Dec. 18, 1951 S. K. JOHNSON 2,578,705

CALCULATING MACHINE

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FIG. 1.

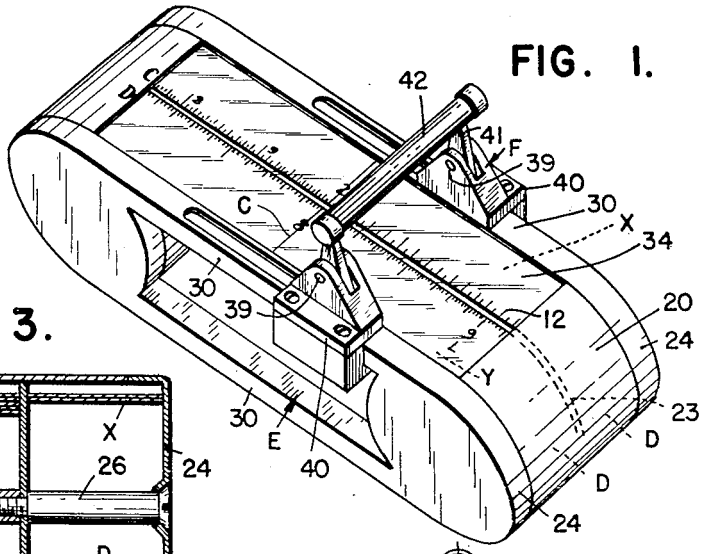


FIG. 3.

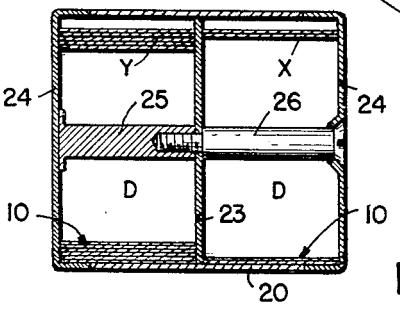


FIG. 2.

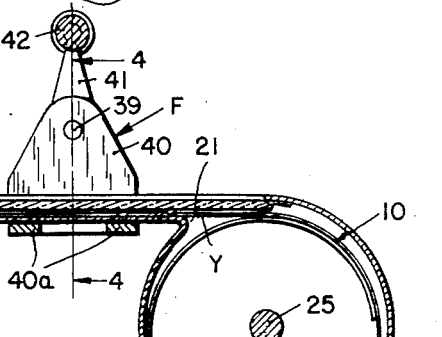


FIG. 4.

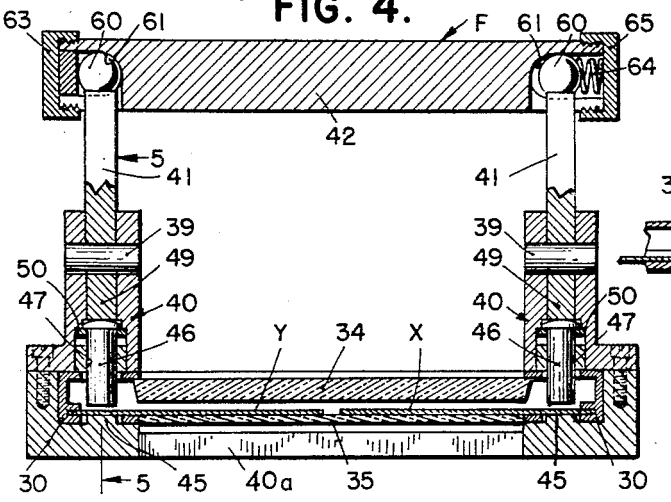
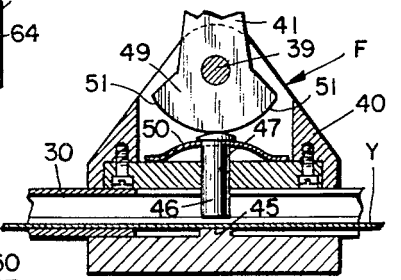


FIG. 5.



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CALCULATING MACHINE

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FIG. 6.

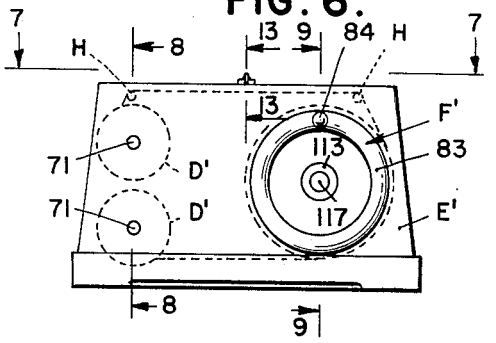


FIG. 7.

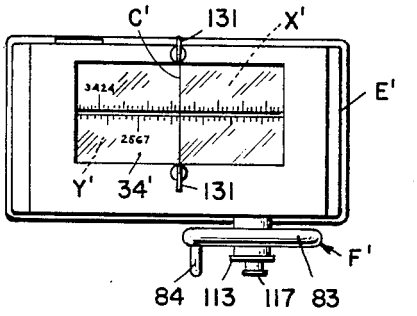


FIG. 8.

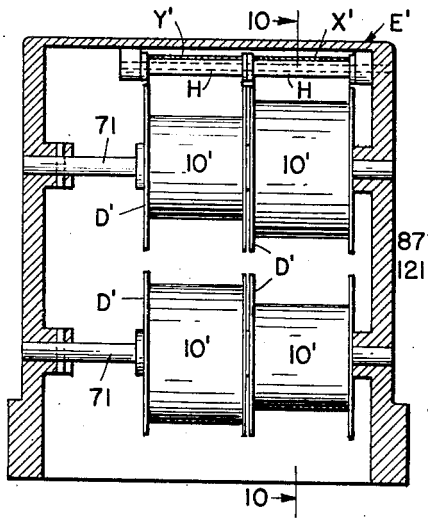


FIG. 9.

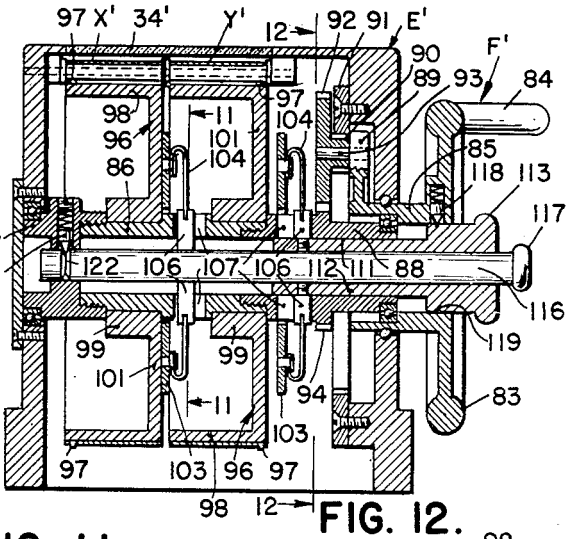


FIG. 12.

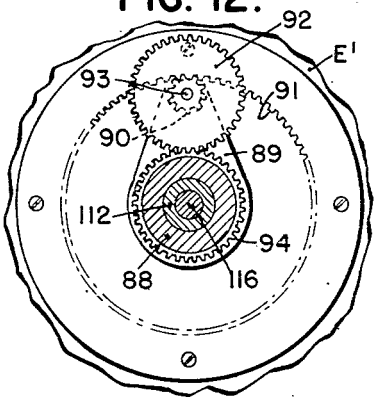


FIG. 10.

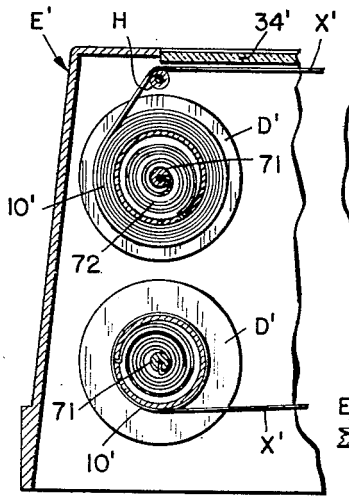


FIG. 11.

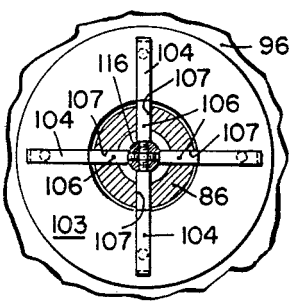
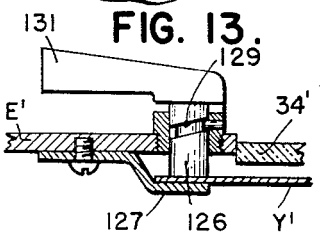


FIG. 13.



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CALCULATING MACHINE

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FIG. 14.

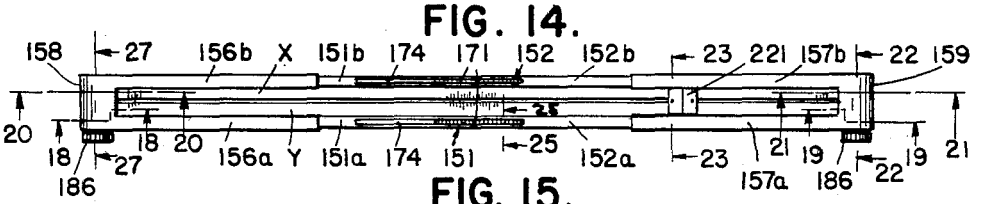


FIG. 15.

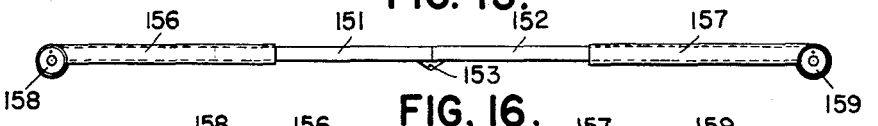


FIG. 16.

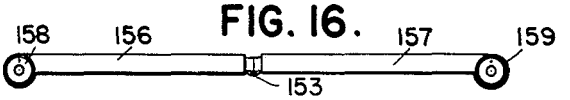


FIG. 18.

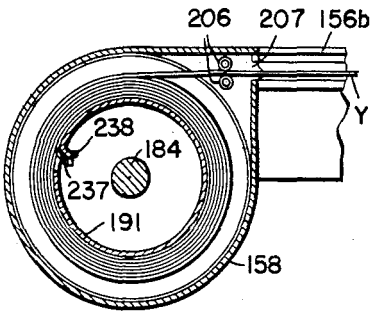


FIG. 17.

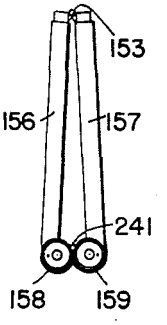


FIG. 19.

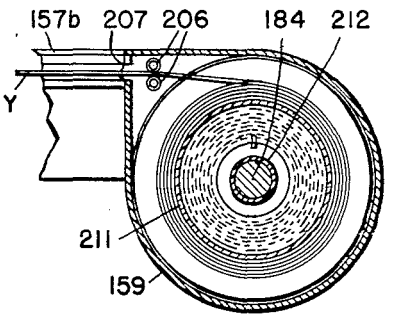


FIG. 20.

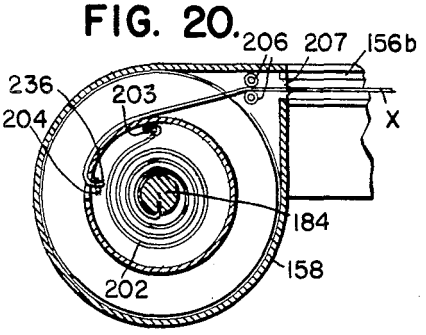


FIG. 21.

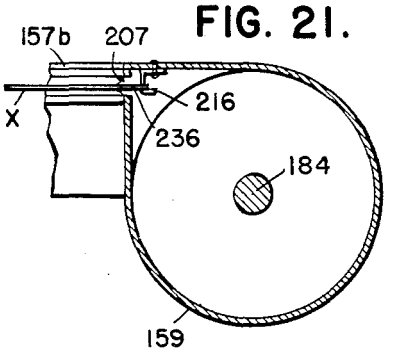
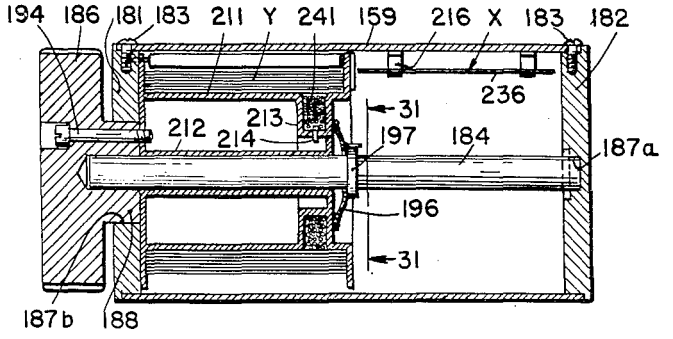


FIG. 22.



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CALCULATING MACHINE

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FIG. 23.

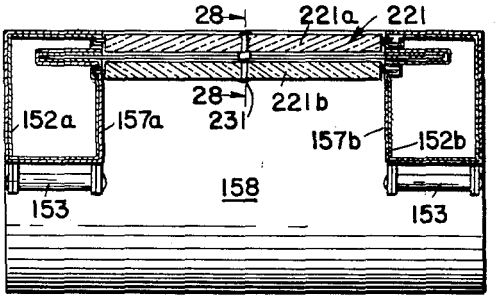


FIG. 24

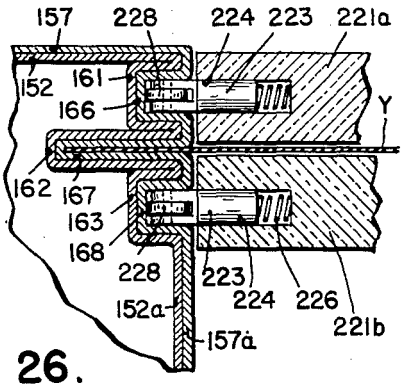


FIG. 25.

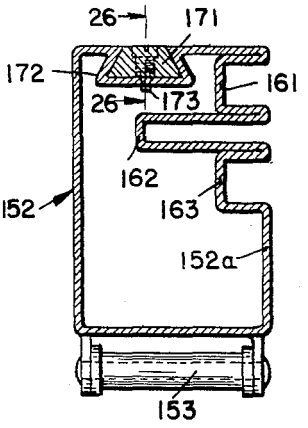


FIG. 26.

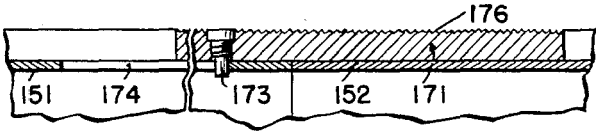


FIG. 27.

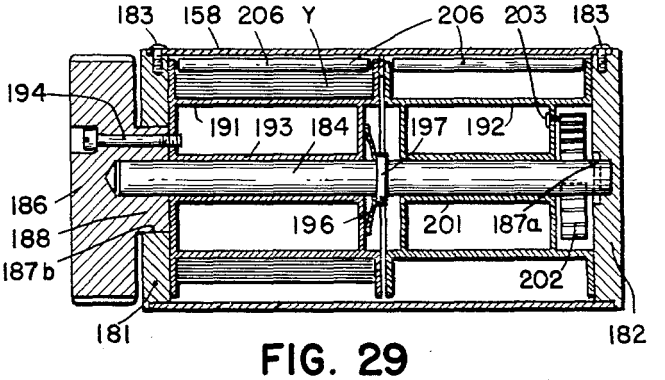


FIG. 28.

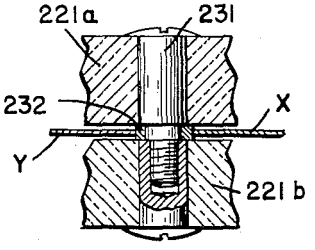


FIG. 29

FIG. 30.

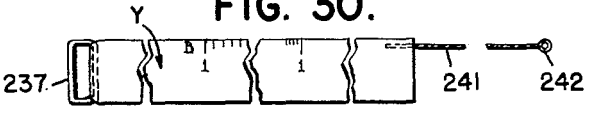
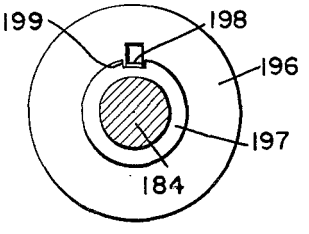


FIG. 31.



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Adams Ely & Hattis

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Patented Dec. 18, 1951 2,578,705

UNITED STATES PATENT OFFICE

2,578,705

CALCULATING MACHINE

Sheldon K. Johnson, Van Nuys, Calif.

Application February 10, 1949, Serial No. 75,701

11 Claims. (Cl. 235—71)

1

This invention relates to a calculating machine utilizing a mathematical system, for example, logarithmic, incorporating cooperating scales of great length to provide great accuracy.

Slide rules employing cooperating logarithmic scales positioned on rigid elongated structures have long been used in making mathematical calculations. They are of limited capacity and accuracy due to the fact that they become unwieldy and impractical if made of sufficient length to give accuracy.

It is a general object of the invention to provide a device employing mathematical scales of relatively great length as compared to those embodied in conventional slide rules. The scales embodied in the device of the present invention are formed by graduated markings on flexible webs or tapes and are exposed between rolls or supplies which may be of substantial size or capacity, the device being light, compact and portable.

A further general object of the present invention is to provide a calculating device in which scales comprising webs or tapes are supported for selective independent or conjoint movement. In the preferred form of the invention the scales are related to a fixed reference mark to facilitate reading, and are movable relative thereto.

Another object of the invention is to provide a device of the general character referred to involving operator actuated means including a slidable reciprocable part by which the scales can be moved readily in either direction.

A further object of the invention is to provide a device of the general character referred to wherein the scales are adjusted by a mechanism actuated by a manually rotatable knob so located that it can be turned conveniently in either direction and connected by speed-increasing gearing to a tape.

Still another object of the invention is to provide a device of the type described in which flexible scales are adjusted manually by means including speed-increasing gearing, or may selectively be given a micro-adjustment by means omitting that gearing.

Other objects and features of the invention will be fully understood from the following detailed description of typical preferred embodiments in which reference is made to the accompanying drawings, in which:

Figure 1 is a perspective view of a first preferred embodiment of the invention showing the structure ready for operation;

Figure 2 is a central longitudinal vertical section through the construction shown in Figure 1;

Figure 3 is a vertical transverse section upon the line 3—3 of Figure 2;

Figure 4 is a vertical section through the actuating mechanism upon the line 4—4 of Figure 2;

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Figure 5 is a detailed sectional view on the line 5—5 of Figure 4;

Figure 6 is a side elevation of a second preferred embodiment of the invention;

Figure 7 is a top plan view of the structure shown in Figure 6 looking in the direction of the arrows on the line 7—7;

Figure 8 is an enlarged sectional view upon the line 8—8 of Figure 6;

Figure 9 is an enlarged transverse sectional view on the line 9—9 of Figure 6;

Figure 10 is a partial longitudinal section on the line 10—10 of Figure 8;

Figure 11 is a detailed sectional view upon the line 11—11 of Figure 9;

Figure 12 is a detailed section on the line 12—12 of Figure 9;

Figure 13 is an enlarged detailed section on the line 13—13 of Figure 6;

Figure 14 is a top view of a third preferred embodiment of the invention in which the rule telescopes and folds to decrease its size for storage purposes;

Figure 15 is a side view of the construction of Figure 14 showing the parts in their operative relationship;

Figure 16 illustrates the length of the rule when telescoped;

Figure 17 shows the telescoped rule of Figure 16 folded for storage purposes;

Figure 18 is a partial longitudinal section through a carrier for the sliding tape upon the line 18—18 of Figure 14;

Figure 19 is a partial longitudinal section upon the line 19—19 of Figure 14 showing the spring wound carrier at the opposite end of the sliding tape;

Figure 20 is a partial longitudinal section upon the line 20—20 of Figure 14 showing the spring-actuated take-up for the fixed scale;

Figure 21 is a partial longitudinal section upon the line 21—21 of Figure 14 showing the hook-type connection at the opposite end of the fixed tape;

Figure 22 is a transverse section upon the line 22—22 of Figure 14 and illustrates the manually rotatable carrier at one end of the sliding tape and the seat formed therein for the cable at the end of the tape;

Figure 23 is a transverse section through the rule and its slide runner upon the line 23—23 of Figure 14;

Figure 24 is an enlarged showing of the runner-supporting means;

Figure 25 is a partial transverse section upon the line 25—25 of Figure 14 and shows the pivotal connection of the center sections of the rule and also the position of the bridge key;

Figure 26 is a partial longitudinal section through the sliding bridge key illustrated in Fig-

ure 25 which functions to hold the foldable center sections of the rule in alignment;

Figure 27 is a transverse section upon the line 27—27 of Figure 14 showing the manually rotatable carrier for the slide scale and the spring take-up for the fixed scale;

Figure 28 is an enlarged partial transverse section upon the line 28—28 of Figure 23 and shows the spacing of the upper and lower runner plates;

Figure 29 is a top view of the fixed stock scale;

Figure 30 is a top view of the slidable scale and shows the cable at one of its ends; and

Figure 31 is a view looking in the direction of the arrows upon the line 31—31 of Figure 22 and shows the brake means which permit rotation of the carrier for the slide scale but prevent over-run.

Referring to the form of the invention illustrated in Figures 1 to 5, inclusive, the structure is seen to include two flexible tapes or webs carrying graduated markings to form scales X and Y. A fixed reference mark or line C cooperates with the scales and extends transversely over their visible exposed portions. The opposite ends of the tapes are wound spirally in the form of rolls or supplies 10. The structure also includes a pair of containers or carriers D at each end of the tapes, side frames E, and manually actuated scale operating means F by which the scales may be adjusted.

The tapes 11 of which the scales X and Y are formed may be of any suitable material, as for example thin, flexible strips of steel or other suitable material commonly employed in the manufacture of flexible rules or the like. The invention contemplates tapes of substantial length, that is, each tape may be many times longer than the conventional slide rule. In practice they may vary considerably in width, the width in a particular case being governed somewhat by the markings. Where the structure embodies but two scales they are preferably of equal width, as shown in the drawings.

The markings 12 on the tapes of scales X and Y may be of any suitable character so far as the broader principles of the invention are concerned. It is preferred, however, that they constitute linear representations of logarithms. In such cases the structure preferably includes a fixed reference mark or line C to facilitate scale reading, the mark corresponding to the shiftable reference mark formed in the ordinary rigid logarithmic scale construction.

In the preferred arrangement the scales X and Y between the carriers D at their ends are exposed, the apposing edges 15 of the tapes closely approaching each other as shown in the drawings. The markings 12 are on the exposed visible faces of the tapes, preferably adjacent the apposing edges 15. In the form of the invention under consideration both top and bottom of the central portions of the tapes are exposed. Accordingly, markings 12 may be applied advantageously to both sides, and when this is done different values may be represented by the markings on opposite sides of a tape. Also, when this is done a reference mark C is provided both above and below the tapes.

Each of the scales X and Y may be shifted longitudinally so that successive portions along its length may be exposed between the rolls 10. As a scale is shifted it is drawn from the roll or supply 10 at one of its ends and fed to the other. It follows that the size of the roll or supply at an end of a tape varies in accordance with the operative position of the tape. Plain unmarked portions may be provided at each end to provide a guide to indicate that the usable length of tape has been withdrawn. In Figure 2 of the drawings the roll 10 at the left is shown containing a substantially supply of tape while the roll at the right is practically depleted. If that tape is shifted to the right it will be fed into the roll 10 at the right, increasing its size, the roll at the left becoming correspondingly reduced in size.

Where the instrument has two scales there will be two rolls of tape at each of its ends. In the preferred arrangement the rolls at each end are arranged side by side to provide a simple, compact construction. In the form of the invention under consideration the containers D at each end are formed by a cylindrical shell 20 having at its top a tangential opening 21 through which the tapes pass. The inner wall of the shell is smooth and preferably polished so that the tape when forced tangentially therein through the opening 21 slides around circumferentially to form a spiral roll as shown at the left in Figure 2. The sliding friction between the roll of tape and the enclosing wall of the shell and between adjacent convolutions of the roll itself provides a desirable drag to prevent overrunning in the sense that it serves to check or brake the travel of the tape upon the removal of the displacing force and also to retain it in a set position. In the form of construction illustrated in Figures 1 to 5, inclusive, two carriers D at each end of the structure are formed in the shell 20 by a partition 23. The ends of each shell are closed by detachable caps 24 secured to the shell and to each other by a central tie involving a stem 25 projecting inward from one cap and having an interiorly threaded end which receives a screw 26 extending inward from the other cap and passing through the partition 23, as is clearly shown in Figure 3. The caps 24 on the same side of the device are connected by longitudinally extending upper and lower frame members 30. Members 30 are rigid and cooperate with the end caps 24 at their opposite ends to form rigid frames E. The scales X and Y extend parallel to and between the upper frame members 30, entering the carriers D through the top openings 21 therein. The underside of the scales X and Y can be viewed by looking downwardly between the lower pair of members 30 with the unit inverted.

The reference mark C may be of any suitable form In the form illustrated the upper mark C is positioned on a transparent cover 34 extending lengthwise of the structure between the top frame elements 30. The mark cooperating with the lower faces of the tapes is on a transparent cover 35 located immediately below the tapes. Cover 35 is carried between the frame members 30 and extends lengthwise of the structure as shown. It is to be understood that the reference mark C may be in the nature of fine scratches or hair lines on the transparencies forming the covers 34 and 35, after the manner common in instruments of this general character.

The operating means for scales X and Y is such as to enable a person using the instrument to operate them separately or simultaneously. In the form of the invention under consideration the means F involves, generally, a manually operated means and a drive from such means to each tape. The manually operated means includes a pair of sliding or reciprocating structures com-

prising blocks 40 slidably carried on the upper frame members 30. An arm 41 pivoted at 39 projects upwardly from each of the blocks and a handle 42 in the form of a cross-member extends between and connects them. Each block 40 slidably embraces the upper, lower and outer sides of a frame member 30 and in practice is fitted as to slide freely thereon, being connected to the opposite block 40 by a transverse member 40*a* underlying the tapes.

The scale operating means F includes tape-propelling drives normally in released position and adapted to be engaged at will by the person operating the machine. Each drive is shown as a clutch construction, there being a clutch for operating each tape, and the means being such that either or both of the clutches may be engaged as the operator may desire. In the case illustrated there is a clutch carried by or related to each block 40 arranged directly to engage the adjacent tape.

The particular clutch construction illustrated involves in each instance a fixed jaw 45 carried by the block beneath the adjacent tape and a shiftable jaw 46 supported slidably in a guideway 47 over the tape and above the fixed jaw 45.

The arms 41 are shown shiftable relative to the blocks from which they extend and each arm has a cam portion at its lower end. The shiftable clutch jaw 46 is normally held up in retracted inoperative position by a suitable leaf spring 50 and the cam part 49 for operating the clutch jaw has oppositely arranged cam faces 51 so located and proportioned as to force the jaw 46 into clamping engagement with the underlying tape when the arm 41 is swung in either direction from its normal vertical position.

When an arm 41 is in its normal upright position, as shown in Figures 1 and 2, the clutch controlled thereby is open or released and the block 40 carrying that arm can slide lengthwise of the structure without moving the adjacent tape. If it is desired to move a particular scale or tape to the left the arm 41 upon that side of the drive is swung to the left, causing the clutch to engage, and continued pressure on the arm toward the left will cause the attached block to move in that direction drawing the scale with it. The movement of the scale or tape to the right may be effected in a similar manner The opposite sides are to be understood to be identical.

In accordance with the present invention the handle 42 of the scale operating means F is so coupled to each of the arms 41 that they can be rocked separately or simultaneously, as the user elects. In the case illustrated ball and socket joints connect the upper ends of the arms to the ends of the handle 42, the handle extending transversely a suitable distance above the top transparency 34. The arms 41 are provided at their upper ends with spherical balls 60 positioned in suitable sockets 61 in the end portions of the handle. At one end of the handle the ball 60 is confined in the socket 61 for limited universal movement by a cap 63 threaded on that end of the handle. At the other end the ball 60 is free to shift longitudinally of the handle for a limited distance and is yieldingly confined by an abutting coil spring 64 held by the cap 65 threaded on the end of the handle. By providing for limited axial movement of the handle relative to the last-mentioned ball 60 either of the arms 41 can be swung in either direction to effect clutch engagement without effecting a corresponding tilting movement in the other arm.

From the foregoing description it will be apparent that the structure embodying the present invention includes the two scales X and Y with markings representing logarithmic values which scales are related to a reference mark C. The operating means F enables a person using the device to shift either scale in either direction or to operate both scales simultaneously in either direction with the result that the scales may be manipulated relative to and may be read in connection with the reference mark C in the manner familiar to persons employing logarithmic scales or slide rules. The scales are not short, limited length elements characteristic of the usual slide rule but rather, being flexible tapes with coiled ends, they are of great length and yet are conveniently and neatly handled. The tapes are in fact made longer than the scaled lengths thereof in order that the user will note that he has reached the end of the scale before moving the tape accidentally all the way from one container and thus avoid the difficulty of replacing it therein.

In the form of the invention illustrated on sheet 2 of the drawings the scales X' and Y' correspond generally to the scales X and Y first described, and likewise there is a reference mark C' similar to the mark C first described and cooperating with the scales X' and Y'. As in the first embodiment scales X' and Y' have central exposed visible portions extending between rolls or supplies 10' supported by rotatable carriers D' which in turn are supported by a rigid enclosing frame E'. Further, in this form of the invention the manually actuated scale operating means F' involves a manually operated member gear connected to clutch drives so that the tapes may be accelerated in their movement through a resulting speed-up provided by the gearing.

In the form of the invention shown on sheet 2 two cooperating scales X' and Y' are arranged with straight exposed visible portions in edge to edge relationship, the markings on the tapes being adjacent the apposed edges. The frame E' is a box-like structure adapted to be positioned on a table or other support, only the top or upper sides being exposed. Consequently, there are markings on the upper sides only of the tapes and there is but one reference mark C' which is carried by a transparent cover or closure 34' suitably mounted in the top of frame E'.

In this form of the invention the structure includes roller guide means H provided at each end of the exposed portion of each scale. The tapes pass over these rollers on their way to and from the carriers D'. Accordingly, the supply rolls 10' may be located other than at the ends of the structure if desired.

The carriers D' are in the form of spools rotatably supported on transverse spindles 71 and yieldingly urged by internal springs 72 to wind in the attached tape. The supplies or rolls 10' are all located at one end of the structure, the rolls of each tape being located one above the other, as clearly illustrated in Figures 6, 8 and 10. The spools D' are formed with side walls of sufficient radial extent readily to receive the entire length of the attached tape.

The manually operated means in this form of the invention comprises a rotatable element 83, preferably a wheel or knob, located at the side of frame E' near one end. The wheel 83 is shown provided with a suitable handle 84 and is rotatably supported in one side of the frame E' by its hub 85. The axis of rotation of wheel 83 ex-

tends transversely and is located near the end of the structure remote from the supplies 10'. A segmented drive shaft 86 is rotatably supported by suitable bearings 87 and 88 and suitably driven from the wheel 83 in a manner to be described. The bearing 87 carrying one end of shaft 86 is supported by the side wall of frame E' remote from wheel 83 while the bearing 88 carrying the other end of shaft 86 is supported within the wheel hub 85.

A speed-increasing gear drive connects manually rotatable member 83 to the shaft 86. The drive involves an arm 89 projecting radially from the hub 85 within frame E' and carrying a pinion 90 engaging an internal ring gear 91 fixed to the frame side wall. A drive gear 92 carried by shaft 93 is keyed to pinion 90 and meshes with a gear 94 fixed on the shaft 86. Rotation of wheel 83 causes the shaft 86 to rotate at a greatly increased rate, the ratio being determined by the ratio of the teeth of pinion to ring gear 91 and the teeth of gear 92 to shaft gear 94.

Each scale tape wraps partially around a sprocket spool 96, the teeth 97 engaging sprocket openings along the outer edge of the tape. Each sprocket spool has a rim 98 supported from a hub 99 by a flat web 101, the hub 99 being rotatable on shaft 86. A clutch plate 103 apposes each sprocket spool web 101, being carried by spring arms 104 projecting from pins 106 extending radially through and being shiftable axially of shaft 86. When the pins 106 are shifted toward the sprocket spool the clutch plate 103 frictionally engages its web 101 to establish a driving engagement. The pins are slidable longitudinally relative to the shaft 86 in slots 107 which, however, permit no relative rotation so that the pins and attached clutch plate rotate with the shaft when it is rotated.

There are a plurality of sprocket spools and tapes and control means are provided by which the wheels can be clutched to shaft 86 individually or conjointly. The shaft 86 is tubular being provided with a central longitudinal bore 111. A hollow operating rod 112 is slidable in bore 111 and extends to the side of wheel 83 where it carries an operating knob 113. The pins 106 of the clutch nearest wheel 83 are fixed to rod 112 and upon the rod being shifted axially the clutch pins are correspondingly shifted in their slots 107. A second operating rod 116 is slidably carried in hollow rod 112, one of its ends extending to the exterior of the structure where it has an operating knob 117 adjacent knob 113. The pins 106 of the second clutch are fixed to the rod 116 at a point beyond the end of rod 112 so that by shifting rod 116 axially that clutch can be operated, its pins 106 sliding in their slots 107 in shaft 86.

The structure preferably includes means to hold releasably the clutches engaged once they are closed. In the form illustrated a spring actuated detent 118 carried by wheel 83 engages a recessed seat 119 in rod 112 to hold it in its clutch-engaging position. A similar spring actuated detent 121 carried by shaft 86 adjacent its outer end engages selectively a recessed seat 122 on the operating rod 116 to hold it in position where the clutch controlled thereby is engaged.

In practice it may be desirable to provide the construction with lock means for the scales so that the operator can set either or both against movement. Accordingly, a lock shoe 126 is shown related to each tape as to cooperate with a fixed underlying abutment 127. A cam device is provided for operating with a cam slot 129 in the shoe. When the shoe 126 is rotated, as by turning the attached handle 131, it is moved either toward or from the abutment 127 and either to clamp or to release the tape positioned therebetween. When so clamped scale movement is positively prevented.

The form of the invention just described may also employ tapes having suitable markings thereon, as for instance logarithmic markings, to the end that it can function in a manner similar to an ordinary logarithmic slide rule. The scales, of course, may be of great length, giving to the instrument far greater accuracy than is possible when using an ordinary slide rule.

The operation of this, the second preferred embodiment of the invention, is believed to be clear from the foregoing. It being desired to adjust either scale X' or Y' relative to marker C', the user first longitudinally adjusts rod 112 or rod 116, depending upon which tape and which sprocket spool 96 he desires to clutch to the rotatable shaft 86. He can, of course, if he desires, clutch both to the shaft. This is accomplished by forcing both knobs 113 and 117 inwardly whereupon the clutch plates 103 make frictional contact with the front surfaces of the spool webs 101 apposed thereto. Manual rotation of the rotatable member 83 then causes the shaft 86 to be rotated at a much greater speed through the speed-multiplying gear connections described. The tapes having been moved, in either direction desired, a point determined by the direction of rotation of the wheel 83, they may then be clamped in place by a simple rotation of the lock handles 131. Regardless of which way the scales are traveling they are moved by the sprocket spool 96 over which they pass and are drawn from the supply 10' at one of their ends and feed upon the supply 10' at their opposite ends, the coil spring 72 of the spools D' functioning in each instance to enable the spool to rotate and to wind the oncoming scale thereon.

In the event that very slow adjustment of the scales is desired, as for example a precise microsetting of a scale mark to the hairline, this may be accomplished by turning manually that knob 113 or 117 which is connected through a clutch to the sprocket carrying the scale which is to be adjusted. These knobs and their connected shafts 112 and 116 are direct connected through the clutch plates to the sprocket spools, whereas the normal actuating wheel 83 is gear connected thereto. When knobs 117 or 113 are used the gearing provides a desirable drag to make the microsetting possible.

Referring now to the third embodiment of the invention illustrated in Figures 14 to 31, inclusive, a construction is shown which in outward appearance more nearly approaches the conventional slide rule when extended in its operative relationship. It has the distinct advantage, however, that while of greater length and encompassing a tape-type scale, as in the previous embodiments, it further magnifies the scale length and so its accuracy through being adapted to telescope and fold into an overall length even less than that of conventional rules.

The rule constructed in accordance with this third preferred embodiment of the invention comprises pairs of center sections 151 and 152, formed of legs 151*a* and *b*, and 152*a* and *b*, respectively, the sections being pivotally connected at their abutting inner ends by a pivotal mounting 153 and telescopically enclosed at their

spaced outer ends by longitudinally slidable outer sections 156 and 157, formed of legs 156a and b and 157a and b, respectively. The latter are provided at their own outer ends with integral cylindrical shells 158 and 159, respectively.

The body upon opposite sides of the pivotal mounting 153 can be considered to be substantially identical. The center section 152 comprises a pair of generally rectangularly sectioned hollow tubes or legs 152a and 152b pivoted at their lower inner ends upon pivotal mountings 153 to the corresponding sections of opposite inner section 151. Each leg of sections 151 and 152 is formed on its inner side adjacent its top with three re-entrant channels 161, 162 and 163, the middle channel 162 being deeper and of lesser height as is clearly illustrated in Figure 24. Leg 157a of outer section 157 telescopically encloses leg 152a and is itself formed with re-entrant channels 166, 167 and 168 which slidingly seat, respectively, in channels 161, 162 and 163 of leg 152a. The relationship is such that the interfitting channels, which also give to the structure increased rigidity, provide for relative longitudinal sliding movement. The interrelationship is common upon both sides of the pivotal center mounting of the rule and to both lips upon each side permitting the sections 156 and 157 to be telescoped over the center sections 151 and 152 from their extended positions illustrated in Figures 14 and 15 to a shortened relationship as illustrated in Figure 16.

When in use the center sections 151 and 152 are maintained in alignment as illustrated in Figures 14 and 15 by a slide locking key 171 seated within a re-entrant channel 172 in the top of each leg a and b of members 151 and 152. When it is desired to collapse the unit and to fold it the slidable bridge keys or slides 171 are forced longitudinally toward the outer ends of legs 151a and 151b, the pin 173 in each slide traveling to the outer ends of its slots 174. This relationship is best illustrated in Figures 25 and 26. With pin 173 abutting the outer or left end (as viewed in Figure 26) of slot 174 the slide lock 171 is entirely within the length of its carrying leg 151a or 151b whereupon the sections 151 and 152 may be pivoted to side-by-side adjacency. To aid in the lateral shifting of slide locks 171 their upper surfaces preferably are roughened or knurled as illustrated at 176 in Figure 26. Outward displacement of each slide lock from its carrying channel 172 is prevented as the bases of the slides are of greater width than the mouths of the channels.

With the unit related for use a pair of parallel tapes X and Y extends between its opposite ends from shell 158 to shell 159. In the present example of the invention scale X corresponds to the stationary or stock scale of the ordinary slide rule while scale Y corresponds to the slide scale and is referred to herein as such. Means must be provided by which slide scale Y can be adjusted longitudinally between the opposite ends of the unit and by which stock scale X can be held in its extended position. Means must also be provided to accommodate the scales with the unit collapsed. These features will now be discussed.

Shells 158 and 159 at the opposite ends of the unit have their open ends closed by end plates 181 and 182 suitably secured by removable screws 183. A transverse shaft 184 extends centrally in each shell, one of its ends being fixed in a suitable bearing seat 187a in end plate 182 while its opposite end is carried by a knob 186 formed

with an inwardly extending hub 188 rotatable in an enlarged bearing seat 187b in adjacent end plate 181. The peripheral surfaces of knobs or rollers 186 are roughened or knurled to aid the operator in rotating them and they preferably have sufficient mass as to insure that upon being given a rapid turn their inertia will be sufficient to insure continued rotation for a limited time period against the braking action provided by friction and other means as will be described. Within shell 156 at the left end of the unit as viewed in Figure 14 shaft 184 supports two scale carriers corresponding to the carriers D of the previous embodiments. These carriers are indicated by the reference characters 191 and 192 and are best shown in Figure 27. Carrier 191 is positioned adjacent shell end plate 181 and includes a hub 193 rotatably seated upon stationary shaft 184 and is connected by a screw 194 to the hub 188 of adjacent knob 186 for rotation therewith. Carrier 191 is formed with end walls of sufficiently deep radial extent as to enable it to receive the entire length of slide scale Y. A conical disc-type spring brake 196 abuts the inner recessed end of carrier 191 and is itself supported by stationary shaft 184 which it encloses non-rotatably through being suitably secured to an adjacent small flange 197 integral with the shaft by means of a struck-out tab 198 extending into a recess 199 in the flange. Brake spring 196 at all times exerts a braking force against rotatable carrier 191 which, while not preventing limited free rotation of the carrier and the connected knob 186 under a momentum stored in the latter, is sufficient to prevent overrunning when rotated slowly by a force transmitted to it through the tape Y seated thereon.

Upon the opposite end of stationary shaft 184 within end shell 158 is also positioned carrier 192 for the stationary tape X. As in the case of carrier 191, carrier 192 is provided with a center hub, herein indicated by the reference character 201, which seats upon shaft 184 for rotation relative thereto. A coil spring 202 in the recessed end of carrier 192 and adjacent shell end plate 182 has its inner end fixed to shaft 184 and its outer end anchored to a pin 203 in the carrier end wall. Carrier 192 in fact is a take-up and the force of spring 202 acting thereon at all times tends to rotate it in a counterclockwise direction, as viewed in Figure 20, to wind in the fixed tape X which is secured at its end to an inwardly pressed tab 204. In the case of both carriers 191 and 192 a pair of tape feed rollers 206 are provided which extend parallel to the shaft 184 and inside the shell immediately adjacent a slot 207 formed in the latter at the outer ends of section 156. As their name indicates these rollers guide the tapes in their travel toward and from the carriers and toward and from the adjacent rule section.

At the opposite end of the rule and within the shell 159 a single rotatable carrier 211 is provided, as is illustrated in Figure 22, which carrier is identical to carrier 191 in shell 158 except as specified. Its center hub 212 seats rotatably upon the supporting shaft 184 and it is connected by the screw 194 to the adjacent knob 186. A brake 196 is provided having the same function as in the case of carrier 191 and is similarly mounted. The principal difference between carrier 211 and 191 comprises the fact that the scale-supporting peripheral surface of carrier 211 is provided adjacent its inner ends with an inwardly extending channel or seat 213 adapted to receive the

cable which extends from the end of tape of slide scale Y for a reason to be explained, the cable being suitably secured to an anchor 214. There is no carrier in shell 159 corresponding to carrier 192 for stock tape X in shell 158 and instead only a spaced pair of hooks 216 is provided fixed to the inner upper surface of shell 159 adjacent slot 207 and at the ends of the channels 167 and 168 of section 157.

The scales X and Y extend between the opposite ends of the unit and specifically in the case of scale X between its take-up carrier 192 and the hooks 216, and in the case of slide scale Y between the manually rotatable carrier 191 and manually rotatable carrier 211. The outer edge of each tape is positioned slidingly in the longitudinally extending channels 167 and 162 of the outer and inner sections, respectively, their inner adjacent edges being closely spaced as illustrated in Figures 14 and 28. Scale Y can be advanced in either direction by the rotation of the knob 186 at that end toward which the scale is to move. Scale X, however, is fixed and not longitudinally adjustable in the operation of the unit.

Because one fixed scale and one movable scale are used, it is necessary to provide a longitudinally slidable runner, indicated by the reference character 221. As is illustrated in Figure 28 the runner comprises an upper transparent plate 221*a* and a lower counterpart 221*b* positioned, respectively, above and below the scales. Upper plate 221*a* is positioned on a level with channels 161 and 166 and lower plate 221*b* on a level with channels 163 and 168 in the inner and outer sections. Each is supported for longitudinal movement by laterally extending pins 223, as illustrated in Figure 24, of which there may be a plurality along each edge. The pins are seated in transversely extending bores 224 in the plates and are spring-pressed outwardly and into the adjacent leg channel by coil springs 226 abutting their inner ends. Pins 223 have a sliding fit with the channels and at their outer ends carry rollers 228 rotatable about vertical axes and adapted to contact the channel base. With the unit extended in operative relationship, depending upon the longitudinal position of the runner, rollers 228 will contact either the channels 161 and 163 or the channels 166 and 168. Unavoidably the extension of the pins when riding in the channels 161 and 163 of outer members 156 and 157 will be greater than their extension when riding in channels 166 and 168 of inner members 151 and 152. The springs 226 perform the important function of enabling the pins to vary their lateral extension and to adjust themselves as the runner moves between the channels of different widths. It is understood, of course, that the difference arises from the fact that the inner and outer sections of the unit must be of different width and size in order to telescope, as previously described.

The upper and lower runner plates 221*a* and 221*b* are secured for conjoint movement by vertically extending pins 231, of which one is illustrated in Figure 28. The upper and lower pin sections are threadedly connected and between them is seated a roller 232 positioned in the plane of the scales X and Y and adapted to pass between the adjacent edges thereof.

Referring now to Figures 29 and 30, the stationary stock scale X and the sliding scale Y are shown and each is seen to include an elongated flexible tape body provided with graduated markings as in the previous embodiments. The markings may be provided upon both sides of the scales to increase the range of usefulness for by inverting the unit the underside of the unit is as usable as the upper. Scale X is provided with hooks 236 at its opposite ends adapted to engage respectively the integral tab 204 upon its take-up carrier 192 and the hooks 216 in the shell 159. The hook 237 at one end of scale Y is adapted to engage a tab 238 upon its carrier 191 while its opposite end is provided with an elongated cable 241 carrying an eye 242 at its end. Cable 241 is wound in channel 213 of carrier 211, the eye 242 at its end being secured to the fixed anchor 214 in the channel while the scale Y is wound upon the surface of the carrier itself. Both scales X and Y preferably include unmarked lengths at their ends as may be desired.

In the use of the slide rule unit constructed in accordance with the present invention the unit is integrated as illustrated in Figure 14, the outer sections 156 and 157 being slid longitudinally to their outermost positions on the inner sections 151 and 152. The inner sections are held in alignment by the slide locks 171 which extend between their abutting ends as illustrated in Figure 26. The scales X and Y extend the full length of the unit between the shells 152 and 159, the scale X being fixed while the scale Y is adjustable as desired by the rotation of knobs 186 at its opposite ends. To move scale Y in one direction the knob 186 is rotated at that end of the unit toward which it is intended that it should move. Runner 221 is longitudinally slidable throughout the length of the construction, the rollers 228 making rolling contact with their supporting channels. The plates of the runner, as stated, are transparent, may be provided with hair lines as desired, and both scales are visible from above by inverting the unit.

To store the construction runner 221 is first moved to the extreme left, as viewed in Figure 14, positioning it at the outer end of section 156. The hooks 236 at the right end of tape X are then unhooked from hooks 216 in shell 159 whereupon the scale is automatically wound upon its carrier 192 in the opposite shell 158 under the action of the take-up spring 202 acting thereon. The hook 236 is thicker than the space separating upper and lower runner members 221*a* and 221*b* so that the wind-up of the tape is stopped when the hook reaches the runner.

Knob 186 at the left end of the unit is then rotated in a counterclockwise direction to wind the full length of scale Y onto carrier 191. The cable 241 at the opposite end of the scale at carrier 211 will finally be drawn outwardly and will extend between the two ends of the unit in place of the scale which will be entirely wound upon carrier 191. The overall length of the unit is then shortened by sliding the outer sections 156 and 157 inwardly to telescope the inner sections 151 and 152, a step which is evident by a comparison of Figures 15 and 16. At this point the two slide locks 171 are moved longitudinally to the left, as viewed in Figures 14 and 26, by a manual force exerted upon their roughened upper surfaces. When the stop pin 173 contacts the end of its slot 174 in each instance the locks will no longer overlie the abutment joint between the sections 151 and 152 and the unit may be pivoted from its straight-line relationship illustrated in Figure 16 to its folded relationship of Figure 17. With the unit in its folded condition illustrated in Figure 17 the cable 241 extends

directly between the shells 158 and 159 as illustrated in Figure 17. To replace the unit in condition for use is merely the reverse operation from that described in placing it in condition for storage.

While the particular apparatus herein shown and described in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as defined in the appended claims.

I claim:

1. A calculating device of the character described including a plurality of cooperating scales each involving a flexible tape and markings on both sides thereof, the scales having straight adjacent visible portions and rolled portions forming supplies to and from which the scales are operable, carriers at the ends of the straight portions supporting the rolled portions, a frame holding the carriers and providing an uninterrupted view of said scales from above and below, and transparent covers at both sides of the visible portions of the scales and each having a reference mark thereon cooperating with the markings on the scales.

2. In a calculating device of the character described including a plurality of cooperating scales each involving a flexible tape and markings thereon and having adjacent visible portions and rolled portions forming supplies to and from which the scales are operable, operating means for the scales including longitudinally slidable clutches directly physically engageable to and disengageable from the scales, and manually operable actuating means to engage the clutches separately or simultaneously and to displace them longitudinally of said scales.

3. In a calculating device of the character described including a plurality of cooperating scales each involving a flexible tape and markings thereon and having adjacent visible portions and rolled end portions forming supplies to and from which the scales are operable, a scale transporting mechanism including a slidable body carrying clutches directly and selectively engaging the scales for separate or simultaneous movement toward said end portions.

4. In a calculating device of the type including a plurality of cooperating scales each involving a flexible tape and markings thereon, the scales having adjacent visible portions and rolled portions forming supplies to and from which the scales are operable; carriers supporting said rolled portions of the scales, a frame supporting the carriers at the ends of the visible portions of the scales, and operating means for the scales including an operator slidably carried by the frame and having pivoted arms, and clutches operated by the arms and coupling the operator and the scales.

5. In a calculating device, a body formed at its ends with carriers for the rolled extremities of a flexible scale, guide means between said carriers for said scale in its movement therebetween, a scale-transporting unit slidable on said body between said carriers, said unit including gripping means positioned to grip said scale to exert a moving force thereon upon the movement of said unit, said unit also including manually operable means to actuate said gripping means and to receive a propelling force.

6. In a calculating device, a body formed at its ends with carriers for the rolled extremities of a pair of flexible scales, guide means between said carriers to guide said scales in side-by-side relationship in a single plane, a scale-transporting unit slidable on said body between said carriers, said unit including gripping means to grip said scales for conjoint movement therewith, and individual actuating means for said gripping means to enable the operator selectively to clamp one or both said scales to said unit for movement therewith.

7. In a calculating device of the type in which a flexible tape scale is movable between rolled supplies at its ends, a body rotatably supporting said supplies to receive and to feed said scale and including rigid members therebetween spaced to form a protecting frame for said flexible scale, a gripping transport unit slidable on said rigid members between said supplies to effect the movement of said scale and including a base slidably mounted on said rigid members, a clutch to secure said scale to said base, and a pivoted arm to open and close said clutch and to receive a propelling force for said unit.

8. The construction recited in claim 7 characterized in that said unit includes a pair of clutches adapted to clamp scales to said base and in that each of said clutches has its own pivoted actuating arm.

9. The construction recited in claim 8 characterized in that said actuating arms are interconnected by a rigid bar through a take-up providing for relative angular movement.

10. In a calculating device of the type embodying a flexible tape scale having rolled supplies at the opposite ends of a central straight portion, a body providing interiorly smooth cylindrical containers in which said supplies may rotate freely as said tape scale is forced therein or pulled therefrom, and a scale-transporting unit movable along said central straight portion and including gripping means to clamp said tape scale, and manually operable means to actuate said gripping means.

11. In a calculating device of the type embodying a flexible tape scale having rolled supplies at its opposite ends of a central straight portion, a body providing interiorly smooth cylindrical containers in which said supplies may rotate freely as said tape scale is forced therein or pulled therefrom, and a scale-transporting unit movable along said central straight portion to force said tape scale into or pull it from said containers.

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