March 4, 1941. R. E. MEDER 2,233,744

AUTOFOCUS ENLARGER

Filed Feb. 17, 1939 2 Sheets-Sheet 1

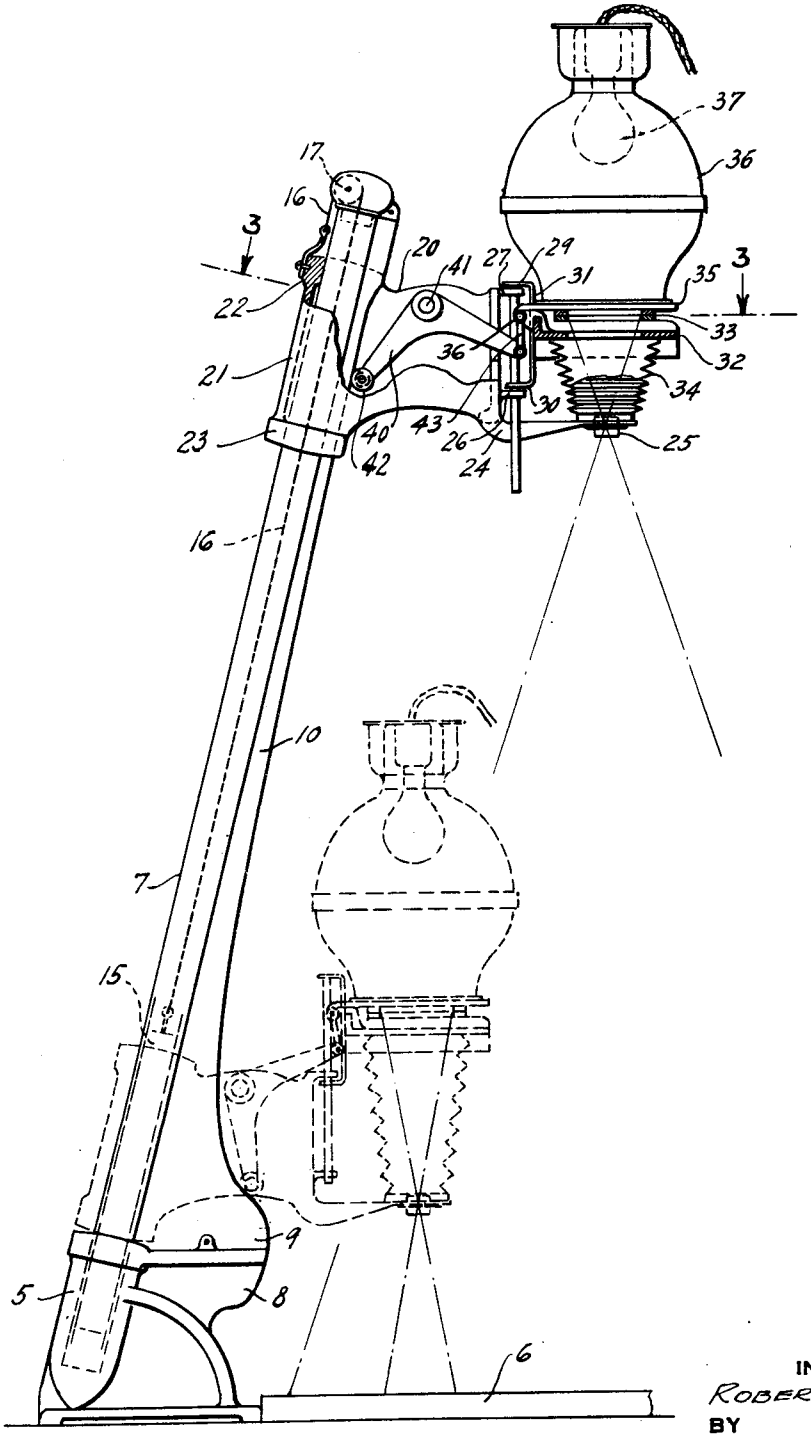


Fig. 1

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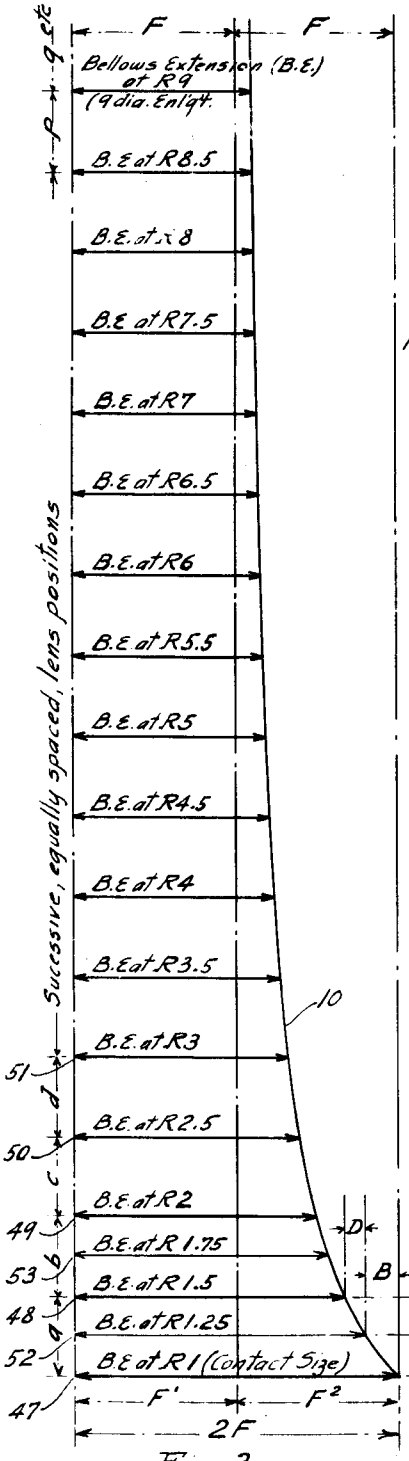


Fig. 2

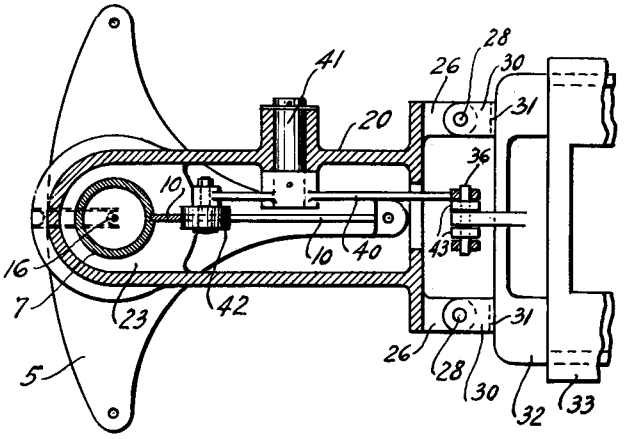


Fig. 3

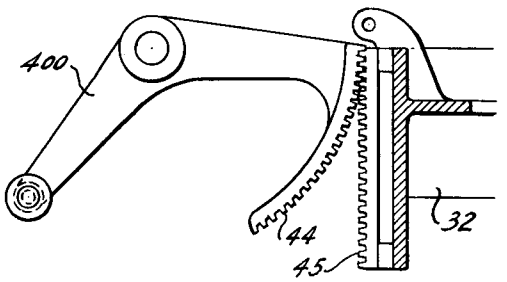


Fig. 4

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Patented Mar. 4, 1941 2,233,744

UNITED STATES PATENT OFFICE

2,233,744

AUTOFOCUS ENLARGER

Robert E. Meder, Milwaukee, Wis.

Application February 17, 1939, Serial No. 256,923

4 Claims. (Cl. 88—24)

This invention relates to improvements in autofocus enlargers.

The primary object of the invention is to provide improved automatic adjustment means in an enlarger of the type wherein vertical adjustment of the lens is accompanied by a corresponding corrective adjustment of the negative to effect correct focusing throughout the range of said vertical adjustment.

More specifically a primary object of the invention resides in the provision of a simplified structure for the transmission of motion from one end of a bell crank to a negative holder.

A further object of the invention is to provide a simplified structure of the character described which is adapted to be manufactured at a low cost.

Other objects will be apparent to those skilled in the art upon examination of the following disclosure of the invention.

In the drawings:

Figure 1 is a view in side elevation showing an enlarger embodying my invention with its carriage and associated parts shown in full lines in elevated position and appearing in dotted lines in a lowered position.

Figure 2 is a chart showing the layout and development of an ideal cam surface for use in the carrying out of my invention.

Figure 3 is a fragmentary view on an enlarged scale taken in section on line 3—3 of Figure 1.

Figure 4 is a fragmentary detail view taken in vertical transverse section through the carriage to expose a modified form of motion transmitting connection for effecting compensatory movement of the negative holder during the adjustment of the carriage.

Like parts are identified by the same reference characters throughout the several views.

In the particular device disclosed there is a base 5 adapted to be screwed or otherwise connected to the surface of the table on which the enlarging easel of screen 6 is laid. Any conventional easel may be used.

The base 5 is designed to support an inclined column 7 and is provided with an integral bracket at 8 to position the enlarged lower end portion 9 of the cam 10 which extends longitudinally of the column to control the compensatory movement which effects automatic focus.

The column 7 is preferably made tubular and within its hollow interior there is a counterweight 15 connected by a flexible wire or cable 16, running over pulley 17 with the carriage 20 which comprises a sleeve 21 having upper and lower bearing portions 22 and 23 accurately fitted to column 7 and cam 10 to slide smoothly on column 7, the cam performing the added function of a key to hold the carriage against lateral or angular displacement respecting the column.

Projecting forwardly from the lower end of the carriage 20 is an arm 24 in which the lens 25 is fixed for the purposes of the present invention. Above arm 24 the carriage is provided with forwardly projecting pairs of ears 26 and 27, the respective ears 26 being spaced laterally as shown in Fig. 3, and the respective ears 27 being disposed directly above ears 26. Slidable through each ear 26 and its corresponding ear 27 is a rod 28 connected with upper and lower ears 29 and 30 which are likewise arranged in pairs on brackets 31 which carry the sub-frame 32 on which the negative holder 33 is mounted. This arrangement permits the bodily movement of the negative holder 33 on sub-frame 32 with respect to the lens 25. To permit of such movement while at the same time confining the light passing from the negative to the lens, the usual bellows 34 is provided.

The negative carrier 33 is held on sub-frame 32 by a super-imposed lamp house mounting 35 which is fulcrumed to sub-frame 32 on the transverse pivot pin 36. Upon the mounting 35 is carried the lamp house 36 which contains lamp 37 and may be made in any desired manner. By oscillating the entire lamp house on its mounting the negative carrier plate is released in order that it may be removed for a change of negative.

The elevation of sub-frame 32, negative holder 33, mounting 35 and lamp house 36 with respect to the carriage 20, is determined by compensating mechanism operated from cam 10. In the construction shown in Figs. 1 and 3 I employ for this purpose a bell crank lever 40 fulcrumed at 41 upon the carriage and provided at one of its ends with a cam follower roller at 42 which rides on the face or margin of cam 10. At its other end the bell crank lever 40 is connected by a link 43 with the fulcrum pin 36 to raise and lower the negative holder, sub-frame and associated parts with respect to the carriage 20 during the up and down movement of the carriage.

If preferred, other compensating connections may be employed such, for example, as the arrangement shown in Fig. 4 in which the link 43 is eliminated and the bell crank 400 is provided with a toothed segment 44 meshing with a rack 45 which is rigidly connected with sub-frame 32 so that the oscillation of the bell crank will raise and lower the sub-frame and negative holder re-

specting the carriage during the reciprocation of the carriage, the compensatory movement in each case being determined by the profile of cam **10**.

Where the bell crank is used, its range of oscillation is such that the adjustment of the sub-frame does not always correspond exactly with the displacement which would be effected by the ideal cam. The deviation is very slight but for accuracy it requires some modification of the cam. Fig. 1 shows a cam which has been designed to deviate slightly from its ideal profile to compensate for the use of the bell crank. Because other types of actuating connections may require other modifications of the cam profile, I have shown only the means of arriving at the ideal cam profile used where sub-frame displacement is directly proportionate to the spacing between the cam profile and the axis of the column at any given point. From such an ideal cam anyone skilled in the art can readily develop modifications necessary to accommodate the different types of actuating connections which may be employed in practice.

In the diagram shown in Fig. 2 the horizontal base line at **47** represents the lowermost carriage position as shown in dotted lines in Fig. 1. In this position the projected image is exactly the same size as the negative image. The distance F1 measured transversely between the first two vertical lines of the chart represents the focal length of the lens. At this ratio of negative size to image size the distance from the image to the lens must correspond exactly with the distance from the lens to the negative. This latter distance is represented by the dimension F2 which will be noted on the chart to be equal to distance F1.

To make an enlargement of one and one-half diameters the carriage is moved through the distance *a* as represented at the left of the chart to the level of the line **48**. **49** represents the position of the carriage and lens required for a two diameter enlargement. **50** represents the position of carriage and lens for a three diameter enlargement, and the remaining horizontal lines of the chart, equally spaced, represent the positions of carriage and lens required for successive stages of enlargement at half diameter intervals. At the lower end of the chart the quarter diameter intervals are shown. The line **52** represents the position for an enlargement of one and one-quarter diameters, and the line **53** represents the position required for enlargement of one and three-quarter diameters.

Between the lines **47** and **52** the carriage and its associated lens must move the distance represented by the dimension A. When the carriage and lens rise to the level represented by line **52**, however, the negative must be given a compensatory movement which is represented by the horizontal dimension B. The proportionate movement of the parts is such that the ratio or dimension A to dimension B is as 5 to 4. Thus at the extreme end of the range (to which ordinary commercial enlargers never go) it will be noted that there is still a greater movement of the carriage than of the sub-frame.

In the next stage of movement from line **52** to **48** the carriage moves through the distance represented by dimension C while the compensatory movement of the sub-frame and negative holder is only that horizontal dimension represented by D. Here the ratio of C to D is 2 to 1. The ratio rapidly increases as the carriage is elevated, so that throughout the upper and greater part of the range the movement of the carriage is always many times as great as that of the lens. This means that the cam follower has quite an extended movement along the cam in proportion to a very slight compensatory adjustment of the negative holder. The result is that great accuracy is secured as compared with the situation which would exist if the cam follower had to effect a great range of compensatory movement while it traversed only a short section of the cam.

These dimensions laid out in accordance with well known optical laws result in the ideal curve or profile of cam **10** as shown in Fig. 2.

As above explained, the device is at least partially self-counterbalancing. This is due to the fact that as the carriage is raised the sub-frame, lens holder, and lamp house are lowered, and as the carriage is lowered the sub-frame, lamp house, and negative holder are raised. Thus, the weight required at **15** is only slightly greater than the weight of the carriage itself and this, due largely to the inclined column **7**, is comparatively slight, even where many diameters of enlargement are to be secured.

In the device as shown, the cam **10** is preferably set into a channel in the column **7** as shown in Fig. 3, but various other assemblies or organizations of the parts may be made, as will be understood by those skilled in this art. It will further be understood that the cam profile used in actual practice may deviate from the ideal profile shown in Fig. 2 to whatever extent is necessary to compensate for the particular type of motion transmitting connections which may be substituted for those shown in Figs. 1 and 4.

I claim:

1. In an autofocus enlarger, the combination with a column provided with a cam surface and a partially counterbalanced carriage mounted to slide along the column and adapted to support a lens in a horizontal position in all positions of carriage adjustment, of a sub-frame provided with substantially horizontal supporting means, a negative holder supported by the carriage in superposed relation to the sub-frame, a bell crank pivoted to the carriage with one end provided with a follower for engagement with the cam surface, link means intermediate the other end of the bell crank and the negative holder, slide rods mounted on the carriage and brackets connecting the negative holder with the slide rods, and a yieldable housing connecting the negative holder with the lens, said negative holder being guided by the slide rods in a vertical path to increase and diminish the distance between it and the lens in inverse correspondence to the cam follower movement along the cam.

2. In a device of the character described, the combination with an inclined tubular column and a cam extending along the under side of the inclined column, of a carriage fitted to said column and including portions spaced to receive said cam, means at the free end of said carriage remote from said column providing a guideway, a sub-frame mounted for reciprocation on said guideway and provided with substantially horizontal negative supporting means, an arm carried by said carriage and projecting below said last mentioned means and provided with a lens, a lamp housing pivoted to said sub-frame and provided at its under surface with a negative clamping plate co-acting with said means, motion transmitting connections on said carriage including a cam follower, a bell crank, and means

for transmitting movement from the bell crank to the sub-frame in the course of movement of the cam follower respecting the cam, whereby the weight of said sub-frame and lamp housing is partially counterbalanced, a pulley at the top of said column, a flexible member connected with the carriage and extending over the pulley, and counterbalancing means housed within the column and co-operative with the weight of the lamp housing and sub-frame to counterbalance said carriage for maintaining it in any position of adjustment on said column.

3. In a device of the character described, the combination with a column, of a carriage guided on said column for reciprocation and provided at its free end remote from said column with laterally and vertically spaced pairs of ears, rods reciprocable through the ears of the respective pairs, a sub-frame mounted on said rods for reciprocation respecting said carriage and provided with a negative holder and a lamp house, means fixed to said carriage for supporting a lens in alignment with said negative holder, motion transmitting connections including a cam follower, a bell crank and means for transmitting movement of the bell crank to the sub-frame for reciprocating the sub-frame and said rods respecting the carriage, and a cam extending longitudinally of the column with which the cam follower is operatively engaged for effecting the adjustment on said carriage of the negative holder and lamp house respecting said arm.

4. In a device of the character described, the combination with a column, of a carriage comprising a hollow structure having spaced sides and top and bottom walls fitted to said column for reciprocation thereon, a cam fixed to said column and extending longitudinally thereof, said top and bottom walls being slotted to receive the cam, a bell crank pivoted between the sides of the carriage and pivoted to one of said sides and provided with a cam follower engaging the cam, means at the end of the carriage through which said bell crank extends, said means providing a guideway, a sub-frame reciprocable on said guideway and provided with a motion-receiving connection from said bell crank, a lamp house pivoted to said sub-frame, said lamp house and sub-frame providing coacting negative engaging means, an arm connected with said carriage and projecting beneath said sub-frame, a lens mounted in said arm in fixed relation to the carriage, a bellows between said lens and sub-frame, and means for partially counterbalancing the weight of said carriage and the parts carried thereby, additional counterbalancing being supplied by the weight of said sub-frame and lamp house as transmitted through the bell crank and cam follower in a direction such, with reference to the shape of said cam, that said sub-frame and lamp house are raised as the carriage descends.

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