Sept. 21, 1954 R. R. LOHMAN ET AL 2,689,916

ACTUATOR FOR BUCKY DIAPHRAGMS

Filed May 3, 1952 2 Sheets-Sheet 1

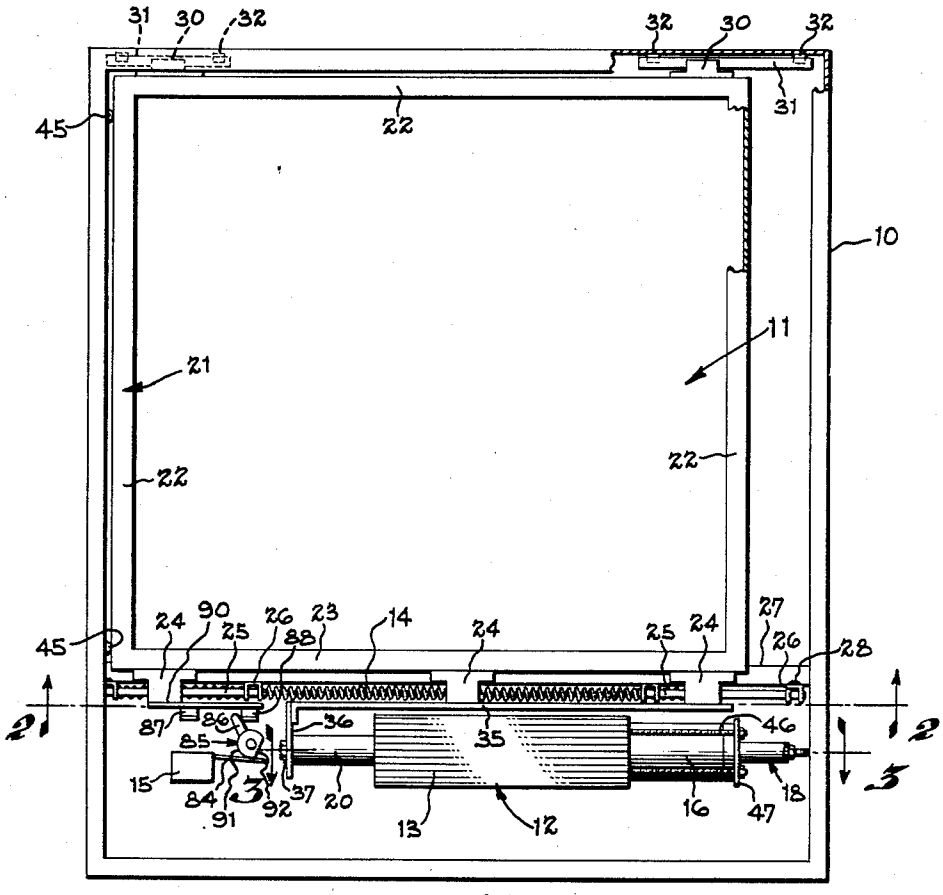


Fig. 1

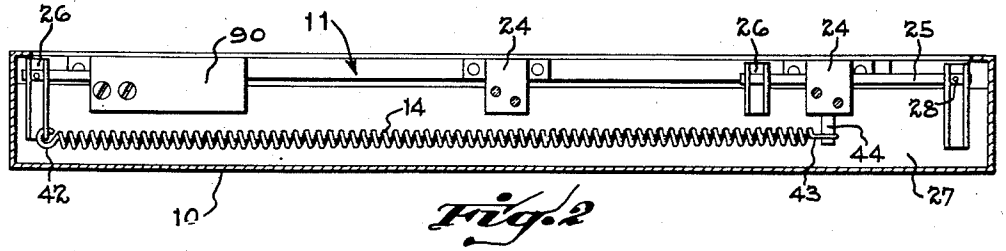


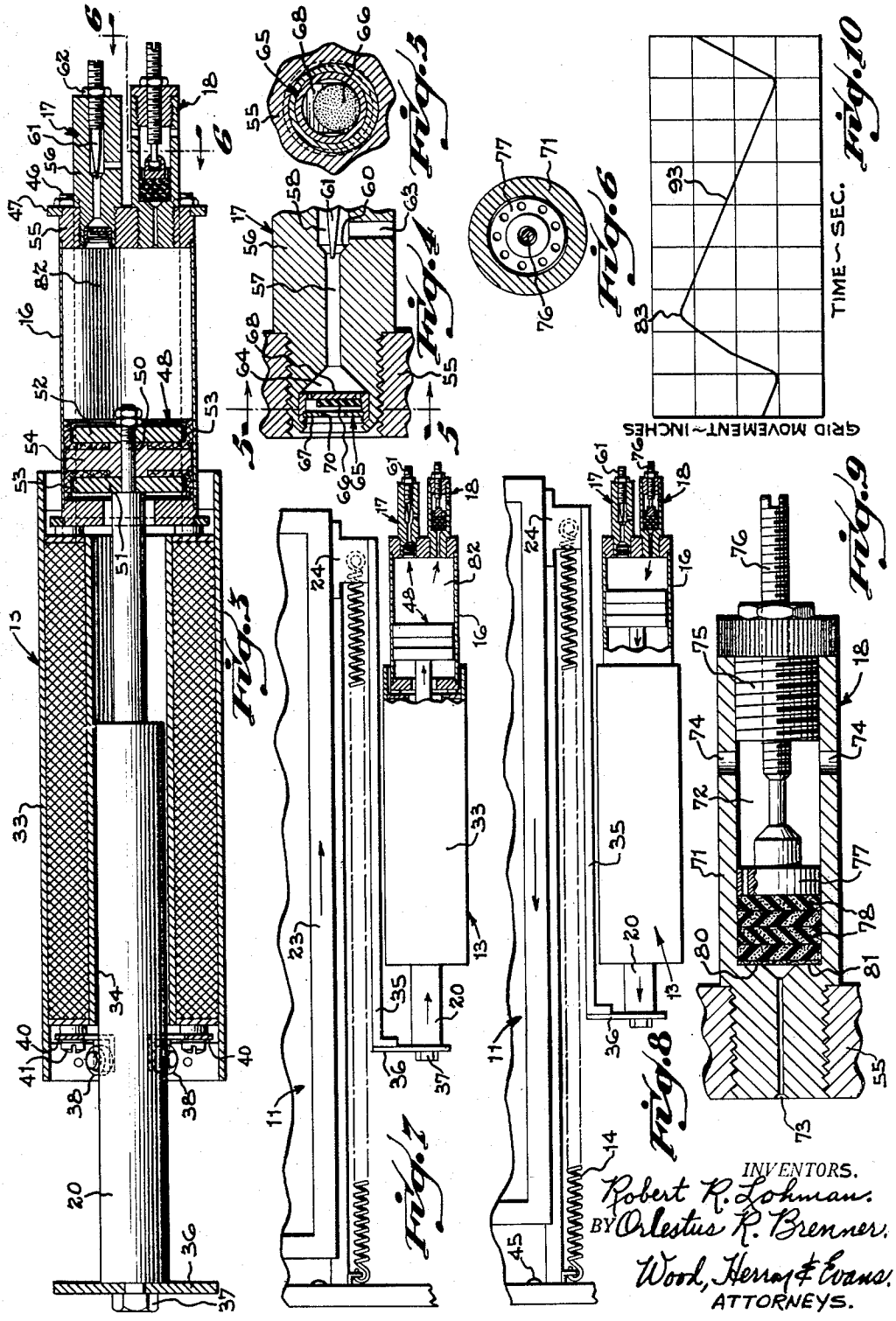
Fig. 2

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ACTUATOR FOR BUCKY DIAPHRAGMS

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12 Claims. (Cl. 250—63)

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This invention relates to diaphragms which are employed for screening secondary radiations from a photographic film in X-ray photography. The invention is directed particularly to an improved actuator through which the diaphragm is moved over the photographic film during an X-ray exposure.

A conventional diaphragm, termed a Bucky diaphragm from the name of its inventor, consists of a plurality of thin strips of material which are opaque to X-rays and which are arranged, on edge, in spaced relationship to one another. The diaphragm is interposed between the subject to be X-rayed and the photographic film or plate. Primary radiations generated at the X-ray tube pass through the subject and through the diaphragm to impinge upon the photographic film or plate, the slits of the diaphragm through which the X-rays may pass being angulated to coincide with the diverging stream of X-rays generated at the tube. However, in passing through a subject, some X-rays are scattered or deflected, thereby producing so-called secondary radiations which would blur the image on the photographic plate if they were unobstructed. It is the function of the Bucky diaphragm to screen such secondary radiations from the photographic medium; this result is accomplished because the grid or diaphragm permits the direct radiations to pass through its slits but it excludes radiations which approach it along paths outside of the angle of acceptance delineated by its slits.

The strips of the diaphragm which are opaque to X-ray would cast their shadows on the film if the diaphragm were stationary during an X-ray exposure. To avoid this result, it is conventional practice to move the diaphragm over the surface of the film during the exposure period. An actuator is employed for this purpose.

Some Bucky mechanisms are of the single-pass type, in which the diaphragm moves in one direction throughout the entire exposure period, the movement commencing just before the beginning of the exposure and terminating just after the end of the exposure period. More recently, so-called reciprocating Bucky mechanisms have been developed; in these devices the diaphragm is shuttled back and forth in opposite directions throughout the entire exposure, however long a period of time it might require. A single-pass actuator mechanism is disclosed in United States Patents to Flarsheim, No. 1,945,499 and 2,147,601 while reciprocating Bucky mechanisms are disclosed in Gieringer et al. United States patent application Serial No. 71,074, now issued as United States Patent No. 2,591,536 dated April 1, 1952, and Arthur G. Billin United States Patent application Serial No. 272,658.

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In both types of mechanisms, it is highly desirable if not requisite that the Bucky diaphragm once placed in motion in a given direction, be moved at a substantially uniform rate of speed, and that the same rate of speed be obtained in subsequent usage of the apparatus under the same setting or conditions. The necessity for this requirement is brought about because the X-rays are produced at the tube as pulsations, and these rays must pass through the slits in the diaphragm. If an X-ray pulsation happens to occur just when the X-ray opaque strips of the diaphragm reach the same relative position that other opaque strips of the diaphragm occupied during preceding pulsations, then the strips, though actually in movement, will cast shadows on the film just as though they were stationary, and the resultant photograph will be imperfect. A condition such as the one just noted is known in the art as synchronism; a non-synchronous condition is one in which the diaphragm is advanced in one direction, or moved in both directions at such rate or rates in relation to the X-ray pulsations and grid strip spacings that coincidence of strip positions with pulsations will not occur repeatedly during an exposure to such an extent that discernible or undesirable shadows will appear upon the photograph. Synchronism is avoidable by causing the diaphragm to be moved at a rate of speed which does not bear an integer or simple submultiple relationship to the pulsations of the X-ray tube, but it is apparent that if the velocity varies appreciably while the diaphragm is being moved in a given direction, the non-synchronous conditions may prevail during a part of its travel, while synchronous conditions may prevail during other parts of the travel because of velocity variation, and the net photographic results will be imperfect.

From these considerations it is apparent that the actuation of a diaphragm requires a motor mechanism of one type or another which imparts a constant speed of movement to the diaphragm each time that it is energized, or a control mechanism which is capable of governing the speed of movement regardless of variations which may occur in the performance of the motor mechanism, and that either or both of these instrumentalities must be consistent and reliable in their performance throughout prolonged usage of the apparatus. It is also desirable that the rate of

movement of the diaphragm be adjustable in order to accommodate the apparatus for use under conditions which may vary from one installation to another, or from one type of exposure to another within a single installation.

The principal objective of this invention has been to provide a simple and reliable Bucky actuator which can be used to obtain a substantially uniform movement of a Bucky diaphragm. The invention, more particularly, is directed to an inexpensive mechanism which can be fabricated without great regard for high precision in the machining of its parts but which is nevertheless capable of providing uniformity of speed in the travel of a diaphragm and which is also conveniently adjustable so that it may be set to produce a desirable or predetermined rate of travel.

Briefly, the apparatus of the present invention embodies a motor mechanism in the form of a solenoid, thrustor or the like which, when energized, exerts a force which is effective to move a diaphragm in one direction, a fluid cylinder and piston, one or the other of which is operated in response to motor actuation so as to produce a compression of a control fluid and thereby provide a force which is counteractive to the motor force, and a governor in the form of a porous membrane through which movement of fluid to or from the cylinder is controlled. The governor membrane is preferably of a multicellular construction, and the control fluid, which may be either oil or air is caused to pass through it. The rate at which the control fluid is allowed to pass through the cells, therefore, controls the rate at which the motor mechanism is capable of causing the Bucky diaphragm to be moved.

In accordance with the present invention, the porous governor membrane is preferably of a compressible nature whereby its density or permeability may be varied. In a typical construction, for example, a cellular sponge-like rubber may be employed as the membrane, and the permeability of the membrane may be adjusted very easily by altering the degree of compression to which it is subjected. The density of the membrane determines its permeability by the fluid, and therefore, controls the rate of movement of the control fluid.

In previous constructions such as the one shown in Flarsheim Patent No. 1,945,499, speed governors embodying hydraulic cylinders have been employed, the rate at which hydraulic fluid is permitted to escape being adjustable by means of an orifice or escape port of variable size. It is apparent that very precise machining of the parts is required to produce a satisfactory mechanism of this type, since any size imperfections, burrs or surface variations are capable of causing appreciable variations in the net size of the orifice. If dirt or gum lodges in the orifice, then the apparatus becomes out of adjustment. Also, even the air entrained in hydraulic fluid is capable of causing appreciable variations in performance because of the compressibility factor which is introduced by its presence, and for that reason a bellows mechanism was additionally employed in the construction of the aforesaid Liebel patent.

Previous pneumatic apparatus, on the other hand, has been unsatisfactory because the lodgment of dust or dirt in a tiny air escape port causes the apparatus to vary widely in performance, and, of course, it is virtually impossible to exclude dust from a mechanism of this

type. In the present construction, on the contrary, the net orifice opening through which air movement is controlled is constituted by a multiplicity of tiny cells, passageways or interstices in the membrane, and the clogging of any one of them has no consequential effect upon the functioning of those remaining open. Therefore, the apparatus operates satisfactorily and consistently under the most adverse dust conditions. Through filtering action of the diaphragm, dust particles caught and retained in its cells may gradually tend to clog it over a long period of time. However, when the diaphragm becomes too clogged to give satisfactory results, it may conveniently be replaced by a new diaphragm.

The compressibility through which permeability or rate of fluid flow is varied is obtained conveniently by mounting the diaphragm between perforated plates, one of which is movable so that the diaphragm between them may be subjected to more or less compression as desired. In this manner the apparatus may be set initially to provide any desired rate of travel under a given motor mechanism force.

As explained more fully in Patent No. 2,591,536 on "Reciprocating Bucky Diaphragm" it is highly desirable to construct a Bucky diaphragm so that it will move at a constant speed in one direction and then at a constant, but much lower speed, in the opposite direction. By arranging the diaphragm so that it always moves initially in the direction of higher speed, it is possible to prevent grid lines on a short exposure as well as on longer ones. It is another object of the present invention therefore, to provide a Bucky diaphragm actuator including a fluid damping cylinder which is provided with two governors, one of which is effective to control the rate piston movement in one direction, the other being effective to control the rate of movement in the opposite direction. The governors are so constructed that the diaphragm travels in one direction at a substantially higher speed than it travels in the opposite direction. Both governors may be of the porous type, or, as in the preferred embodiment disclosed herein, one governor of the porous type may be combined with another kind of governor.

While this invention is disclosed principally in connection with reciprocating diaphragm actuators, it will be understood that the principles of this invention may also be employed in a diaphragm actuator of the single stroke type.

These and other advantages of the present invention will be apparent from a consideration of the following detailed description of the drawings illustrating a preferred embodiment of the invention.

In the drawings:

Figure 1 is a general top plan view of a reciprocating Bucky diaphragm provided with an actuator of the present invention.

Figure 2 is a cross sectional view taken along line **2—2** of Figure 1.

Figure 3 is a cross sectional view taken along **3—3** of Figure 1.

Figure 4 is an enlarged view of the high speed valve shown in Figure 3.

Figure 5 is a cross sectional view taken along line **5—5** of Figure 4.

Figure 6 is a cross sectional view of the low speed valve taken along line **6—6** of Figure 3.

Figure 7 is an enlarged view of the actuator shown in Figure 1, both of the valves being shown in section to illustrate details of the valve action.

Figure 8 is a cross sectional view similar to Figure 7 showing the valve action as the piston cylinder moves in the opposite direction.

Figure 9 is an enlarged longitudinal cross sectional view of the low speed valve.

Figure 10 is a graph showing the relationship of grid position and time.

A reciprocating diaphragm provided with an actuator of this invention is shown in Figure 1. The apparatus includes a rectangular sheet metal housing **10**, a grid **11** disposed for sliding movement within the housing and an actuator mechanism indicated generally at **12**. The actuator includes a solenoid or thrustor mechanism **13** for moving the grid in one direction and a spring **14** for moving it in the opposite direction. To provide for continuous reciprocation throughout an exposure period, an electrical circuit of the type generally disclosed in Patent No. 2,591,536 may be electrically connected to the solenoid for alternately energizing and deenergizing it. This electric circuit includes a switch **15** actuated by movement of the grid structure and arranged to deenergize the solenoid each time the grid reaches the end of its travel toward the right. Also in series with the reversing switch is a control switch (not shown) manipulated by an operator or by mechanical or electric timer to control the length of time during which the diaphragm will continue to reciprocate.

So long as this control switch is closed, the grid will continue to reciprocate, moving to the right whenever the solenoid is energized and moving in the opposite direction under the influence of the spring tension whenever the solenoid is deenergized. The rate of diaphragm movement in either direction is controlled by a damping cylinder, indicated generally at **16**, and including valves **17** and **18**. The damping cylinder **16** may be mounted in any convenient manner upon housing **10**, or, as in the preferred embodiment, the damping cylinder may be secured directly to solenoid **13**, and contains a reciprocating piston **20** which is secured to the grid structure **11**.

The Bucky grid itself includes the usual plurality of vertically disposed lead strips, delineating slits through which X-rays pass to the photographic plate; the exact diaphragm structure is not illustrated and in fact this invention may be used with any diaphragm which is effective to prevent secondary radiation from striking the photographic plate. The diaphragm is slidably mounted within a marginal frame **21**, preferably formed of channel shaped strips **22** joined together at the corners. The forward edge **23** of the grid assembly **11** carries bearing blocks **24** which are slidably mounted on a pair of rods **25**.

Rods **25** are supported by U-shaped brackets **26** which are, in turn, secured, as by spot welding, to bar **27** extending transversely of the housing **10**. Set screws **28** are provided for fastening the rods within apertures provided in the brackets **26**. The rearward edge of diaphragm **11** is reciprocally supported by bearing blocks **30**, engaging rails **31** which are supported from frame **10** by means of brackets **32**. Thus bearing blocks **24** and **30** support the Bucky diaphragm relative to housing **10** and permit it to be reciprocated transversely with respect to the housing.

The exact construction of solenoid **13** constitutes no part of the present invention, since any of a number of commercially available solenoids may be employed. Generally, however, the solenoid includes a wound coil disposed within a housing **33** which is mounted in any suitable manner upon the housing **10**. A plunger **20** is reciprocally mounted within the central opening **34** of the solenoid coil. The plunger is joined to the diaphragm by means of a bracket **35** which is carried by bearing blocks **24**. Bracket **35** includes an extension **36** to which the plunger **20** is joined as by bolt **37**. Bearing rollers **38** for guiding plunger **20** are mounted upon the solenoid housing **33** by means of brackets **40** and bolts **41**. The solenoid when energized is effective to cause the plunger **20** to move to the right, in turn causing the movement of the entire diaphragm structure.

Spring **14** is also connected to the diaphragm frame **11**, the spring being placed in tension by diaphragm movement to the right. As shown particularly in Figure 2, one end **42** of spring **14** is looped and engages a suitable opening in left hand bracket **26**. The other end **43** of the spring is looped around an extension **44** on bearing block **24**. The spring is in a condition of maximum tension when the diaphragm reaches the limit of its travel to the right, and causes reversal of the diaphragm almost as soon as the solenoid is deenergized. Travel of the diaphragm to the left is governed by the position of stops **45** mounted upon the left hand edge of housing **10** and disposed for engagement with frame **11** of the Bucky diaphragm.

Control of the rate of Bucky movement is exercised by damping cylinder **16** which is axially aligned with the central opening in the solenoid housing and is joined to the housing by means of bolts **46** engaging flange **47** of the cylinder. At one end the damping cylinder is provided with an aperture for receiving the solenoid plunger. Preferably the aperture is substantially larger than the solenoid plunger so that air can freely enter or leave this end of the cylinder. A piston head **48** resides within cylinder **16** and is secured to the end of solenoid plunger **20** by means of bolt **50**. The piston head may be of any type adapted for air-tight engagement with the cylinder wall, and as shown includes discs **51** and **52** and packing members such as leather cups **53** which fit between discs **51** and **52** and central disc **54**.

The end of cylinder **16** remote from the solenoid housing is fitted with two valves **17** and **18** for controlling the rate of admission and escape of air from cylinder **16**. Since piston **48** compresses the air within cylinder **16** when the piston moves to the right and creates a vacuum when it moves to the left, piston movement is impeded by an amount dependent upon the rate at which air can enter or leave cylinder **16** through valves **17** and **18**. Valve **17** controls the escape of air from the cylinder and consequently regulates the movement of the Bucky diaphragm to the right under the influence of solenoid energization. Valve **18** controls the admission of air to the cylinder and consequently regulates the rate of Bucky movement to the left under the influence of spring **14**.

More particularly, valves **17** and **18** are threaded into end member **55** which is secured as by welding to the end of the casing and is held in place by flange **47**. High speed valve **17** includes a casing **56** configurated to form a longitudinal passageway **57**, and an enlarged open portion **58** forming a seat **60** for cooperation with needle valve **61**. Needle valve **61** is threaded into the end of opening **58** and is held in position by means of nut **62**. Threading the needle valve inwardly or outwardly decreases or increases the rate at which air can pass between the needle valve **61** and seat **60** and through passageway **57** and opening **63**. A sec-

ond enlarged chamber 64 is provided for receiving the check valve 65 which functions to close valve 17 completely to the flow of air into the cylinder. The check valve structure includes a disc 66 mounted between plates 67 and 68. Plate 67 is provided with a central aperture 70 of a diameter smaller than disc 66. Plate 68 is provided with a series of peripheral apertures, some of which are disposed so that they are not closed by disc 66 even when the disc is in a position abutting the plate. The check valve functions so that when the piston is moving to the right and the pressure inside the cylinder is higher than it is outside, disc 66 is moved from a position covering the central aperture in plate 67 to a position abutting plate 68. In this latter position air can flow from the cylinder through the central aperture in plate 67, through the peripheral apertures in plate 68 and then through passageways 57 and 63 into the atmosphere.

The setting of needle valve 61 regulates the rate of flow of air from cylinder 16, and hence the rate at which the piston can be moved by the solenoid toward the right hand end of the cylinder. However, when the piston is moving toward the left, the lower air pressure within cylinder 16 causes disc 66 to shift to a position covering central aperture 70 of plate 67. In this position the disc prevents air from entering the cylinder through valve 17 so that only valve 18 exercises control over piston movement to the left.

Low speed valve 18, in the embodiment disclosed, functions to control the inlet of air to cylinder 16 whenever the Bucky diaphragm and piston are moving to the left under the influence of the tension of spring 14. As previously explained, when used in conjunction with a reciprocating Bucky diaphragm, it is highly desirable that the piston move to the left at a lower rate of speed than to the right. Consequently, valve 18 should admit air to the cylinder 16 at a substantially smaller rate than it escapes through valve 17 when the piston moves to the right. Valve 18 thus must present a high resistance to air flow; but for any given setting of the valve, the resistance should remain substantially constant and should not be appreciably affected by the accumulation of dust particles. I have found that a high resistance to air flow may be obtained by constructing valve 18 so that it presents a multiplicity of minute air paths rather than a single path of larger size.

More particularly, valve 18 includes a housing 71 which is threaded into end plate 55, the housing is provided with an axial chamber 72 and a small passageway 73 interconnecting the chamber and the interior of cylinder 16. Opening 74 vents chamber 72 to the atmosphere, the end of the chamber remote from the cylinder being closed by a threaded plug 75. Plug 75 is also threaded interiorly to receive threaded rod 76. Rod 76 is provided with a perforated plate 77 disposed at one end of the rod in abutment with cellular member 78. Cellular member 78 forms a large number of small passageways through which air may pass through the member. The member 78 may be constituted by any suitable type of material; sponge rubber having been found very satisfactory. In the embodiment shown, the cellular member includes four discs of rubber which are compressed between plate 77 and a wire disc 80, residing against shoulder 81 formed at the end of chamber 72.

The cellular member 78 provides a very large number of air passages from passageway 73 to chamber 72, the resistance of these passageways offer to air flow is determined by the density of the cellular material, which in turn is affected by the degree to which it is compressed by perforated plate 77. Consequently, flow of air through the valve can be accurately regulated by tightening or loosening threaded rod 76.

When the piston head is moving from right to left, the pressure within cylinder 16 is less than the pressure of the atmosphere and disc 66 is forced against plate 67 covering the central aperture 70 to prevent any entrance of air into the cylinder through valve 17. Consequently, the return movement of the Bucky diaphragm is controllably retarded solely by the amount of air permitted to enter chamber 16 through valve 18 and relieve the pressure in space 82 behind the piston.

Obviously, the damping cylinder and valves can be arranged in a number of ways, for example, so that valve 18 governs the escape of air from the cylinder and valve 17 controls the intake of air to the cylinders. Also it is possible to employ a multicellular construction such as is utilized in valve 18 for the high valve, or for both the low and high speed valves.

When the control switch in the solenoid energization circuit is depressed, the grid, which always starts an exposure period from its extreme left hand position, starts to move to the right due to the attraction of the solenoid coil. As shown diagrammatically in Figure 10, the diaphragm moves relatively rapidly to the right, slowing down only slightly as it approaches its extreme position indicated at 83 where it reverses its direction of travel. Just prior to the point at which the diaphragm reaches this position, switch 15 is tripped to deenergize the solenoid thereby rendering spring 14 effective to return the diaphragm to the left.

Any suitable type of switch can be used to deenergize the solenoid at this point in the diaphragm travel, one effective type of switch being shown in Figure 1. As shown, a microswitch is provided with a spring finger 84 which rides against a cam plate 85, pivotally mounted upon housing 10. The cam plate has an arm extension 86 disposed for engagement with either of two lugs 87 and 88 secured to bracket 90. Lug 88 is located so that just as the diaphragm reaches its extreme left hand position the lug comes into engagement with arm 86 of cam 85 rotating the cam so that portion 90 depresses spring finger 84 to close switch 15. This energizes the solenoid conditioning the actuator for Bucky movement to the right. Similarly as the diaphragm approaches its extreme right hand position, lug 87 engages finger 86, rotating the cam so that flat portion 92 engages switch finger 86, allowing the switch finger to spring toward the cam thereby opening the switch and deenergizing the solenoid. This conditions the diaphragm for movement to the left under the influence of spring 14.

As the diaphragm starts to move to the left after deenergization of the solenoid, a vacuum is created in space 82 behind the piston, forcing disc 66 of valve 17 over aperture 70 and thereby preventing air from entering the cylinder through that valve. Low speed valve 18 thus controls the flow of air into the cylinder, and, since this valve presents a high resistance to air flow, a pressure unbalance is created on the piston head, retarding diaphragm movement to the left. This slower rate of movement is indicated diagrammatically

in Figure 10 by the portion of the curve marked 93.

Having described our invention we claim:

1. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising, a motor mechanism for providing an actuating force in one direction, a cylinder having a piston in connection with the motor mechanism to provide a counteractive force, the said cylinder and piston mechanism having a fluid outlet, and a governor for controlling the rate of passage of fluid through said outlet comprising a porous cellular diaphragm disposed within said outlet and being adapted for fluid flow therethrough, the fluid within said cylinder acting upon said piston to provide a force counteractive to said actuating force.

2. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising, an electric solenoid having a movable plunger, a cylinder and piston damping mechanism in connection with said plunger for providing a force counteractive to the thrust of said plunger, and a fluid circuit in communication with said damping mechanism having a governor member in the form of a porous diaphragm disposed within said fluid circuit and adapted for fluid flow therethrough, said diaphragm being effective to control the extent of counteractive force provided by said damping mechanism.

3. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising, motor mechanism for exerting a force in one direction, fluid damping means in connection with said motor mechanism for exerting a counteractive force in an opposite direction in consequence of motor actuation said damping means includes a fluid circuit, and a governor member for controlling the degree of counteractive force exerted by said fluid damping means, said governor member including a porous cellular member in said fluid circuit of the damping means for impeding the flow of fluid in said damping means.

4. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising, a cylinder having a piston therein and a valved inlet, a power actuator for moving said piston, said cylinder having an air outlet passageway through which air can escape in consequence of piston movement, and a sponge rubber cellular member, permeable by air, said sponge rubber cellular member being disposed within said air outlet passageway, to control the rate of air escape from said cylinder.

5. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising, a motor mechanism for providing an actuating force in one direction, a cylinder having a piston in connection with the motor mechanism to provide a counteractive force, the said cylinder and piston mechanism having a fluid passage and a governor for controlling the rate of flow of fluid through said passage comprising a porous cellular diaphragm residing within said passageway, the said porous cellular member being compressible, and means for compressing the said member to adjust its permeability with respect to flow of air therethrough.

6. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising, a cylinder having a piston therein and a valved outlet, a power actuator for moving said piston, said cylinder having an air inlet passageway through which air can enter in consequence of piston movement, and a sponge rubber cellular member, permeable by air in communication with said inlet passageway to control the rate of air admission to said cylinder.

7. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising a motor mechanism for providing an actuating force in one direction, spring means for alternately providing an actuating force in the opposite direction when said motor mechanism is rendered inoperative, means for rendering said motor mechanism alternately operative and inoperative, a cylinder having a piston in connection with the motor mechanism to provide a counteractive force opposing whichever of said actuating forces is causing diaphragm movement, the said cylinder and piston mechanism having two fluid valves including passageways communicating with said cylinder, at least one of said valves having a porous cellular diaphragm residing within said passageway.

8. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising a motor mechanism for providing an actuating force in one direction, spring means for alternately providing an actuating force in the opposite direction when said motor mechanism is rendered inoperative, means for rendering said motor mechanism operative and inoperative, a cylinder having a piston in connection with the motor mechanism to provide a counteractive force opposing whichever of said actuating forces is effective to cause diaphragm movement, the said cylinder and piston mechanism having two fluid valves including passageways in communication with said cylinder, at least one of said valves having a flow controlling porous cellular diaphragm disposed within its passageway, and means for adjustably compressing said porous cellular diaphragm for varying its resistance to fluid flow whereby the magnitude of said counteractive force can be regulated.

9. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising a motor mechanism for providing an actuating force in one direction, means for providing an actuating force in the opposite direction when said motor mechanism is rendered inoperative, means for rendering said motor mechanism operative and inoperative, a cylinder having a piston reciprocably mounted therein, said piston being in mechanical interconnection with said diaphragm and being effective to apply a counteractive force thereto in opposition to whichever of said actuating forces is effective to cause diaphragm movement, said cylinder and piston mechanism having a first and a second fluid valve therein, each of said valves including a passageway communicating with said cylinder, said first valve being open at all times to permit fluid flow therethrough, said second valve being open to permit fluid flow therethrough when the piston is moving in one direction but being closed to fluid flow when the piston is moving in the opposite direction, said first valve including a porous cellular diaphragm residing in fluid connection with said passageway and presenting a higher resistance to fluid flow than said first valve.

10. An actuator for a diaphragm for screening secondary X-ray radiations from a photo-

graphic film, said actuator comprising a motor mechanism for providing an actuating force in one direction, a cylinder having a piston reciprocably mounted therein, said piston being in mechanical interconnection with said diaphragm and being effective to transmit thereto a counteractive force, said cylinder and piston mechanism having a valve therein, said valve including a fluid passageway in communication with said cylinder, and a porous cellular diaphragm residing within said passageway, the resistance to fluid flow of said cellular member resulting in a pressure unbalance on opposite sides of said piston to provide said counteractive force.

11. An actuator for a diaphragm for screening secondary X-ray radiations from a photographic film, said actuator comprising a motor mechanism for providing an actuating force in one direction, a cylinder having a piston reciprocably mounted therein, said piston being in mechanical interconnection with said diaphragm and being effective to transmit thereto a counteractive force, said cylinder and piston mechanism having a valve therein, said valve including a fluid passageway in communication with said cylinder, and a porous cellular diaphragm residing within said passageway having a resistance to fluid flow which is sufficient to provide a pressure unbalance on opposite sides of said piston and means for adjustably compressing said porous member to alter its resistance to air flow, thereby changing the magnitude of the counteractive force.

12. An actuator for a diaphragm for screening X-ray radiations from a photographic film said actuator comprising a motor mechanism for providing an actuating force in one direction, a cylinder having a piston reciprocably mounted therein, said piston being in mechanical interconnection with said diaphragm and being adapted to transmit a counteractive force thereto, said cylinder and piston mechanism having a fluid valve, said valve being provided with a fluid passageway communicating with the interior of said cylinder, a porous cellular diaphragm disposed within said passageway and presenting a resistance to the flow of fluid therethrough, a stationary apertured member abutting one surface of said diaphragm, a movable apertured member abutting the opposite surface of said diaphragm, and means for adjustably positioning said movable apertured member for compressing said porous cellular diaphragm to vary the resistance offered by said diaphragm to fluid flow through said passageway.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,464,478	Greenwood	Aug. 7, 1923
1,508,391	Greenwood	Sept. 16, 1924
1,945,499	Flarsheim	Jan. 30, 1934
2,077,295	Whitney	Apr. 13, 1937
2,147,601	Flarsheim	Feb. 14, 1939
2,309,499	Chenault	Jan. 26, 1943
2,591,536	Gieringer et al.	Apr. 1, 1952