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P. A. DROUIN

UNIFORM MICRODISPLACEMENT DEVICE, PARTICULARLY FOR GRATINGS SCRIBER

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2,506,141

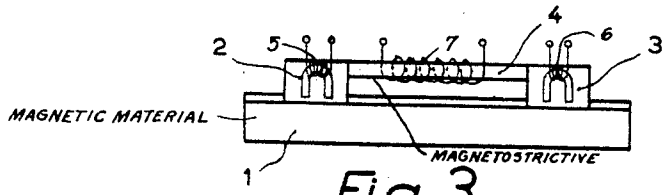


Fig. 3

Fig. 1

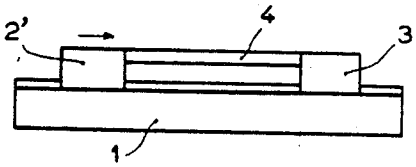


Fig. 4

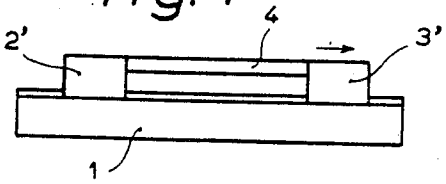


Fig. 2

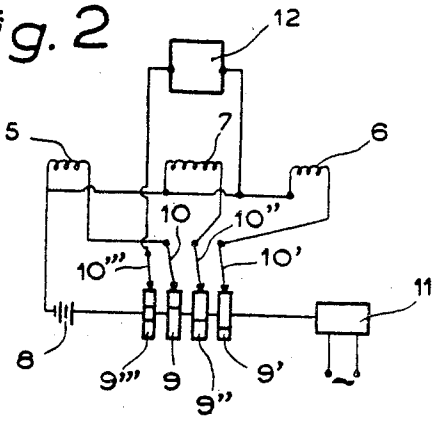


Fig. 5

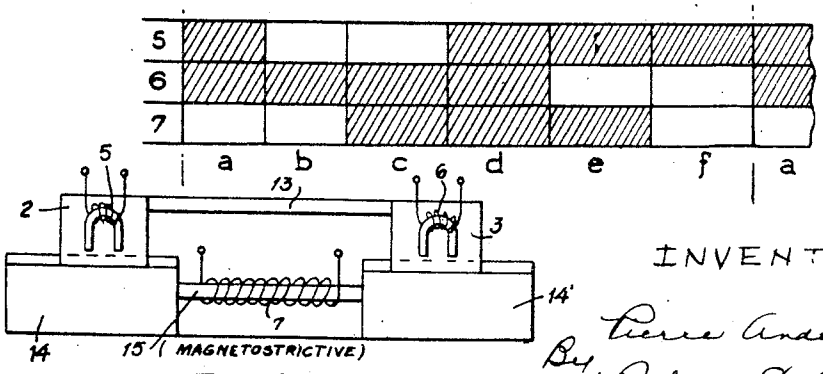


Fig. 6.

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UNIFORM MICRODISPLACEMENT DEVICE, PARTICULARLY FOR GRATINGS SCRIBER

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1

The present invention relates to a device which makes it possible to obtain automatically a succession of very small displacements for a mechanical piece, the said displacements being all equal to one another and which is more particularly applicable to the automatic manufacture of a diffraction grating.

A work of this kind is usually performed by means of a dividing machine; the small displacements are then obtained by means of a micrometer screw which for each operation turns by a determined fraction of a complete turn driving a nut which is guided on a length which is equal to the same pitch fraction. But on one hand it is very difficult to obtain a screw having a strictly constant pitch and on the other hand it is still more delicate to obtain successive turnings all equal to one another, for instance by means of a ratchet wheel owing to the play which is unavoidable in this kind of apparatuses.

The result is that the dividing machine when it is used to obtain a succession of very small displacements of the order of one micron for instance allows displacements to be obtained the average value of which is accurately known, but which are individually affected with respect to the said average value by positive or negative errors of which the relative value becomes very important when the displacements to be obtained are very small.

Those deviations are unacceptable for certain applications, particularly for the tracing of diffraction gratings whose lines are very near to one another and for which it is much more important to obtain the strict equality of the distances between two successive lines than to give that distance an average value which is known accurately but which comprises positive or negative individual deviations.

The device which is the object of the present invention comprises neither any screw nor any ratchet wheel. It provides the translation of a slide by means of successive displacements that are strictly equal to one another without any catch mechanical devices introducing some causes for altering this value, the said devices necessarily involving some play. This device is characterized by the fact that it comprises a member which is capable of contracting or expanding with means for locking the ends of the said member, simultaneously or separately.

The said member comprises for instance two slides or carriages which can slide freely on a bench to which they can also be locked separately, the said carriages comprising also between them a rigid connection capable of instantaneously undergoing small variations in length, which are strictly determined, under the action of an appropriate physical agent.

2

The rigid connection capable of undergoing small and successive expansions and contractions is preferably constituted by a bar made of a magnetostrictive material such as nickel

By way of example, an embodiment of the invention has been described hereunder and shown diagrammatically in the attached drawing; on the said drawing:

Fig. 1 is a diagrammatical side view of the device.

Fig. 2 shows a wiring diagram of the electric control.

Figs. 3 and 4 show the successive positions of the movable equipment during the course of one operation, the displacements of the said equipment being shown at a much enlarged scale.

Fig. 5 is a diagram of commutation.

Fig. 6 is a view showing a more complete embodiment of the invention.

The device shown diagrammatically on Fig. 1 includes a bench 1 upon which can slide a movable equipment constituted by two carriages 2 and 3 connected to one another by a bar 4 made of magnetostrictive material, that is a material capable of expanding or contracting when it is placed in an intense magnetic field produced by the exciting coil 7, for instance made of nickel which, under those conditions, undergoes a contraction. Moreover carriages 2 and 3 are provided with electromagnets 5, 6 for at will locking the said carriages on bench 1. It can be seen on Fig. 2 showing the wiring diagram of the arrangement for the electric control of the device that the windings 5, 6 of the locking magnets on carriages 2, 3 and the exciting coil 7 of the magnetostrictive bar 4 are supplied from a common source 8 in a prescribed order through a commutator constituted by rings 9, 9', 9'' comprising conducting steps whose lengths and respective angular relations are differing and by wipers 10, 10', 10'', the said commutator being driven by an electric motor 11.

The succession of operations controlled automatically by commutator 9—10 is as follows:

(a) Locking windings 5, 6 alone are excited so that carriages 2, 3 are both locked at a distance apart which corresponds to the state of rest of bar 4 (Fig. 1).

(b) Locking winding 5 alone is cut off so that carriage 2 is released.

(c) Locking winding 6 being still excited and

winding 5 being cut off, the exciting coil 7 on bar 4 is excited so that the said bar undergoes a contraction and that carriage 2 moves in 2' in the direction of arrow over a very small length which is equal to the contraction of the bar (Fig. 3).

(*d*) Windings 6 and 7 being still excited, winding 5 is again excited so that the movable equipment happens to be locked in position 2'—4—3 of Fig. 3.

(*e*) Windings 5 and 7 remaining excited, winding 6 is cut off thus releasing carriage 3.

(*f*) Winding 5 remaining excited, that is carriage 2 being locked, coil 7 is cut off, the bar 4 on account of the disappearance of the magnetic field expands to take back its initial length so that carriage 3 moves in the direction of the arrow (Fig. 4) to take position 3', the relative positions of the two carriages 2, 3 being the same as on Fig. 4 but the ensemble having displaced itself by a small determined quantity.

The cycle of operations repeats afterwards with carriage 3 being locked again by magnet winding 6.

Fig. 5 shows a diagram representing the respective time for energizing and de-energizing windings 5, 6, 7 during cycle *a, b, c, d, e, f* described above. This diagram supplies immediately the relative lengths of the conducting and insulating parts of the areas on the rings 10, 10', 10'' of the controlling commutator. It can be seen in fact that windings 5, 6 must be energized during ⅔ of a cycle while winding 7 must be energized during half the cycle corresponding to one turn of the commutator.

When the device according to the invention is used for automatically tracing diffraction gratings, the grating to be traced is secured upon one of the carriages while the tool mounted upon a support integral with table 1 and which moves in a plane perpendicular to that of the figure is preferably operated by an electric device 12 controlled by a fourth ring 9''' and a fourth wiper 10''' of the rotating commutator. This drive of the tracing tool takes place in phase *a* for each cycle when the two carriages 2, 3 are locked. In this manner the distance between the lines drawn in succession is equal to the contraction of the bar 4 with an accuracy that depends only on the stability of the supply current and which can therefore be extremely high owing to the stabilizing means which are now available for voltages and currents.

The locking windings may be carried by the carriages and may even be constituted by the said carriages or they may be fitted on the bench; they may also be constituted by the bench itself which is then magnetically divided in two.

In another embodiment of the invention shown in Fig. 6, the length of the ensemble of the two carriages 2, 3 and of their rigid connection 13 is invariable while the bench which consists of two halves 14, 14' connected by a magnetostrictive member 15 is alternately expanded or contracted, one of the parts 14 of the said bench being then stationary while the other 14' being free to undergo some small longitudinal displacements is resting over one or several rollers to avoid flexure.

The operation of the device is the following: carriage 2, resting upon the fixed part 14 of the bench being locked by energizing magnet 5 and carriage 3 being free to slide on the movable part 14', the winding 7 of the magnetostrictive member 15 is energized causing a contraction of same and a relative displacement of carriage 3 with respect to part 14'. Carriage 3 is then locked with respect to part 14', carriage 2 liberated from part 14 and winding 7 is cut from the voltage supply, resulting in an expansion of member 15 and in displacement of movable part 14' together with the movable equipment 2—3 with respect to the fixed part 14. Carriage 2 is again locked, the tracing device is operated and the same cycle is again repeated.

What I claim is:

1. Device for obtaining automatically the successive very small displacements of a mechanical member, of the order of one micron, all those displacements being equal to one another, particularly for the purpose of making automatically diffraction gratings comprising: a bench, a movable equipment sliding freely on the said bench, two carriages constituting the said equipment, a bar made of magnetostrictive material rigidly connected by its end to the said carriages, electromagnetic means for at will locking the said carriages individually and simultaneously upon their bench, electromagnetic means for energizing the said bar made of magnetostrictive material, a common source of supply to feed the said electromagnetic means for locking the carriages and for energizing the magnetostrictive device, means for connecting the said locking and energizing means to the common source of supply in a given order.

2. Device for obtaining the successive very small displacements of a mechanical member, the said displacements being all equal to the order of one micron, particularly for the purpose of making automatically diffraction gratings comprising: a bench, a movable equipment sliding freely on the said bench, two carriages constituting the said equipment, a bar made of magnetostrictive material of the group nickel, cobalt, nickel alloys, the said bar having its ends rigidly secured to the said carriages, two electromagnets respectively for at will locking individually and simultaneously the two said carriages, an exciting coil for the said bar made of magnetostrictive material, a common source of supply to feed the said locking electromagnets and the said exciting coil, a commutator comprising means to connect the said electromagnets and the said exciting coil to the said common source of supply, the respective angular relations of the said means being different and permitting to lock or to release the carriages and to supply the exciting coil in a prescribed order, an electric motor driving the said commutator.

3. Device for obtaining the successive very small displacements of a mechanical member, the said displacements being all equal to the order of one micron, particularly for the purpose of making automatically diffraction gratings comprising: a bench, a movable equipment sliding freely on the said bench, two carriages constituting the said equipment, a bar made of magnetostrictive material of the group nickel, cobalt, nickel alloys, the said bar having its ends rigidly secured to the said carriages, two electromagnets respectively for at will locking individually and simultaneously the two said carriages, an exciting coil for the said bar made of magnetostrictive material, a source of supply, three rotatably mounted rings connected to said source comprising three conducting steps whose lengths and respective angular settings are differing, three wipers which are respectively in contact with the said three rings and which are connected to the

exciting coil and to the electromagnet coils respectively, an electric motor driving the said rings.

4. Device for obtaining the successive very small displacements of a mechanical member, the said displacements being all equal to the order of one micron, particularly for the purpose of making automatically diffraction gratings comprising: a bench, a movable equipment sliding freely on the said bench, two carriages constituting the said equipment, a bar made of magnetostrictive material of the group nickel, cobalt, nickel alloys, the said bar having its ends rigidly secured to the said carriages, two electromagnets respectively for at will locking the two said carriages individually and simultaneously, an exciting coil for the said bar made of magnetostrictive material, a source of supply, three rotatably mounted rings connected to said source and comprising conducting steps, three wipers respectively in contact with the said three rings and connected to the exciting coil and to the electromagnet coils respectively, an electric motor driving said rings, the lengths and the angular settings of the conducting steps of said rings being different from one another so as to effect the locking of the two carriages in the first place, then the release of the second carriage and the supply of the exciting coil, and afterward the locking of the second carriage, the release of the first carriage, the switching off of the supply on the exciting coil and the relocking of the first carriage, the said cycle of operations being repeated indefinitely.

5. Device for obtaining the successive very small displacements of a mechanical member, the said displacements being all equal to the order of one micron, particularly for the purpose of making automatically diffraction gratings comprising: a bench constituted by two separate parts the one fixed and the other movable, a bar made of magnetostrictive material of the group nickel, cobalt, nickel alloys, the said bar having its ends rigidly secured to the two separate parts of the bench and being capable of undergoing instantaneous small variations in lengths and strictly determined in a magnetic field of high intensity, a movable equipment provided with, two carriages sliding on both parts of the bench respectively, a rigid and invariable connection between the said carriages, electromagnetic means for locking the said carriages individually simultaneously, electromagnetic means for exciting the bar made of magnetostrictive material, a common source of supply to feed the said electromagnetic means, means to connect in a prescribed order the said locking means and the said exciting means to the common source of supply.

6. Device for automatically obtaining very small successive displacements of a mechanical member, for example of the order of one micron, all these displacements being equal to one another, particularly for the purpose of automatically tracing diffraction gratings comprising a support, a movable equipment slidably arranged on said support and driving means for said movable equipment comprising a rigid member capable of instantaneously contracting and expanding under the action of an electric voltage applied thereupon and means for at will locking separately and simultaneously the ends of the movable equipment with respect to its support.

7. Device for automatically obtaining very small successive displacements of a mechanical member, for example of the order of one micron, all these displacements being equal to one another, particularly for the purpose of automatically tracing diffraction gratings comprising a bench, a movable equipment arranged to freely slide on the said bench and constituted by two carriages and a bar of magnetostrictive material the ends of which are rigidly secured to said carriages respectively, means for subjecting said magnetostrictive bar to a strong electromagnetic field, means for at will locking the said carriages individually and simultaneously upon the bench.

8. Device for obtaining automatically successive very small displacements of a mechanical member, of the order of one micron, all those displacements being equal to one another, particularly for the purpose of making automatically diffraction gratings comprising: a bench, a movable equipment sliding freely on the said bench, two carriages constituting the said equipment, a bar made of magnetostrictive material rigidly connected by its ends to the said carriages, electromagnetic means for at will locking the said carriages individually and simultaneously upon their bench, electromagnetic means for energizing the said bar made of magnetostrictive material, a common source of supply to feed the said electromagnetic means for locking the carriages and for energizing the magnetostrictive device, a tracing tool, electric means for controlling said tool, a commutator for connecting in a given order to the common source of supply the said locking, energizing and tool control means.

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