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CALCULATING DEVICE

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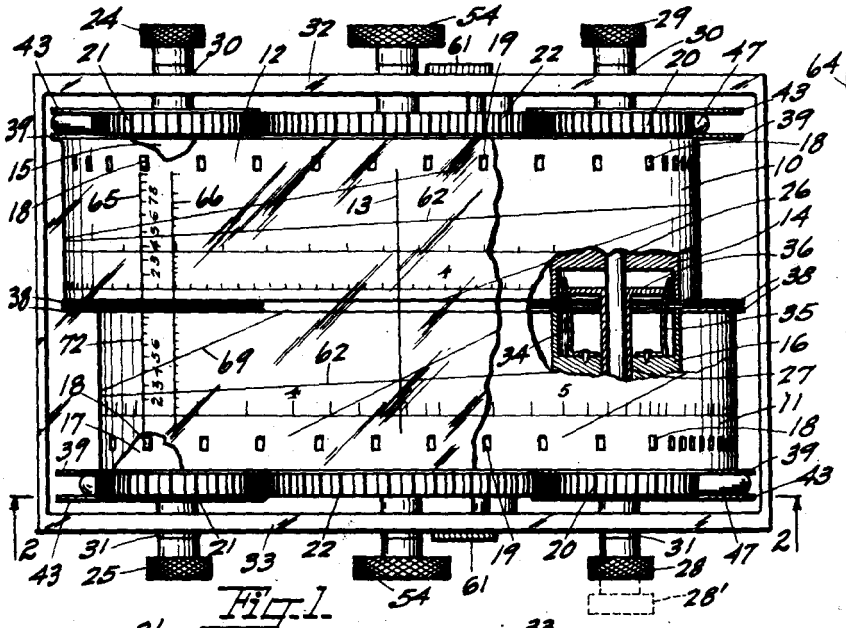

Fig. 1.

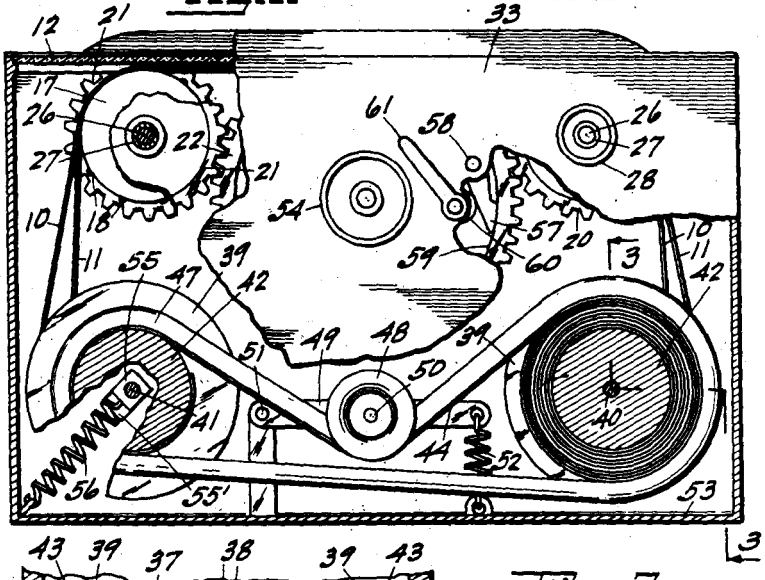

Fig. 2.

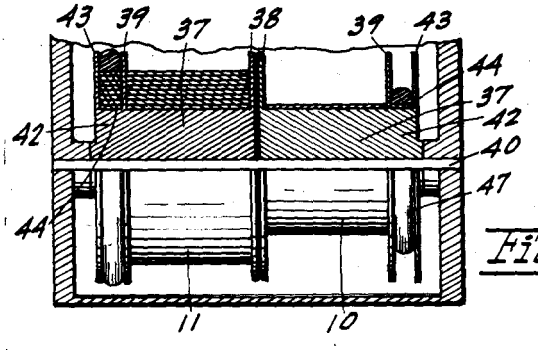

Fig. 3.

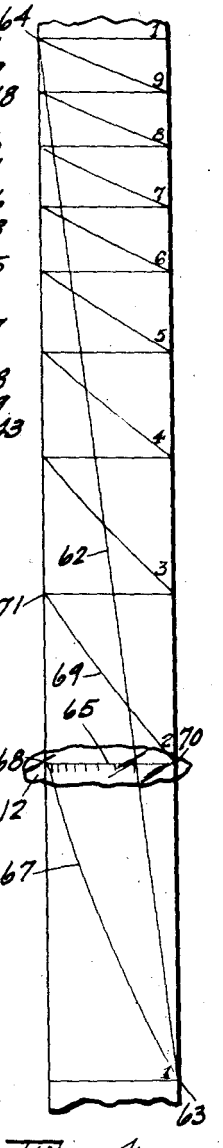

Fig. 4.

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UNITED STATES PATENT OFFICE

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CALCULATING DEVICE

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11 Claims. (Cl. 235—86)

This invention, a calculating device, is an improvement over the conventional slide rule, over which it differs in being constructed with a stationary cursor and movable body and slide, the body and slide being formed of flexible tapes or ribbons, which may be made of any desired length according to the degree of accuracy required in the calculations, and the body may be a single ribbon or divided into two ribbons, and the same also applies to the slide. Two or more ribbons can be employed or incorporated in the device, according to the type of calculations which are to be solved.

The usual types of slide rules are substantially limited to a length of about ten inches for convenient manipulation, while this device may be provided with ribbons and their associated scales of any desired length, since the ribbons can be either a continuous band with the unexposed portion gathered in and delivered from a suitable receptacle underneath the exposed portion, or may have their opposite ends deposited in a suitable receptacle or wound on reels.

As will be readily understood, if ribbons having scales 100 inches long are employed, there can be ten times as many divisions as in a ten inch slide rule, and the accuracy will thus be multiplied ten-fold. The scales obviously are not limited to a length of 100 inches, but may be of any length.

The objects and advantages of the invention are as follows:

First, to provide scales in a slide rule which may be formed to any desired included length, whereby the degree of accuracy in calculations may be increased to any desired value over those obtainable with existing types of slide rules.

Second, to form the scales on flexible ribbons which may be gathered in a suitable receptacle or wound on reels.

Third, to provide means for rapidly or slowly propelling said ribbons, either separately or collectively, at will.

Fourth, to provide means for indicating the relative position of the various indices or divisions of the scales to the hair line on the cursor as the ribbons are propelled either rapidly or slowly, without reference to the scales.

Fifth, to provide reeling means and driving means therefor, which cooperate to automatically compensate for variations in the cumulative diameters of the reels, and which functions to take up and pay out the ribbons without either drag or slack.

Sixth, to provide means for maintaining the exposed portion of the ribbon under a uniform degree of tension.

Other objects and advantages of the invention will become apparent as the following description is read on the drawing forming a part of this specification, and in which similar reference characters are used to designate similar parts throughout the several views, of which;

Fig. 1 is a plan view of the invention, with portions broken away to show the clutch mechanism for simultaneous driving of the ribbons, and the spools, and also with the gear covers removed to show the gear arrangements.

Fig. 2 is a sectional elevation taken on a line 2—2 of Fig. 1, with the exception that a portion of the side wall of the housing is retained to show the brake mechanism, and a portion of one pinion is broken away to show the sprocket teeth on the spools.

Fig. 3 is a fragmentary sectional end elevation taken on a line 3—3 of Fig. 2.

Fig. 4 is a diagrammatic view of the high speed and low speed scale position indicators on the ribbons and cursor.

The conventional slide rule consists of a body and slide of rigid material which are relatively movable, and a cursor which is slidable over the length of the body, and having a hair line for registration with the respective scales formed on the body and slide.

In this invention, the slide and the body are made of flexible ribbons, which may be continuous, or which may have their ends gathered in a suitable receptacle or wound on reels, and these ribbons may be independently adjusted, or they may be locked together for synchronous adjustment, at will, and the cursor is fixed in position.

This calculating device consists of two units, respectively a body unit and a slide unit, which are structurally identical but oppositely disposed, and mounted in parallel relation as shown in Fig. 1, although the device may have a plurality of units or ribbons, and still fall within the scope of this invention.

The slide consists of one of the ribbons, as 10, and the body consists of another ribbon, as 11, and the cursor consists of the transparent cover 12 which is provided with a hair line 13, the body ribbon being supplied with the usual scales provided on the body of the conventional slide rule, and the slide ribbon being provided with the usual scales provided on the slide of the conventional slide rule, except that the scales are divided into a greater number of parts and the scales are of much greater length.

Each ribbon, 10, 11, is operated over two spaced apart spools, as 14, 15 for scale or ribbon 10, and 16, 17 for ribbon 11, and these spools are all of the same diameter and are provided with sprocket teeth 18 for cooperation with the perforations 19 formed in the respective ribbons.

The respective pairs of spaced apart spools are geared together for synchronous rotation, as by means of pinions 20 and 21 and gear 22, (gear 21 being partly broken away to show the spool

and sprocket structure), and functioning to keep the exposed portions of the ribbons taut between the spaced apart spools, and also functioning as high ratio driving means for the ribbons.

The spools at one end of the device, as 15 and 17, are always independently rotatable and are provided with knobs 24 and 25 respectively, through the medium of which the spools may be independently rotated in either direction at will.

The spools at the other end, as 14 and 16 are mounted and equipped for either independent or simultaneous rotation, the general structure being identical to the structure of spools 15 and 17 except for the clutch for locking the two spools together for rotation as a unit.

With this arrangement, it is of utmost importance that the spools be locked together in any relation, therefore a friction type clutch is shown as illustrative of one means of attaining this result.

In both sets of coaxial spools, one spool is fixedly mounted on a shaft 26, with the other spool mounted on a quill shaft 27, spool 17 being fixed against rotation and sliding on its quill shaft, while the quill shaft is slidable but non-rotatable in the spool 16, and the ends of shafts 26 are in both instances rotatable in their associated quill shafts.

The quill shafts 27 have affixed at their outer ends the knurled knobs 25 and 28, and shafts 26 are provided with the knurled knobs 24 and 29.

The shafts 26 and 27 are rotatable in the bearings 30 and 31 respectively, and which are integral with, or mounted on the housing side walls 32 and 33 respectively.

The clutch consists of a plurality of bowed spring fingers or shoes, as 34 and 35, which are fixed to the spool 16 and tend to normally clear the inner periphery of spool 14 as shown.

A disc 36 is fixed to the inner end of the shaft 27 for spool 16, and which upon retraction by means of knob 28 as indicated by the dotted lines at 28', causes the disc to urge the fingers outwardly to grip the spool 14 to cause it to turn with the spool 16 in adjusted registry.

When the clutch is engaged, both ribbons 10 and 11 are driven as a unit at the same speed and adjusted together relative to the hairline 13. The clutch is instantly releasable at will by pressing the knob back to the position shown at 28.

The reels and compensating driving means therefor are identical, and each reel, as shown in Fig. 3, consists of a hub 37 provided with a flange at each end, respectively 38 and 39, the hubs all being of the same diameter and mounted on the respective shafts 40 and 41 on which they are freely rotatable.

The ends of the shafts 40 and 41 are mounted in bearings in the respective side walls 32 and 33, and the terminal ends of the ribbons are attached to the respective hubs.

The means for propelling the ribbons at slow speed or for fine adjustments consists of the knobs 24, 25, 28 and 29 together with the sprockets and associated devices.

The means compensating for variations in cumulative diameters of the ribbon reels consists of two sets of auxiliary reels and a tape for each set, and each set consists of two spaced apart compensating reels, each having a hub 42 of the same diameter as the hubs 37 and coaxial therewith, and having a flange 43, with the flange 39 functioning as the other aligning member for the tape, the reel 42 being comparatively narrow to receive a narrow flat band or tape 44 which has its opposite ends attached to the respective hubs of the spaced apart reels.

The ribbons 10, 11, and tapes 44 are of the same thickness but may be of different material, tapes 44 being preferably formed of a flexible material having friction surfaces which may be produced by oxidation or mechanical means, but should consist of material having a very low coefficient of expansion under the influence of either heat or moisture while ribbons 10 and 11 do not require any friction surfaces, and may be formed of metal, cellulosic, or other materials.

The ribbons and their associated tapes are simultaneously wound on or unwound from the same reel set, therefore the accumulated thickness of ribbon and tape respectively on the hub 37 and associated hub 42 are identical as shown in Fig. 3.

The compensating driving means between the tape reels consists of a belt 47 for each tape, and preferably of a half round form as shown in section in Fig. 3, with the flat side cooperating with the tape 44 and encompassing the spaced apart cumulative reels, and lying on the intervening section of tape between the reels. A grooved idler pulley 48 cooperates with the portion of the belt 47 extending between the spaced apart reels, and belt tensioning means consists of a lever 49 having an idler shaft 50 fixed intermediate its ends to support the idler 48, one end of the lever 49 being pivoted at 51, and a tension spring cooperates between the other end of the lever and the bottom 53 of the housing, as shown at 52.

Since the belt 47 operates over the accumulation of tape on the reels, and the accumulated diameters of ribbon reels and tape reels are always identical, perfect compensation and uniform speed of both ends of the ribbon alone can result.

When the ribbon is driven by the low ratio driving means, as by means of knobs 24, 25, 28, 29 and their associated sprockets, the same results as to synchronism and compensation are attained as when operated by the high ratio driving means through the knobs 54 and associated gears and pinions, as the tapes, ribbons, belts and reels all cooperate to maintain a uniform tension on the exposed portions of the ribbon.

For the purpose of maintaining uniform tension on the ribbons, the bearings 55 at the respective ends of shaft 41 are diagonally slidable in the slot 55' and are retracted by means of springs 56 coupled between the bearings and the bottom of the housing.

Means for retaining the ribbons individually at desired scale settings consists of a brake shoe for each gear 22, indicated at 57, which shoe is pivoted at 58 to the housing side wall, 32, 33, and urged to cooperate with the inside surface 59 of the gear flange by means of a cam 60 which is controlled by a lever 61, providing for accurate setting of either ribbon with any division or point between divisions to the hair line 13.

The high speed position indicating means for indicating the relative location of the indices of the scales consists of a straight line 62 of some distinguishing color or character extending diagonally from one end 63 of the set of scales on the ribbon to the diagonally opposite end 64, and a plurality of transverse scales 65 and 66, (which may be formed diagonally if desired), formed in the cursor or transparent top 12 of the de-

vice, whereby, as the ribbon is driven at high speed it is merely necessary to watch the transverse travel of the line 62 relative to the scales 65, 66 until it falls between the two numbers which include the value desired.

As shown in Fig. 1, the line 62 falls between 4 and 5 on scale 65, and the ribbon has reached the position for slow speed adjustment to any value between 4 and 5.

Since the distance between 1 and 2 for instance, in a logarithmic scale 100 inches long is about 30 inches, and in longer scales would be correspondingly longer, it is advisable to provide additionally, low speed position locating means, therefore, additional lines, straight or curved, as may be required, are formed between diagonal points on each scale section, such as line 67 extending from 63 to 68, corresponding to 1 to 2 on the scale and forming one scale section, another line 69 extending from 70 to 71 diagonally across another scale section 2 to 3, and so on for each unit scale section of the scale.

As indicated in Fig. 1, line 62 on ribbon 11 registers between 2 and 3 on the transverse scale 72, while line 69 lies between 3 and 4. For line 62 the scale is read for the first significant figure, while line 69 is used for the second significant figure, and for further significant figures the reading is attained through the medium of the hair line, or may be obtained through the medium of additional locating lines adapted to divisions of the unit scales. The reading indicated would be 2 for the first significant figure, and about .38 for the second and third significant figures. The ribbon is now adjusted until the exact value, say 2.383 registers with the hair line 13, being the final adjustment.

In operation it is merely necessary to register the required values on the ribbons with the hair line 13, and when required in calculations, instead of moving the cursor as on the conventional slide rule, after suitable correlation of the body and slide scales to the hair line, the knob 28 is pulled out to the position 28' which forces the shoes 34, 35, to clutch the spool 14, after which the ribbons are adjusted as a unit to the next selected value by means of either high ratio or low ratio driving. By pressing the knob 28 back to the full line position, the clutch is released for individual adjustment of the respective scales.

It will be understood that the reeling means shown in Fig. 3 may be dispensed with and continuous ribbons in the form of a belt may be employed, permitting the unexposed portions of the ribbons to gather in the lower portion of the housing. The form and structure illustrated and described is merely one preferred form of the invention.

It will be understood that variations in construction and arrangement of parts, which variations are consistent with the appended claims, may be resorted to without detracting from the spirit or scope of the invention or sacrificing any of the advantages thereof.

We claim:

1. A calculating device comprising two ribbons each having sprocket-tooth-receiving perforations formed throughout its length; two parallel spaced-apart shafts rotatably mounted; a spool fixed on each shaft and a spool freely rotatable on each shaft; sprocket teeth formed on each spool; a knob associated with each spool for independent rotation thereof; a clutch associated with one spool and cooperatively related to the other spool on the same shaft and means associated with one of said knobs and operatively connected to said clutch for selectively clutching and declutching the other spool at will through axial movement of said one of said knobs; positive acting mutual driving means cooperating between the respective spools on the respective shafts for maintaining the respective sprockets in predetermined ribbon-tightening relation.

2. A calculating device comprising two parallel ribbons each having sprocket-tooth-receiving perforations formed throughout their lengths; two sets of spaced apart spools, one set for each ribbon forming two pairs of coaxial spools; sprocket teeth formed on each spool; positive-acting mutual driving means cooperating between each of said two sets of spaced-apart spools maintaining the angular relation of the sprockets to keep the intervening portions of the ribbons taut through cooperation of predeterminedly related sprocket teeth with the perforations; a clutch associated with one pair of said spools; a driving knob associated with each spool of one pair, one of said driving knobs having an operative connection with said clutch for clutching and de-clutching said one pair of spools at will by axial movement of said one of said driving knobs.

3. A structure as claimed in claim 2; a ribbon reel for each end of each ribbon and a coaxial compensating reel fixedly associated with each ribbon reel forming two sets of spaced-apart compensating reels; and compensating, mutually acting takeup means cooperating between the spaced apart compensating reels; said mutually acting takeup means being independently actuated through the movement of the associated ribbon and being free of any directional urging effect on said ribbons and being controlled entirely by the urgence of said ribbons and forming auxiliary means for maintaining the intervening portions of said ribbons taut.

4. A structure as claimed in claim 2; a ribbon reel for each end of each ribbon and a coaxial compensating reel fixedly associated with each ribbon reel forming two sets of spaced-apart compensating reels; and compensating, mutually acting takeup means cooperating between the spaced apart compensating reels; said mutually acting takeup means being independently actuated through the movement of the associated ribbon and being free of any directional urging effect on said ribbons and being controlled entirely by the urgence of said ribbons and forming auxiliary means maintaining the intervening portions of said ribbons taut, said compensating mutually acting takeup means comprising cumulative means winding from one compensating reel to the other of each set, and mutual driving means associated with said cumulative means accumulated on said compensating reels.

5. A structure as claimed in claim 2, and compensating, mutually acting takeup means comprising a coaxial compensating reel attached to each ribbon forming two sets of compensating reels; cumulative means windable from one compensating reel to the other of each set, and mutual driving means associated with the cumulative means equalizing opposed tension on the intervening portions of the ribbons and being free of urging influence on the ribbons toward driving the ribbons in either direction.

6. A structure as claimed in claim 2, a coaxial compensating reel fixedly with each

ribbon reel forming two sets of spaced apart compensating reels; a compensating ribbon windable from one compensating reel to the other of each set and having cumulative diameters on the compensating reels equal to the cumulative diameters of the ribbons on the associated ribbon reels; and, a belt operating over the cumulative diameters of the compensating reels of each set, forming mutual driving means between the compensating reels of each set subjecting the ribbons to equalized tension at opposite ends and being free of directional driving urgence on the ribbons.

7. A structure as claimed in claim 2, a coaxial compensating reel fixedly associated with each ribbon reel forming two sets of spaced apart compensating reels; a compensating ribbon windable from one compensating reel to the other of each set and having cumulative diameters on the compensating reels equal to the cumulative diameters of the ribbons on the associated ribbon reels; and, a belt operating over the cumulative diameters of the compensating reels of each set, forming mutual driving means between the compensating reels of each set subjecting the ribbons to equalized tension at opposite ends and being free of directional driving urgence on the ribbons, and means increasing the wrap of said belts on the cumulative peripheries of said compensating reels and coincidently maintaining uniform tension and taking up stretch of the belts.

8. A structure as claimed in claim 2, a coaxial compensating reel fixedly associated with each ribbon reel forming two sets of spaced apart compensating reels; a compensating ribbon windable from one compensating reel to the other of each set and having cumulative diameters on the compensating reels equal to the cumulative diameters of the ribbons on the associated ribbons reels; a belt operating over the cumulative diameters of the compensating reels of each set subjecting the ribbons to equalized tension at their opposite ends and forming mutual driving means free from directional driving urgence on the ribbons; said belts having a plane inner face for full coperation with said compensating ribbons, and an outer face convex in cross-section; a grooved pulley cooperating with said outer face and intermediately located relative to the compensating reels of each set to maintain alignment of the belts with the compensating ribbons, to increase the wrap of the belts on the cumulative peripheries, and to maintain predetermined tension on the belts.

9. A calculating device comprising two sets of spaced apart ribbon sprockets, the respective sprockets of the respective sets being coaxially mounted forming two pairs of coaxial sprockets; a knurled knob associated with each sprocket of at least one pair for manual rotation thereof at will; a clutch associated with one sprocket and cooperatively related to the other coaxial sprocket; means associated with the knurled knob of one of said last named sprockets and cooperating with said clutch and engaging and disengaging said clutch with said other sprocket through axial movement of the said knurled knob; a pinion fixedly associated with each sprocket of both sets forming two sets of pinions; a gear for each set of pinions and coincidently meshing with both pinions thereof for maintaining the predetermined relation between the teeth of the sprockets of its associated set and for rotating the sprockets in synchronism; and a scale ribbon for each set of sprockets and having sprocket tooth perforations formed therein; the teeth on said sprockets through the medium of said gears maintaining the intervening portions of said ribbons taut and additionally functioning to feed the ribbons upon manual rotary urgence of the knobs.

10. A structure as claimed in claim 9; a ribbon reel for each end of each scale ribbon; a compensating reel fixedly associated with each ribbon reel and being of the same initial diameter, forming two sets of spaced apart compensating reels; a compensating ribbon coincidently taken up on one compensating reel and paid out on the other of each set and having under all conditions of takeup and payout a cumulative diameter exactly equal to the cumulative diameter of the scale ribbon on its associated ribbon reel; and a belt for each set of compensating reels and operating over and about the accumulations of compensating ribbon on the respective compensating reels of each set, forming in combination, auxiliary tensioning means for the intervening portions of the respective scale ribbons and mutual driving means free of directional urgence on the scale ribbons.

11. A calculating device comprising two coaxial units in parallel, each unit comprising a set of two spaced apart sprockets, two spaced apart scale ribbon reels and a compensating reel of equal diameter coaxial with and fixed to each scale ribbon reel; a scale ribbon having its respective ends attached to the respective scale ribbon reels and operating over said sprockets and having perforations for receiving the teeth of the sprockets; an axially-movable knob for manual rotation of one sprocket; a clutch for said one sprocket and cooperatively related to the coaxial sprocket for the other unit; means cooperatively associated with said clutch and said one knob engaging and disengaging said clutch with respective opposed axial movements of said one knob; positive-acting, relation-maintaining means for said sprockets maintaining the intervening portion of said scale ribbon taut; a compensating ribbon having its ends attached to the respective compensating ribbon reels and having a thickness equal to the thickness of said scale ribbon and having its respective top and bottom surfaces frictionally formed and having a cumulative diameter on each compensating reel equal to the accumulated diameter of scale ribbon on its associated scale ribbon reel; and mutual driving means comprising a belt operating over the accumulations of compensating ribbon on the respective compensating reels; wrap increasing and tensioning means for said belt; and tensioning means urging retraction of one compensating reel and its associated scale ribbon reel, providing predetermined tension on both ends of the intervening portion of said scale ribbon through coincident transference of the urgence through one end of the intervening portion of said scale ribbon, and in opposition through said belt to the other end of the intervening portion of said scale ribbon, whereby the tension on the scale ribbon is equalized; said mutual driving means being free of directional urgence on said scale ribbon and being controlled by movement of said scale ribbon.

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