Dec. 1, 1936. R. F. DENT 2,062,562

BUCKY DIAPHRAGM

Filed Dec. 31, 1934

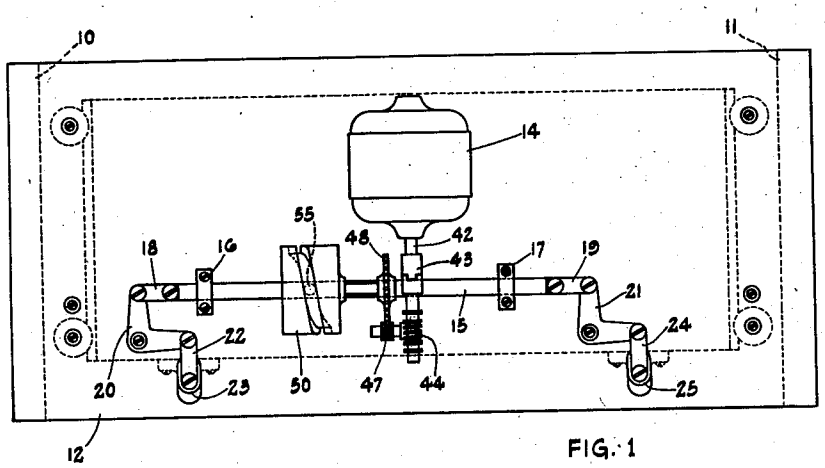


FIG. 1

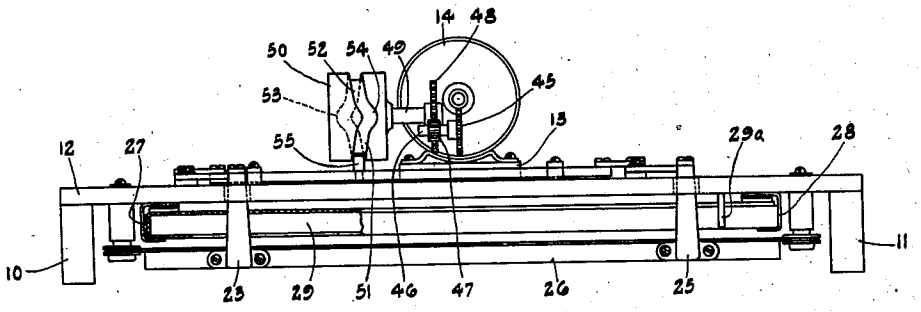


FIG. 2

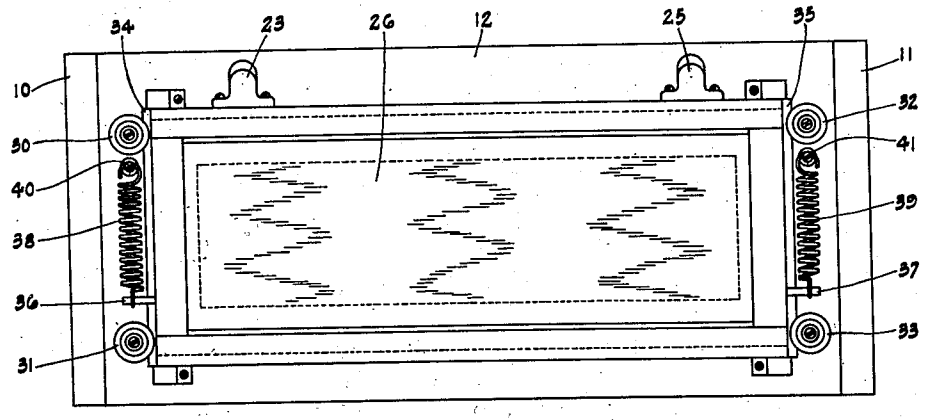


FIG. 3

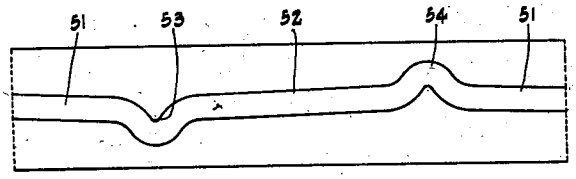


FIG. 4

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BUCKY DIAPHRAGM

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2 Claims. (Cl. 250—34)

The present invention has to do with X-ray photography or radiography as it is frequently designated, and relates to an improved means for actuating a bucky diaphragm during its use in extended exposures.

The primary object of the present invention is the provision of an improved means for moving a bucky diaphragm so that it may be successfully used during extended exposures without producing excessive shadow lines upon a film or plate.

A secondary object of the invention is the provision of an improved means for moving a bucky grid in a manner which will produce the most efficient results and avoid undesired uneven markings upon a film or plate.

A further object of the invention is the provision of novel means for mounting a bucky grid and for moving such grid in its mounting.

These objects, and such other objects as may hereinafter appear, are obtained by the novel construction, improved arrangement and unique combination of the several elements which constitute the invention, one embodiment of which is illustrated in the accompanying single sheet of drawing, hereby made a part of this specification, and in which:

Figure 1 is a plan view of a device made in accord with the invention and illustrating the motor, cam, and driving parts for the bucky diaphragm;

Figure 2 is a side elevation of the device shown in Figure 1;

Figure 3 is a plan view of the device shown in Figure 1 and taken from the opposite side of the apparatus; and

Figure 4 is an enlarged detail, in a flat plane, of a cam track employed to impart movement to the bucky diaphragm shown in Figures 1, 2 and 3.

Like reference characters are used to designate similar parts in the drawing and in the following description.

A frame supports the bucky diaphragm and comprises end pieces **10** and **11** which are suitably attached to a table, stand or the like (not shown). Between the end pieces **10** and **11** is a base or platform **12**. The platform **12** supports a motor base **13** on which a motor **14** is mounted.

Extending longitudinally of the base **12** is a reciprocating bar **15**. The bar **15** is supported by bearing brackets **16** and **17** suitably mounted on base **12**. At each end of the bar **15** are links **18** and **19**. Links **18** and **19** are pivotally connected to bar **15** and to bell crank levers **20** and **21**. One end of each of the bell crank levers is pivotally connected to a link. The central point or fulcrum of each bell crank lever is pivotally mounted in any suitable manner upon the adjacent face of the base **12**. The other end of each bell crank lever **20** and **21** is connected to a link. Link **22** at one end of base **12** is pivotally connected to a bracket **23**. Link **24** at the other end of the base **12** is pivotally connected to a similar bracket **25**. Brackets **23** and **25** are secured to the edge of a bucky diaphragm **26**.

On the side of the base **12** opposite to that on which the linkage just described is mounted are a pair of opposed U-shaped members **27** and **28** which form tracks for a cassette **29**. The cassette **29** is removably disposed on said tracks. A stop **29***a* limits movement in one direction. Means in the form of a latch or lock, not shown, may be used for seating the cassette in a predetermined position on said tracks and to maintain said cassette against accidental movement and against said stop **29***a*.

The cassette **29** is between the bucky diaphragm **26** and the base **12**. The bucky diaphragm shown is of the flat type comprising alternate strips of lead and wood. This is a conventional structure for flat bucky diaphragm.

Also mounted upon the diaphragm side of the platform **12** are standards **30**, **31**, **32** and **33**, having at their ends grooved roller bearings. The bucky diaphragm **26** has flanges **34** and **35** which fit into the roller bearings to permit of transverse movement of the bucky diaphragm **26** from one side to the other side of the platform. Such rollers maintain the bucky diaphragm **26** in a fixed path at a predetermined distance from the cassette **29** whether the apparatus is used above a tube, below a tube or in a vertical position at the side of a tube. At each end, the cassette **26** has a stud, **36** and **37**. On each stud is a hook end of a coil spring, the spring engaging stud **36** being marked **38**, and that engaging stud **37** being marked **39**. Each spring has a hook at its other end, such other hook end being anchored to a pin or other suitable fastening means **40** and **41** anchored in platform **12**. The bucky diaphragm, therefore, is always under spring tension, the two springs **38** and **39** urging the diaphragm at all times to one end of its course of movement on the platform. Such tension assists materially in maintaining a uniform cycle of movement for the diaphragm.

The bucky diaphragm is motor driven. The driving mechanism comprises the electric motor **14** suitably connected by a source of energy, by conduits and a switch, (not shown). The motor

14 drives a shaft 42 which is coupled at 43 to a suitably supported worm 44. The worm 44 meshes with a gear 45 upon a shaft 46 having thereon a gear 47, the shaft 46 being suitably mounted for rotation.

The gear 47 meshes with a gear 48 on a shaft 49 also suitably mounted for rotation. The gear 48 is at one end of a shaft 49 and a cam 50 with a peripheral track is at the other end of said shaft 49.

The cam 50 has a peripheral track divided into straight sections 51 and 52 and curved sections or humps 53 and 54. (See Figure 4.)

A pin 55 upon bar 15 rides in the track in the face of cam 50, and through the several gears described is given alternate reciprocal and accelerated movement as the cam 50 is rotated by the motor 14.

The shape of the cam track is such that it produces movement of the pin 55 first in one direction and then in the other direction. The rate of movement may be constantly changed. At the points of direction reversal, the movement of the pin 55 is accelerated. The acceleration is approximately in the ratio of four to one. The bucky diaphragm which moves in a cycle controlled by the pin movements travels transversely of the support 12 at a uniform speed until the end of its path of movement in each direction is approached. At the ends of the path, the speed of the diaphragm is accelerated as indicated and such acceleration extends to the end of the path of movement and for a limited distance over the path of movement in the reverse direction. The bucky diaphragm then travels to adjacent the other end of its path at a selected rate of speed which may be constant or changing. Its speed is accelerated at the other end in the same manner over the period of the reversal of its movement. Equal portions of the movement of the diaphragm toward and away from the end of its path in either direction are accelerated in equal degree.

The operation of the apparatus is substantially as follows:

A cassette containing a sensitized film or plate is put in position upon the tracks 27. It may be latched into a fixed position. The motor 14 is then energized. The exposure is then started. An X-ray tube is energized for this purpose. The object to be radiographed is disposed between the tube and bucky diaphragm 26. The length of the exposure generally is a large multiple of the time required for the bucky diaphragm 26 to travel across the base 12 and back again. In fact, the cycle of movement of the bucky diaphragm may be ten seconds and the exposure may be an hour and a half or more.

The present apparatus overcomes the difficulty which has been encountered from time to time in the taking of X-ray photographs using a bucky diaphragm. Bucky diaphragms have been made to move transversely of tables and other supports. The speed has been regulated by a dashpot or by a mechanical means when the bucky was moved from one side to the other only. When it was necessary to move the bucky diaphragm from one side to the other side before the exposure was complete heavy shadow lines developed on the photograph. Numerous efforts have been made to obtain pictures using a bucky diaphragm and without objectionable shadow lines.

Continuous diaphragms have been suggested but these are bulky, difficult to handle, and generally get out of order because it is necessary to make such diaphragms with relatively movable parts. All previous efforts to take satisfactory pictures with a reciprocating diaphragm have been more or less unsuccessful in that undesirable shadow lines have developed on the photograph parallel to the lead strips within the diaphragm. These lines were produced incident to the changes in the course of the diaphragm, that is, the undesirable shadow lines resulted from the diaphragm coming to a stop as it reversed its movement.

It has been discovered by the applicant that by accelerating the speed of the diaphragm at the end of its strokes in either direction and continuing such acceleration during the initial portion of the return movement of the diaphragm and by establishing a ratio between the periods of acceleration and the periods of normal movement, he can overcome the difficulty of photographing undesirable lines upon the radiograph and the distorting lines heretofore developed and found objectionable are not found in negatives produced with the present apparatus.

From experiment and actual operation, it has been found that highly satisfactory results are obtained when the proportion of the movement of the diaphragm that is accelerated is about one-sixth or one-seventh of the total travel of the diaphragm, and the degree of acceleration is about four times the normal movement of the diaphragm. The period of complete stoppage of the diaphragm under these circumstances is quite brief if a complete cycle of movement of the diaphragm in both directions requires ten seconds. Care, of course, must be exercised not to have the movements of the diaphragm 26 in synchronism with the energization of the X-ray tube, such energization being timed by the impulses of current impressed thereon. In half wave rectification of sixty cycle current, these impulses are sixty to the second and in full wave one hundred and twenty to the second.

As illustrated, the apparatus may be used with the X-ray tube above the diaphragm 26, or below the diaphragm, or at the side of the diaphragm by reversing the apparatus in a horizontal plane or by moving the apparatus into a vertical plane. The operation of the device is substantially the same in any of these positions because of the spring tension under which the diaphragm is maintained at all times. The inertia to be overcome by the motor in each position, for operative purposes, is substantially the same.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. In combination, a support frame, a radiographic diaphragm mounted for reciprocating sliding movement on said frame, a cylindrical drum journalled on said frame, means on said frame for rotating the drum at substantially uniform angular velocity, said drum having a continuous slot formed in the cylindrical surface thereof, said slot comprising complementary substantially helical portions extending oppositely in said drum from a point spaced from one end thereof to a point spaced from the opposite end of the drum, said slot at the intersection of said complementary helical portions defining salients extending each toward the adjacent end of the drum, cam following means supported on said frame and extending in said slot and drivingly connected with said diaphragm to reciprocate the same in response to rotation of said drum.

2. In combination, a support frame, a radiographic diaphragm mounted for reciprocating

sliding movement on said frame, a cylindrical drum journalled on said frame, means on said frame for rotating the drum at substantially uniform angular velocity, said drum having a continuous slot formed in the cylindrical surface thereof, said slot comprising complementary substantially helical portions extending oppositely in said drum from a point spaced from one end thereof to a point spaced from the opposite end of the drum, said slot at the intersection of said complementary helical portions defining salients extending each toward the adjacent end of the drum, cam following means supported on said frame and comprising a member longitudinally slidable on the frame in a direction substantially parallel with respect to the axis of said drum, said member having a cam following projection extending in said slot and bellcrank means tiltable on said frame and having a portion connected to said member and another portion drivingly connected with said diaphragm whereby reciprocating movement imparted in said member by the turning of said drum may cause reciprocation of said diaphragm in a direction intersecting the direction of reciprocating movement of said member.

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