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Blatherwick

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[45] **June 19, 1973**

[54] **CAMERA CARRIAGE PRECISION POSITIONING SYSTEM**

[75] Inventor: **Delbert T. Blatherwick,** Arcadia, Calif.

[73] Assignee: **Acti Products, Inc.,** Arcadia, Calif.

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[52] **U.S. Cl.** **33/125**

[51] **Int. Cl.** **B23q 17/02,** G01b 3/22

[58] **Field of Search** ..... 33/125 R

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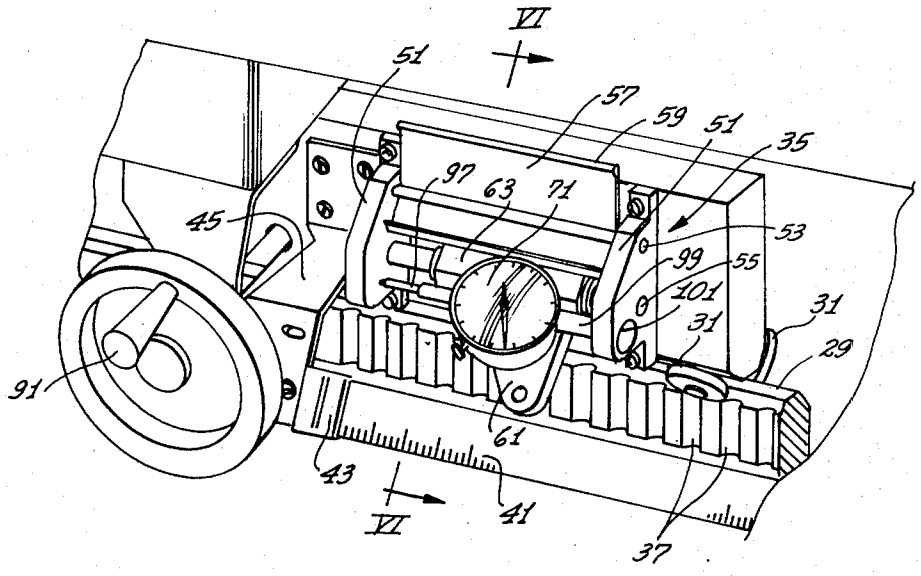
Primary Examiner—Robert B. Hull

Attorney—Smyth, Roston & Pavitt

[57] **ABSTRACT**

A precision positioning device may be mounted on each of two or more carriages which are movable relative to one another. Such movable carriages are positioned for movement along a track or similar device and a notched bar is fixedly mounted in position relative to the track. Each notch in the bar is situated at a carefully defined, predetermined location. Each positioning device comprises a sub-carriage assembly upon which is pivotally mounted a dial indicator which is actuated by a position indicator pin. An engagement pin is also attached to the dial indicator for selective engagement with notches in the notched bar when the dial indicator is properly positioned relative thereto. A cover is provided which, when closed, causes the dial indicator and engagement pin to be pivoted so as to prevent contact between the engagement pin and the notched bar. When the cover is opened, a biasing spring causes the engagement pin to enter into engagement with the selected notch. The sub-assembly is limited to a predetermined amount of lateral movement when the engagement pin is engaged in a notch and the dial indicator describes the precise position of the carriage relative to the selected notch.

2 Claims, 6 Drawing Figures



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Fig. 1

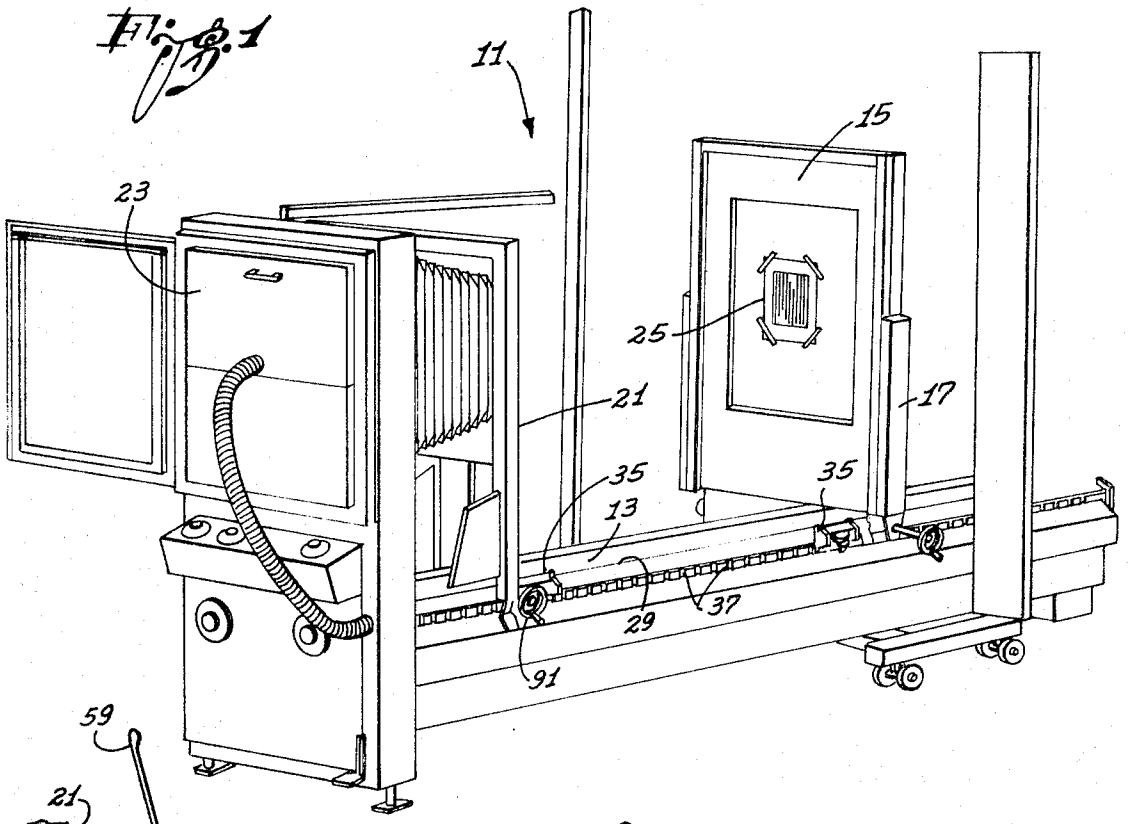


Fig. 6

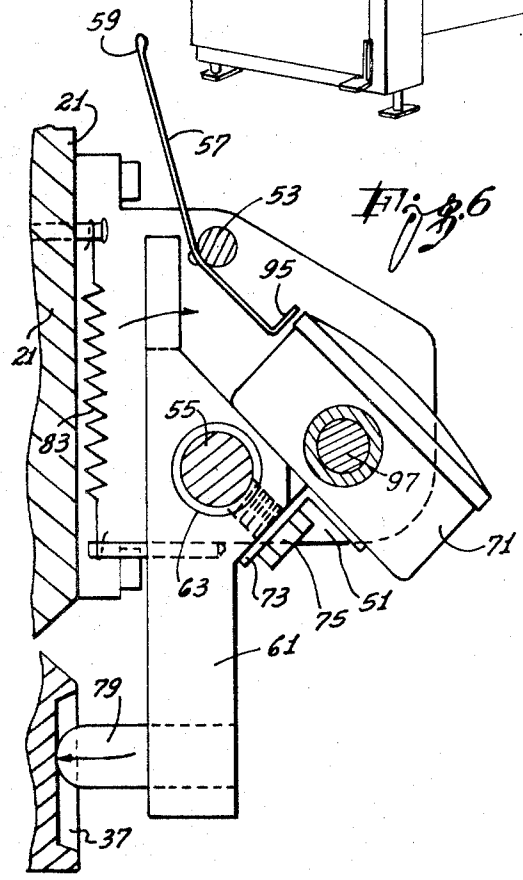
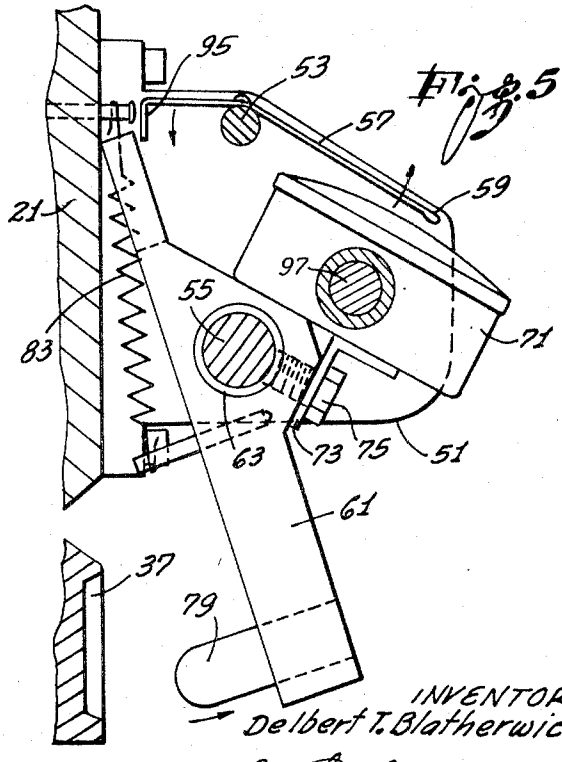


Fig. 5

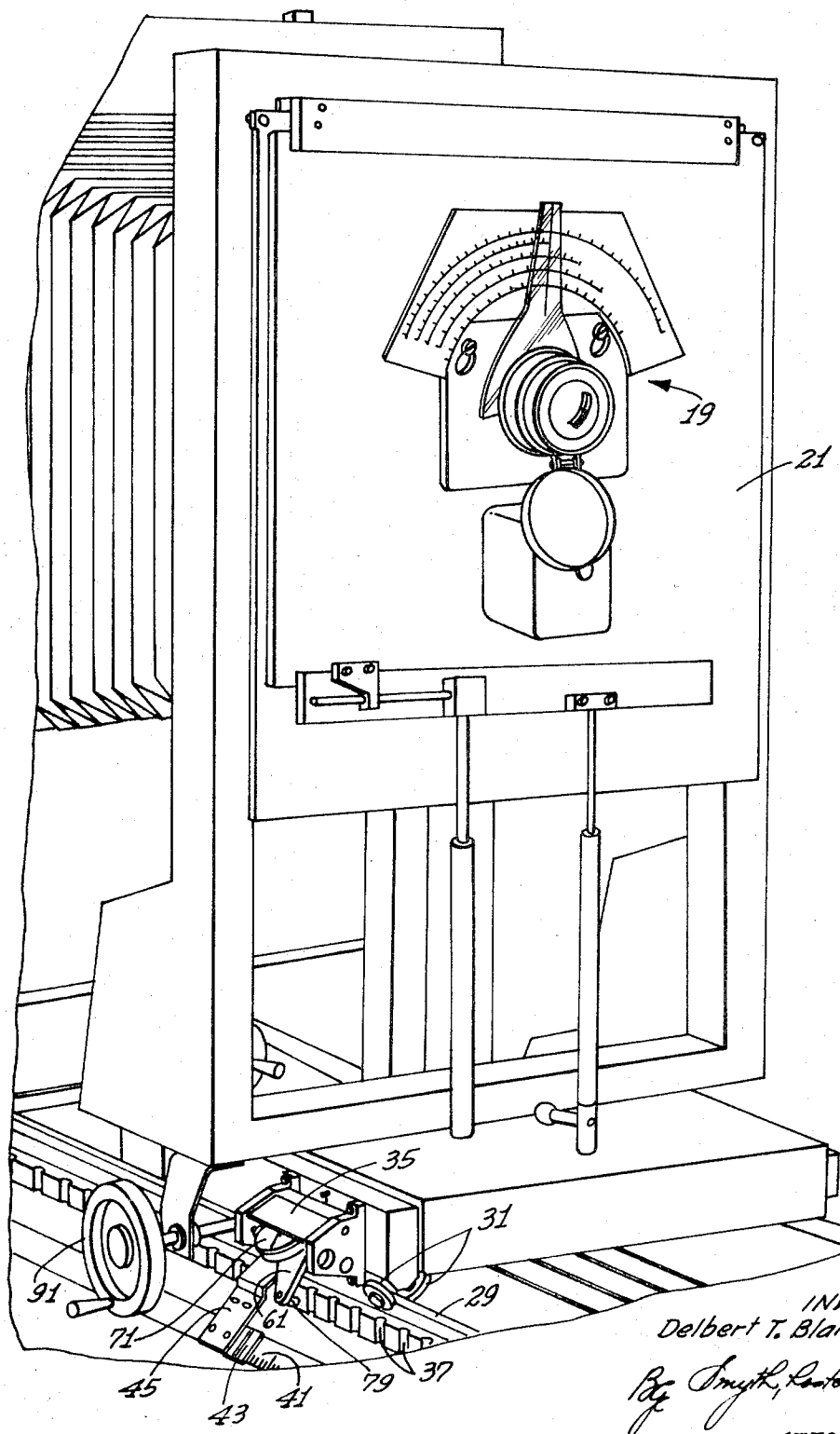


INVENTOR.
Delbert T. Blatherwick

By Smyth, Roston & Pavitt

ATTORNEYS

Fig. 2



INVENTOR:
Delbert T. Blatherwick
By Smyth, Roston & Pavitt
ATTORNEYS

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Fig. 3

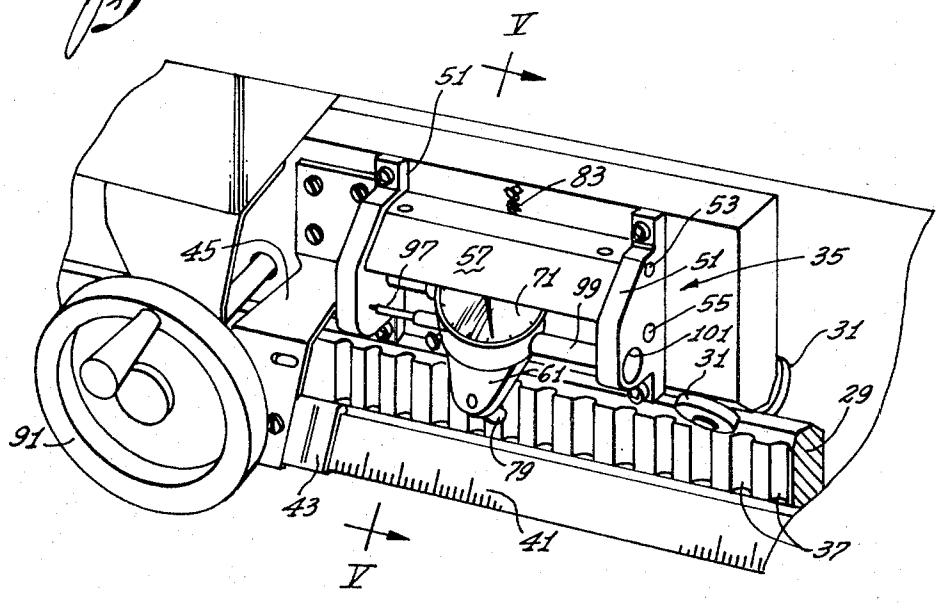
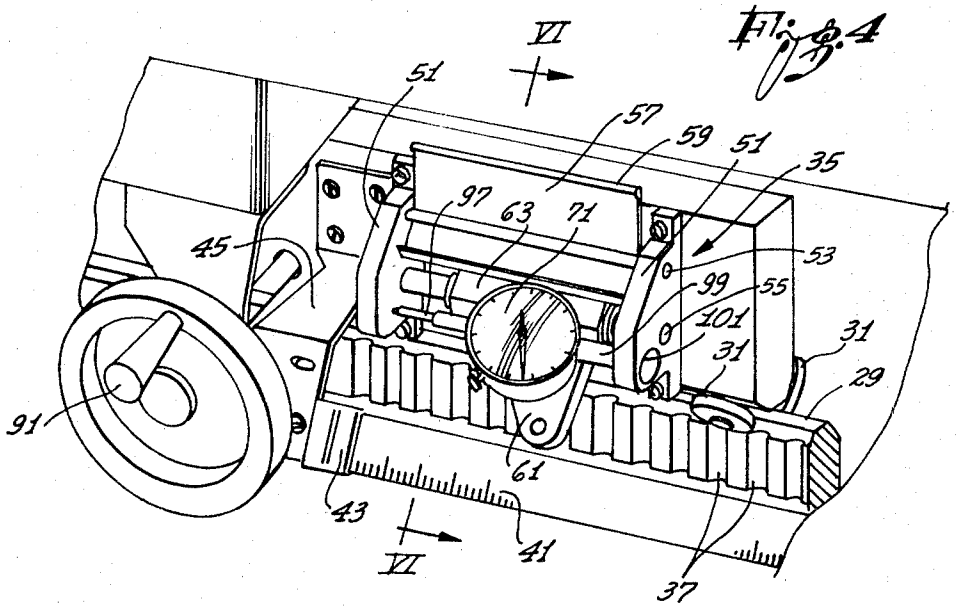


Fig. 4



INVENTOR.
Delbert T. Blatherwick
By Smyth, Roston & Pavitt
ATTORNEYS

CAMERA CARRIAGE PRECISION POSITIONING SYSTEM

BACKGROUND OF THE INVENTION

When photographs are to be reproduced for use in manufacturing printing plates, etc., it is quite common to manufacture such reproductions through photo-mechanical methods involving process cameras. In many cases in which photographs, drawings, or other materials are reproduced, it is often necessary to alter or change the scale or size of the reproduction, as opposed to that of the original. Whether the reproduction is to be on an enlarged or reduced scale, relative to the original, two or more elements in the camera optical system must be movable and positionable in precise relationship to one another. In other words, when considering (1) the structure which holds the object or "original" which is to be reproduced, (2) the camera lens, and (3) the film holder, at least two of the three elements must be readily and easily positionable relative to one another.

Most photo-mechanical reproduction work can be performed with scale changes within a range of tolerances of from 0.1 percent 0.5 percent. A large number of machines have been provided which may be relatively positioned within this range of tolerances. Most of these machines are provided with calibrated linear scales which are fixed in position and relative to which the movable optical elements may be positioned with the accuracy of the positioning being determined by pointers or cursor read-outs. With such machines the relationship of the optical elements can generally be set and read through simple calibrations. It should be quite obvious to those familiar with the art of photo-mechanical reproduction that this range of tolerances is totally unsatisfactory when the machine is being utilized for color separation, the production of printed circuitry, precision dials, scales, charts, cartographic maps, photo templates, etc. For this type of work the tolerance for error is very small, e.g., as low as 0.001 percent.

Various machines have been provided which will produce work within this range of accuracy and, generally speaking, most of these machines employ rotating dials or Veeder-Root type counters which are directly or indirectly coupled to the movable optical elements. With these devices, it is generally impossible to determine the precise positioning of any of the elements by referring to the read-out. This is due to the fact that there is no direct relationship between the read-out reading and the optical system as a whole. When an operator positions an optical element in such a machine, he must refer to a chart or some type of tabulated data in order to determine the true optical relationship in accordance with the reading from the indicator.

Unfortunately, these machines are subject to two basic failings: lack of direct read-out relative to the optical components as described above, and inefficiency due to the relatively long period of time required to position the elements.

In this type of reproduction work, it sometimes happens that the elements must be moved 10 feet or more in order to obtain the desired scale relationship and yet they must be capable of being positioned within a tolerance of 0.001 inch. Both manual-drive and power-drive systems have been provided with such machines but the positioning tolerance requirements cause the movement of the elements to be very slow. It has been found that in order to fulfill the tolerance requirements while increasing the element movement speed, the manufacturing and hardware costs must be increased in a proportion which quickly becomes prohibitive. On the other hand, even if component positioning could be accomplished quickly, the time required to set up the optical system would still be relatively long due to the requirement that the operator refer to the supplemental chart in order to correlate the settings of the elements as indicated by the mechanical read-out devices.

A third type of system for accomplishing this function is generally referred to as a "secondary reference system." These systems are used as a supplement to calibrated scales which are permanently mounted on the machines. Perhaps the most common apparatus utilized in such a system employs a micrometer head or dial indicator which is attached to a body or support which is positioned relative to the movable optical element by means of a notched bar or a series of locating holes or pins. The body or support includes mating components thereon which allow the unit to be removed and remounted accurately.

The movable optical element is provided with carefully machined surfaces which are so aligned with the micrometer head so as to bump or touch it and produce a close-tolerance positioning of the element.

These secondary reference systems have been found to be deficient since they are not completely self-contained on the optical element. In the usual case, the read-out head or support must be mounted on the optical element as it is brought near the desired position. Further, it usually must be removed from the element before the element can be repositioned over a substantial distance. In operations in which the elements are repositioned often, the constant mounting and removal of the body or support increases the wear of the materials and reduces system accuracy. Additionally, since the components are not fixed to the element at all times, they are much more susceptible to loss, damage, and misuse. As the components wear, inconsistent results occur more frequently due to mounting error. These systems are also relatively slow due to the mounting and demounting of the read-out hardware.

In another type of system, pins, positionable stops, etc., are mounted in preselected stations to limit the movement of the elements. Obviously, these are practical for only a few preselected stations and do not provide suitable positioning throughout the range of potential usage of the machine.

Optically enlarged scales have also been provided in some cases with these machines and it has been found that the accuracy of element positioning is limited not only by machinery tolerances but also by the cost of the positioning optics. In other words, extremely fine scales may be produced and utilized, but only at what amounts to prohibitive expense.

Consequently, it is obvious that the prior art devices are inefficient, cumbersome, and often highly expensive when used in extremely close tolerance reproduction work.

SUMMARY OF THE INVENTION

In general, the present invention relates to a precision positioning device which may be utilized in a wide variety of applications. For the purposes of description and clarity of illustration only, the device of the present

invention is herein described as being utilized with a photo-mechanical reproduction machine and may be mounted on the subject holder, the lens, or the film holder for precise positioning thereof.

Generally speaking, the subject holder and the lens of a photo-mechanical reproduction system are movably mounted relative to one another by means of one or more guide rails or tracks. The guide rail prevents the camera elements from rotating about the axis of the lens as they are moved parallel to the lens axis. A precision notched bar may be mounted adjacent and parallel to the main guide rail with the notches thereon precisely positioned relative to one another.

Assuming that the lens and the subject holder are the movable elements, each is mounted on a carriage and, in accordance with the present invention, a support assembly is mounted on each of the carriages. When engaged, the support assembly is generally movable between limits defined by the centers of adjacent notches on the notched bar.

A range dial indicator of any well-known type and having a range equal to the distance between the notches may be mounted on the support. An engagement pin is also mounted on the support for cooperation with a selected notch on the notched bar. The dial indicator and the engagement pin assembly are pivotally mounted about a common pivot point on the support, allowing the engaging pin to be inserted and removed from a selected notch.

The dial indicator assembly is mounted so as to allow lateral movement thereof relative to the support, and thus to the carriage, to the extent of the distance between the axes of successive notches. When the structure is pivoted from the notched bar, the entire carriage may be moved along the main guide rail until a hairline device, cooperating with a scale, indicates that a rough positioning of the carriage has been accomplished.

The positioning assembly is then pivoted so that engaging pin extends into the selected notch and the operator moves the carriage while observing the dial indicator to accomplish fine position of the carriage.

The present invention results in a system utilizing a minimum of moving parts with improved long-term accuracy due to a significant reduction in wear. Further, the accuracy of the system is enhanced since there is no inherent back-lash or play as is usually found in the present systems which employ lead screws, gearing, high-speed rotating shafts, etc.

Further, the dial indicator and scale, taken together, indicate the precise positioning of the carriage and no data tables, etc., need be referred to by the operator. The apparatus may be permanently mounted on such a carriage and need never be remounted or repositioned thereon.

When it is not necessary to produce fine tolerance positioning of the carriage, only the main scale need be utilized and apparatus such as that formed according to the present invention, while permanently mounted, need not be employed and does not get into the operator's way. Obviously, when work is to be performed in which relatively large tolerances are satisfactory, camera productivity is very large. On the other hand, when fine tolerance work is required, productivity is reduced only slightly, due to the convenience of the device.

As an important result of the present invention, manufacturers of such cameras may design the camera beds to be of nearly any length without worrying about longitudinal tolerances, the size and number of carriages mounted on the bed, or carriage movement velocity.

Consequently, the present invention results in a precision positioning device which is low-cost, non-complex, produces very fine tolerance positioning, but does not require slow movement of carriages between positions, thereby allowing high machine productivity.

Other objects, advantages, modes, and embodiments of this invention will become obvious to those skilled in the art through reference to the Detailed Description and perusal of the accompanying drawings which illustrate what is presently considered to be a preferred embodiment of the best mode contemplated for utilizing the novel principles set forth in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective illustration of a camera bed utilized to perform photo-mechanical reproduction;

FIG. **2** is an enlarged view of a portion of the machine illustrated in FIG. **1**, as viewed from the right end of the machine, showing the mounting of a precision positioning device with greater clarity;

FIGS. **3** and **4** are enlarged illustrations of the precision positioning system formed according to the present invention, showing the system in the disengaged and engaged positions, respectively; and

FIGS. **5** and **6** are side elevations of the positioning system, taken along a line V—V of FIG. **3** and a line VI—VI of FIG. **4**, respectively.

DETAILED DESCRIPTION

Referring now to the drawings in greater detail, there is shown in FIG. **1** a camera system **11** comprising a bed **13**, a subject holder **15** mounted on a carriage **17** and a lens system **19** (FIG. **2**) mounted on a movable carriage **21**. A film holder **23** is mounted at one end of the bed **11** so that, when a shutter within the lens system **19** is actuated, the matter on a workpiece **25** may be suitably reproduced on a film within the holder **23**. When the carriages **17** and **21** are properly positioned relative to one another and to the film within the holder **23**, the relative size of the matter on the workpiece to be reproduced on the film may be controlled by the machine operator.

Referring now to FIGS. **1–4**, it is seen that the bed **13** is provided with a main guide rail **29** along one side thereof which cooperates with suitable rollers **31** on each of the carriages to guide the movement thereof. Each of the carriages is also provided with a precision positioning system **35**. The positioning systems are essentially identical and only that mounted on the carriage **21** will be described in detail.

At one side of the guide rail **29**, a plurality of notches **37** may be formed either in the rail itself or on a bar which may be fixed relative thereto. The notches constitute means establishing a series of spaced indexing positions. As an example, the notches may be accurately machined at 1 inch centers. A scale **41** may also be mounted on the machine so as to mark the position of each notch **37**. A suitable hairline device **43** may be attached to an arm **45** fastened to the carriage so as to position the carriage relative to the scale.

With reference now to FIGS. **3–6**, it is seen that the positioning system comprises a pair of support members **51** which are attached to the carriage by any suitable means such as bolts. A first rod **53** is mounted in the upper portion of each of the supports and a second

rod 55 is mounted in a lower portion of the support. A dial cover 57 is suitably fastened to the upper pivot rod 53 so that when the operator lifts the leading edge 59, he can pivot the cover from the position illustrated in FIGS. 3 and 5 to that shown in FIGS. 4 and 6.

A rocker arm 61 is fixedly mounted on a bushing 63 which is pivotable about and slidable along the second pivot rod 55. A readout device such as a dial indicator 71 is suitably mounted on the rocker arm 61, for example by a flange 73 fastened to the rocker arm 61 by a bolt 75. The bolt 75 may also be utilized to fix the rocker arm relative to the bushing 63.

An engaging or locating pin 79 is positioned at the lower end of the rocking arm 61 so as to enter into cooperation with a selected notch 37 when the precision positioning system is properly actuated by the camera operator.

The weight of the pivotable assembly and a spring 83, acting between the carriage 21 and the rocker arm 61 tends to bias the rocker arm toward the position shown in FIG. 6.

In operation, the cover 57 may be closed as shown in FIGS. 3 and 5. The carriage may then be moved along the guide rail or track 29 by any suitable means until it is properly located in a "rough" position relative to the other camera elements. For example, handle 91 may be drivingly associated with a suitable gear and drive shaft system, a pulley system, the track-engaging wheels directly, etc. (all not shown) so that rotation of the handle results in motion of the carriage along the track.

When the carriage is properly located, as may be indicated, for example by the location of the hairline reader device 43 with respect to a predetermined location along the scale 41, the operator may then grasp the forward lip 59 of cover 57 and open the cover to the position shown in FIGS. 4 and 6. Whether or not the illustrated embodiment is that employed, the operator's action in opening the cover results in movement of the engaging pin 79 into contact with a suitable indexing device, such as one of the notches 37. Thus, the pin 79 is moved from the position shown in FIG. 5 to that in FIG. 6.

Since the rocking arm 61 can slide along the pivot rod 55, the carriage can still be moved along the track 29, within the limits imposed by abutment of the bushing 63 with the supports 51. Any further movement of the carriage is prevented due to the fact that the pin 79 is engaged within a notch 37. In this condition, the rocker arm 61 and the dial indicator 71 on the arm remain fixed while the carriage may be moved; but, when the carriage is moved until the bushing 63 contacts one of the supports 51, the carriage is thus prevented from being moved further in that direction. In other words, the rocker arm 61 and the structure it supports may be moved within predetermined limits relative to the carriage.

In the illustrated embodiment, the weight of the rocker arm assembly, combined with the force of spring 83, may be used to pivot the assembly and the bushing 63 about the axis of the pivot rod 55 and thus to hold pin 79 in the selected notch 37. Of course, if the pin should pivot to a position between adjacent notches, for example as a result of improper carriage alignment by the operator, the handle 91 can be used to move the carriage until the pin drops into the proper notch. Spring 83 will then ensure that the pin 79 is not inadvertently rotated out of the selected notch.

A dial indicator pin 97 (FIGS. 3–6) may be used to operate the dial indicator 71 in a well-known manner when acted upon by relative movement of the adjacent support 51. In one commercially available embodiment of such a device, the pin 97 is telescopically received within a tubular, non-continuous member 99 which extends from each side of the indicator. If such a device is utilized with the present invention, a suitable bore 101 may be provided in the second support 51 which does not abut pin 97 so that the rocker arm assembly can freely slide along the rod 55 without obstruction between member 99 and the support 51. The bore 101 may be large enough to accommodate the passage of receiving member 99 in either of the pivot positions of the dial indicator.

Thus, when pin 73 is engaged in a selected notch 37, the illustrated carriage may be moved along the track by turning the wheel 91. Since the rocking arm 61 is then fixed relative to the track however, it must slide along the rod 55 as the carriage is moved.

In the normal situation, before the carriage is accurately located, the end of the indicator pin will be just touching the surface of the adjacent support 51, regardless of the pivotal position of the rocking arm 61. Therefore, when the pin and notch are in engagement and the carriage is moved as described above, even very slight movement will cause the pin 97 to actuate the indicator device of dial 71 which thus displays a reading which corresponds to the amount of travel of the carriage relative to the engaged notch 37. In other words, the support 51 adjacent pin 97 also provides a secondary reference surface against which the dial indicator acts.

When the operator desires to reposition the carriage, he merely returns the cover 57 to the position shown in FIG. 5, causing the rear edge 95 of the cover 57 to act against an upper extension of the rocker arm 61, causing it to pivot so as to withdraw the engaging pin 79. The operator then repositions the carriage by rotating the handle 91 or by other suitable devices until the hairline readout device 43 indicates that the carriage has been rough-positioned in the new location.

Consequently, it should be obvious to those skilled in the art that the precision positioning system of the present invention may find wide usage within the camera reproduction field but will also be readily usable in a wide range of similar applications.

With this disclosure, the applicant has provided a description of an embodiment of a new and improved concept in the measurement art which yields a true advance in that art. Many modifications, alterations, and other embodiments of the present invention will be obvious to those skilled in the art, wherefore what is claimed as the invention is:

I claim:

1. Apparatus for precisely locating a movable carriage along a track at a predetermined position relative thereto comprising

positioning means for establishing a series of spaced indexing positions fixedly located relative to said track at precisely predetermined locations therealong,

means fixedly associated with said positioning means for marking the relative locations of said indexing positions,

means fixed on said carriage and cooperating with said marking means for indicating the appropriate position of said carriage along said track,

support means fixed on said carriage,

pivot means fixedly mounted on said support means,

relative precise position readout means mounted on said pivot means for pivotal movement between a first and a second position and for movement parallel to said track relative to said support means between limits determined by said support means and said readout means including

actuating means for transmitting a force to said readout means in response to relative axial movement between said support means and said precise position readout means,

means for locating said readout means relative to any selected one of said indexing positions, disengaged from said positioning means when said readout means is in said first position and operatively engaged therewith when said readout means is in said second position, and

means for moving said carriage along said track to align said approximate position indicating means with a predetermined location on said marking means at which point said readout means may be pivoted from said first to said second position whereupon continued movement of said carriage will be indicated on said relatively precise position readout means.

2. The apparatus of claim **1** including

movable means for covering said readout means and operable to move said readout means toward said first position as said movable means is moved to cover said readout means, and

means for urging said readout means toward said second position when said covering means is operated to uncover said readout means.

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