in the condition shown in Fig. 1, the resulting rotation is prevented by the engagement of the ends 28a, 29a of the locking levers 28, 29 with the notches 26a, 27a.

The first blind locking lever 28 is rotatably mounted on a pin 30, and is urged by a coiled spring 32 to have its end 28a held in abutment against the peripheral surface of the first blind locking cam disc 26, the spring 32 having one end anchored to a stationary pin 31 and having its other end engaged with an arm 28b of the lever 28 which is located on the opposite side from the end 28a. The second blind locking lever 29 is rotatably mounted on a pin 33, and is urged by a coiled spring 35 to have its end 29a removed from the peripheral surface of the second blind locking cam disc 27, the spring 35 having one end anchored to a stationary pin 34 and its other end engaged with an arm 29b of the lever 29 which is located on the opposite side from the end 29a. On the rear side or on the side which is remote from the cam disc 27, an arm of the locking lever 29 extending between the pin 33 and the end 29a is engaged by a portion 36a of a lock-hold lever 36, which is rotatably mounted on a pin 37 and which is urged by a coiled spring 39 in a direction to maintain the second blind locking lever 29 in abutment against the second blind locking cam disc 27. The spring 39 has one end anchored to a stationary pin 38 and its other end engaged with an arm of the lever 36 which is located on the opposite side of the pin 37 from the portion 36a.

The arm 29b of the second blind locking lever 29 carries near its end a fixedly mounted pin 41 rotatably carrying an armature 40. The armature 40 is located opposite to a pair of pole pieces 42a, 42b of an electromagnet 44 having a core 42 on which a coil 43 is disposed. The electromagnet 44

is energized in response to a shutter release, and is deenergized by a photometric device, not shown, at the time when a proper amount of exposure is given to a film, not shown. The energization and deenergization of the electromagnet controls the operation of the second blind locking lever 29. As will be further described later, the first blind locking lever 28 and the second blind lock-hold lever 36 are adapted to move away from the first blind locking cam disc 26 and the second blind locking lever 29, respectively, in response to a shutter release.

A pair of braking torsion springs 45, 46 are disposed on the shafts 19, 20, respectively, at positions below the sector-shaped gears, and have their one ends bearing respectively against pins 47, 48, fixedly mounted on and depending downwardly from the lower surace of the respective cam discs 26, 27, and have their other ends bearing respectively against a top portion of a braking pin 49, 50, respectively. These braking pins 49, 50 each extend through an arcuate slot 51a, 51b formed in a stationary plate 51, and are fixedly mounted on the ends of respective arms of a pair of braking levers 52, 53. The levers 52, 53 are rotatably mounted on pins 54, 55, respectively, and their other end 52a, 53a are located adjacent to a pair of brake release pins 56a, 56b fixedly mounted on and depending downwardly from the lower surface of the first blind winding gear 24. The arcuate slots 51a, 51b are located on arcs of circles which are centered about the pins 54, 55, respectively.

The braking pins 49, 50 extend below the braking levers 52, 53, and disposed below their lower ends are a pair of brakes 57a, 57b which are formed as an integral part of a braking member 57, which comprises a resilient blade. Each of the brakes 57a, 57b has a slant formed in it, rising from its right-hand end to its left-hand end so that as the braking pins 49, 50 move from right to left within the respective slots 51a, 51b as will be described later, they undergo an increasing friction against the brakes 57a, 57b. The braking member 57 is fixedly mounted, as shown at 58, on a stationary member (not shown) by using set screws.

A pair of resilient tabs 59, 60 are secured to the top and bottom of the end member 3 of the first blind 1 at positions which are located outside an image field P (shown in phantom line) of the film. Each of the tabs 59, 60 has a folded end 59a, 60a which is maintained by its own resilience in the path of movement of the second blind 9 (see Fig. 4). However, when the shutter is not operated, the folded ends 59a, 60a are moved out of the path by the end member 11 of the second blind 9 (see Figs. 1 and 3). In the right-hand portion of Fig. 1 or toward the terminal end of the path of movement of the blinds, there are provided a pair of guide members 61, 62 which have their one ends 61a, 62a fixedly mounted on suitable stationary members, not shown, for expelling the folded ends 59a, 60a of the resilient tabs 59, 60 out of the path of movement of the shutter blind.

The operation of the focal plane shutter will now be described. Fig. 1 shows the condition of the shutter when a shutter winding operation is completed and a shutter release may be triggered. Under this condition, the first blind 1 covers the image field P of the film, and the gaps 24a, 25a of the winding gears 24, 25 face toward the pinions 21, 22, which thus do not mesh with the gears 24, 25. The braking pins 49, 50 are located opposite to the right-hand end portions of the brakes 57a, 57b and thus are not braked.

In response to a shutter release, the arm 28b of the first blind locking lever 28 is pushed in the direction indicated by an arrow *b*, whereby the first blind locking lever 28 has its one end 28a disengaged from the notch 26a formed in the cam disc 26. Also, the arm 36b of the lock-hold lever 36 is pushed in the direction indicated by an arrow *c* in response to the shutter release, whereby the portion 36a is disengaged from the second blind locking lever 29. In addition, the electromagnet 44 is energized in response to the shutter release to attract the armature 40 mounted on the second blind locking member 29, thus taking the place of the lock-hold lever 36 to maintain the lever 29 in its initial position in which it locks the cam disc 27.

When the lever 28 is disengaged from the cam disc 26, the first blind winding drum 8 is released from constraint, whereby the rotative power stored in the first blind take-up drum 2 is effective to take up the first blind 1, which thus runs in the direction from drum 8 to drum 2 to produce an exposure of the image field P. At this time, the resilience of the torsion spring 45 acts on the cam disc 26 to assist the running of the first blind 1.

As the first blind 1 runs to be taken up on the take-up drum 2, the first blind winding drum 8 follows to rotate in the direction of the arrow *a* together with its support shaft 17. As the shaft 19 rotates, the cam disc 26 rotates in the same direction, whereby the pin 47 thereon moves in a direction away from the torsion spring 45. The cam disc 26 is designed to rotate through exactly two revolutions from its start position until the end of running of the first blind 1. Toward the beginning of the second revolution, the pin 47 thereon bears against the torsion spring 45 from the side which is opposite to the side from which it engaged the spring 45 initially, thus angularly moving the tor-

sion spring 45. The torsion spring 45 continues to be rotated, disengaging the braking pin 49, and later bearing against it from the opposite side toward the end of the second revolution of the cam disc 26. As a consequence, the braking pin 49 is moved from right to left within the slots 51a, and is subjected to an increasing braking effect applied by the brake 57a (see Fig. 2). The braking effect is transmitted to the cam disc 26 through the torsion spring 45, and also acts through the shaft 19 and the first blind winding drum 8 to retard the running of the first blind 1. In this manner, a desirable braking action is applied to the first blind 1 toward the end of its running. Toward this time, the first blind locking lever 28 returns to a position in which it locks the cam disc 26, which is therefore locked by the lever 28.

After the first blind 1 has commenced to run, the electromagnet 44 is deenergized by a photometric device when a proper amount of exposure has occurred, thereby releasing the armature 40 on the second blind locking lever 29. Thereupon the lever 29 rotates under the resilience of the coiled spring 35 in a direction to move the end 29a away from the notch 27a formed in the cam disc 27, thus freeing the cam disc 27.

When the cam disc 27 is freed, there is no longer constraint on the second blind 9, which therefore begins to run, under the action of the rotative power stored in the second blind take-up drum 16, to be taken up thereon, thus closing the image field P to terminate a photographic cycle. During the running of the second blind 9, the torsion spring 46, braking pin 50 and brake 57b function in a similar manner to the torsion spring 45, control pin 49 and brake 57a to apply a desirable braking action on the running of the second blind 9.

Figs. 3 to 7 show the relationship between the first and second blinds 1, 9 during a high speed shutter operation. Prior to a shutter release, the both blinds 1, 9 are maintained in their initial position in which the end members 3, 11 are in overlapping relationship, as shown in Fig. 3. The folded ends 59a, 60a of the resilient tabs 59, 60 are expelled out of the path of movement of the second blind 9 by the action of the end member 11 provided thereon. When the first blind 1 begins to run in response to a shutter release, the folded ends 59a, 60a are disengaged from the end member 11 and resiliently move back into the path of movement of the second blind 9. When the second blind 9 begins to run subsequently, it follows the first blind 1, as shown in Fig. 4, and eventually catches up with the first blind 1, as shown in Fig. 5, because of its faster running speed than the first blind 1. However, the end member 11 is subsequently maintained in abutment against the folded ends 59a, 60a of the resilient tabs 59, 60, so that the two blinds 1, 9 run while maintaining a slit therebetween of a width which correspond to the effective length of extension Δd of the tabs 59, 60. In this manner, a minimum slit having a width Δd is assured during a high speed operation of the shutter, thus obviating the occurrence of a failure to provide an exposure.

Toward the end of running of the first blind 1 (see Fig. 6), the folded ends 59a, 60a of the two resilient tabs 59, 60 are expelled out of the path of movement of the second blind by the guide members 61, 62, so that the end member 11 on the second blind can terminate its running while passing betwen the tabs 59, 60 and the guide members 61, 62. The provision of the guide members 61, 62 avoids the abutment of the end member 11 against the folded ends 59a, 60a which might give rise to a bouncing or a damage to other parts.

In Fig. 8, curves A and B represent the distances d travelled by the first blind 1 and the second blind 9, respectively, of a conventional shutter, as plotted against time t. It is seen from this Figure that the two blinds may travel across the image field P while maintaining an overlapping relationship, thus failing to provide a proper exposure. With the focal plane shutter according to the preferred embodiment of the invention, the provision of the resilient tabs 59, 60 assures a minimum slit width of Δd as shown in Fig. 9, thus assuring a proper exposure even during a high speed shutter operation.

When the two blinds have terminated their running to complete an exposure of one frame of the film, there follows a winding operation of the two shutter blinds 1, 9. The winding operation of the shutter blinds 1, 9 takes place in response to a film winding operation, which is performed by driving the shutter winding shaft 23 in a direction indicated by an arrow *d* (see Fig. 2). As the shaft 23 is driven in the direction of the arrow *d*, the two winding gears 24 and 25 rotate in the same direction, and the brake release pins 56a, 56b fixedly mounted on the first blind winding gear 24 angularly move the arms 52a, 53a of the braking levers 52, 53 until the braking pins 49, 50 fixedly mounted thereon are displaced from their braked position (Fig. 2) to their brake-free position (Fig. 1). Figs. 10 and 11 illustrate such operation in terms of the braking lever 52.

When the braking action is released in this manner, the two blinds 1, 9 which remain at rest in definite positions become free to be driven into normal take-up positions, and accordingly, the two pinions 21, 22 are properly positioned. Thus, the wind-

ing gears 24, 25 for the blinds 1, 9 are brought into proper meshing engagement with the pinions 21, 22 to define the winding commencement position of these blinds during a shutter winding operation, which assures that the blinds start their running from a correct position at the next time the shutter is operated. Specifically, considering the first blind winding gear 24, its first tooth 24b is capable of initiating meshing engagement with a particular tooth 21a on the first blind pinion 21 (see Fig. 11).

In response to the rotation of the shutter winding shaft 23, the first blind winding gear 24 and the second blind winding gear 25 are both rotated in the direction of the arrow *d* to drive the pinions 21, 22 so that these pinions are driven through two revolutions in the opposite direction from the arrow *a* during one revolution of the gears. Referring to Fig. 12, an angle $\theta 1$ through which the first blind winding gear 24 is rotated from its initial position until it begins to mesh with the first blind winding pinion 21 is chosen smaller than an angle $\theta 2$ through which the second blind winding gear 25 has to be rotated from its initial position until it begins to mesh with the second blind winding pinion 22. Consequently, after the two gears 24, 25 have started to rotate, the first blind winding gear 21 is initially driven, and the second blind winding pinion 22 begins to be driven after the two gears 24, 25 have rotated through an angle corresponding to $\theta 2$-$\theta 1$.

Driving the two pinions 21, 22 with a time delay therebetween assures that the first blind 1 is first moved in the winding direction and is brought into an overlapping relationship with the second blind before the latter is driven in the winding direction. The two blinds 1, 9 are wound while maintaining the two end members 3, 11 in overlapping relationship, thus preventing any adverse incidence of undesirable light onto the film. Toward the end of the winding operation, the winding of the first blind is first terminated, followed by the termination of the winding of the second blind 9 after a rotation of the both gears 24, 25 through an angle corresponding to $\theta 2$-$\theta 1$. Now the two blinds 1, 9 resumes their normal relative position.

During the rotation of the two blind winding gears 24, 25 through one revolution, the two blinds 1, 9 are returned to their original positions shown in Fig. 1 as are the other members. The torsion springs 45, 46 return to their original positions by a procedure which is substantially similar to, though in the opposite sequence, the procedure which they followed when initiating the running of the blinds 1, 9. Since the braking action of the braking member 57 is continuously interrupted during a shutter winding operation, such operation can be effected without undue stress.

WHAT WE CLAIM IS:—

1. A focal plane shutter including a first blind and a second blind, a take-up drum and a winding drum supporting the opposite ends of the first blind, a take-up drum and a winding drum supporting the opposite ends of the second blind, a pair of winding pinions each connected to a respective one of the two winding drums for rotation therewith, and means for driving the two winding pinions to rotate the respective winding drums in synchronism during part of a shutter charging operation, said drive means comprising a pair of shutter winding gears each having a gap to maintain the respective gear out of meshing engagement with the corresponding pinion during operation of the shutter to effect an exposure and being adapted to rotate into meshing engagement with the respecive winding pinion during a shutter charging operation, the gaps being arranged to be positioned at the start of a shutter charging operation such that rotation of the first blind winding pinion to rotate the first winding drum precedes rotation of the second blind winding pinion to rotate the second winding drum.

2. A focal plane shutter as claimed in claim 1, in which a first end member is secured to the trailing end of the first blind, a second end member is secured to the leading end of the second blind, and a resilient tab is mounted on one of the end members at a position out of an image field, the tab having a tip which can bear against the other end member and can be moved out of the path of movement of the blind which carries said other end member when the two blinds are at the same time in either of their terminal positions to close a shutter opening, the tip of the tab extending a predetermined distance from said one end member and being freed from said other end member to move into the path of movement of the blind which carries said other end member when the end members of the two blinds are spaced apart by a distance greater than said predetermined length, whereby a slit of a width which is at least equal to the predetermined length between the blinds is assured during operation of the shutter to effect an exposure.

3. A focal plane shutter as claimed in claim 2, further having a guide member located within a camera so as to move the tab out of said path of movement at the end of a shutter operation to effect an exposure.

4. A focal plane shutter constructed and

arranged and adapted to operate substantially as hereinbefore particularly described with reference to and as illustrated in Figs. 1 to 7 and Figs. 9 to 12 of the accompanying drawings.

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1565388 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1

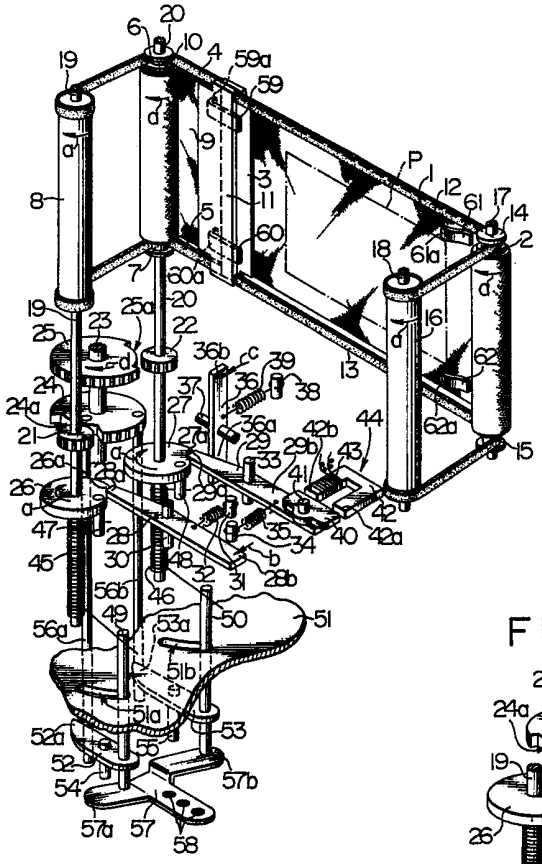

FIG. 2

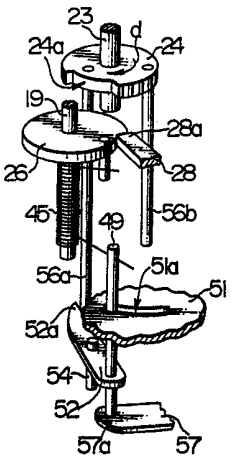

FIG. 3

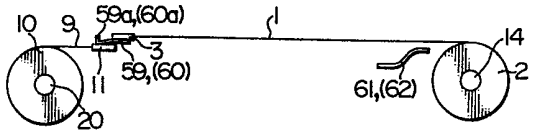

FIG. 4

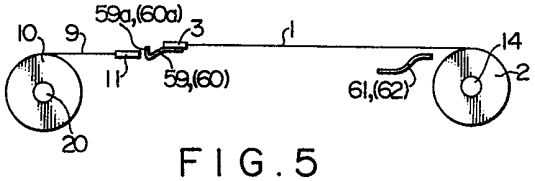

FIG. 5

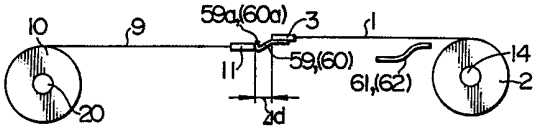

FIG. 6

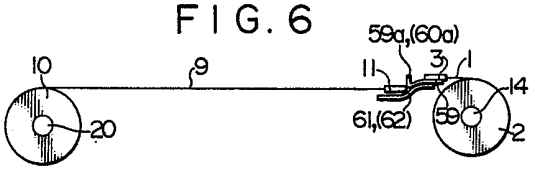

FIG. 7

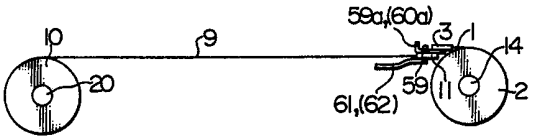

FIG. 8

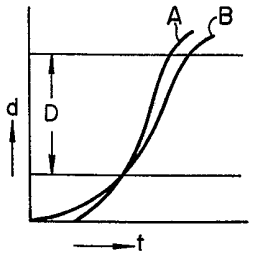

FIG. 9

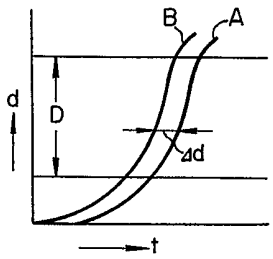

FIG. 10

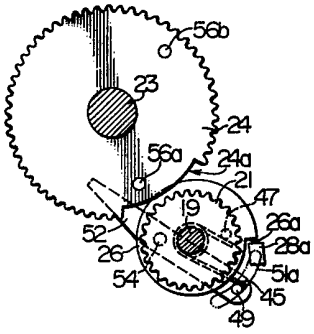

FIG. 11

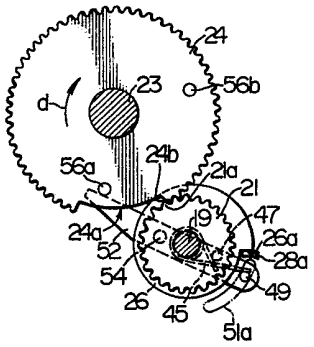

FIG. 12