Nov. 3, 1953 B. D. SPENCER 2,657,463

FOOT-MEASURING MACHINE

Filed March 5, 1952 3 Sheets-Sheet 1

Fig. 1.

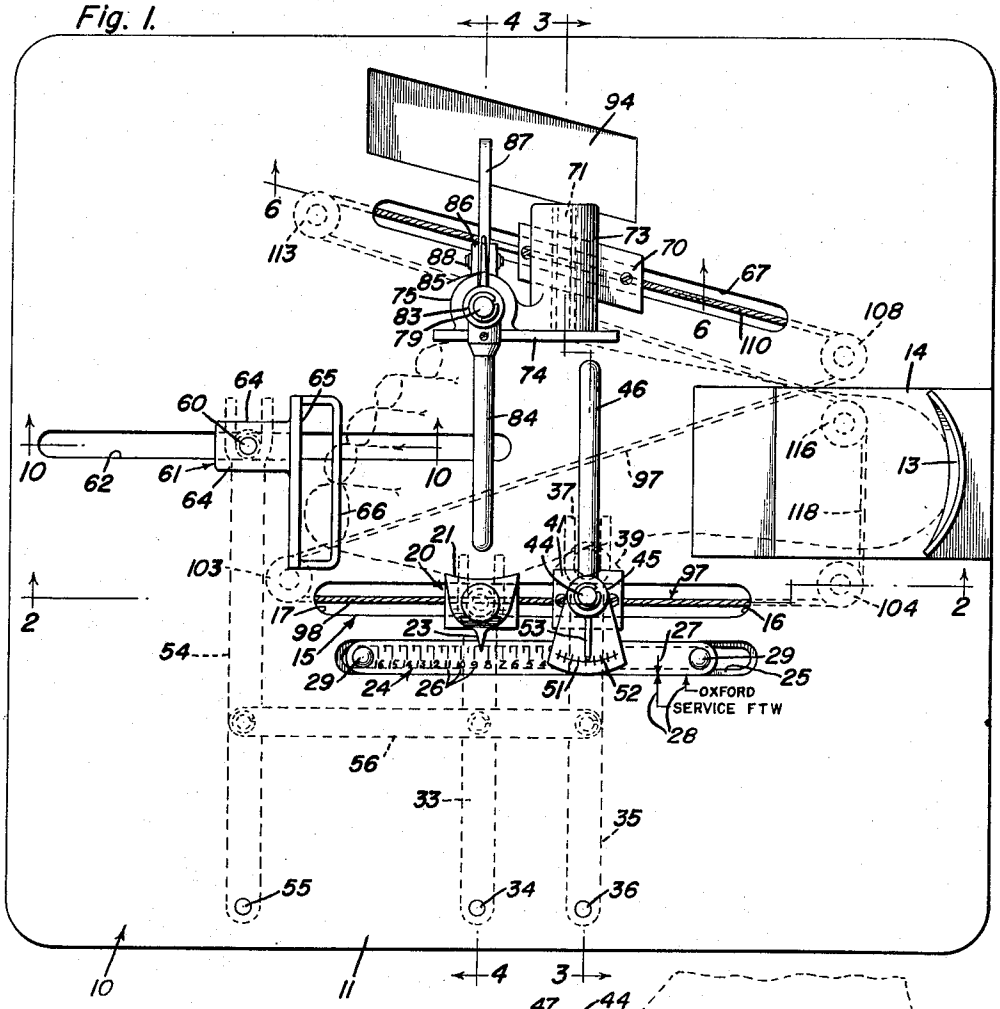
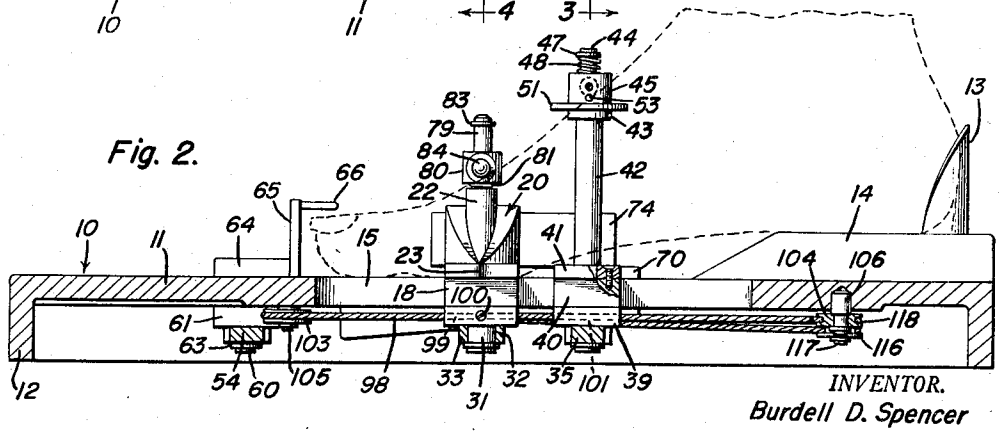


Fig. 2.



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Fig. 3.

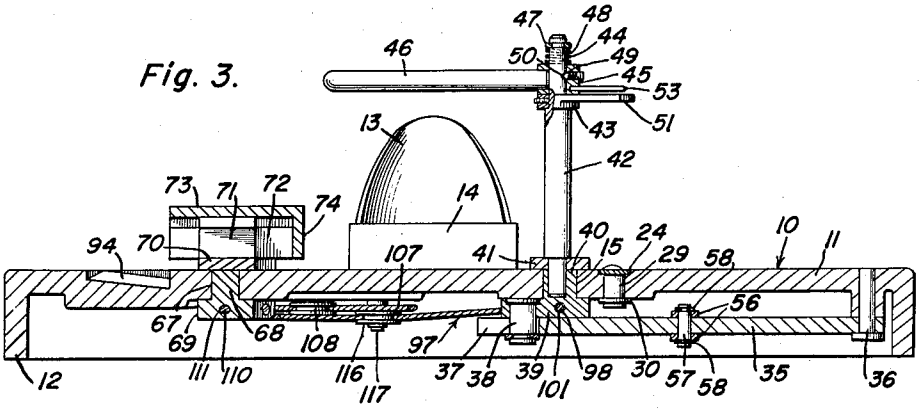


Fig. 4.

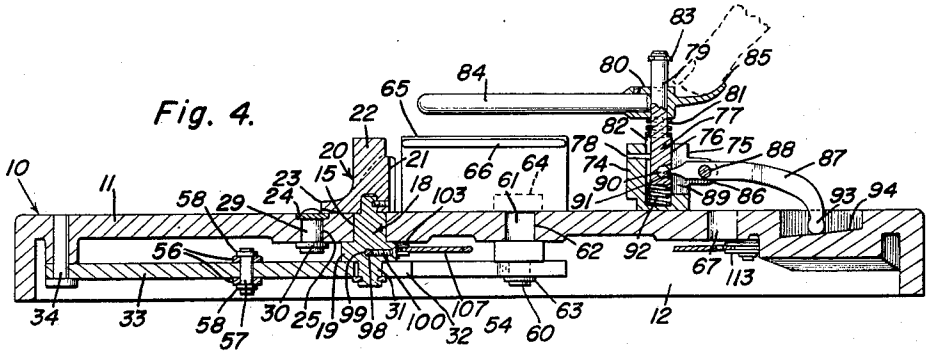


Fig. 5.

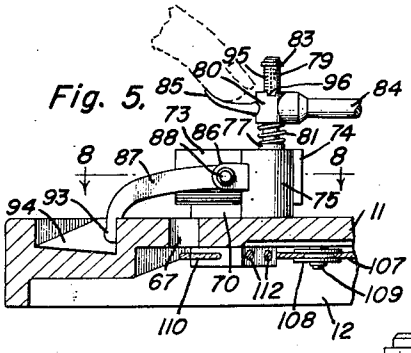


Fig. 6.

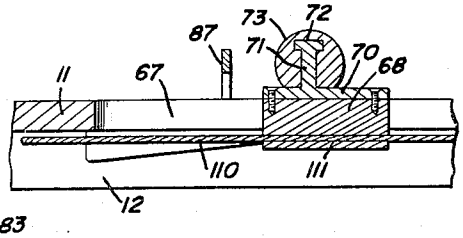
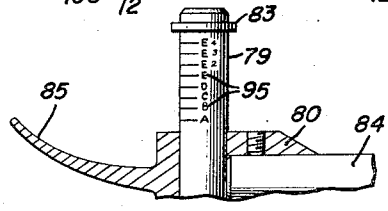


Fig. 11.



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Fig. 7.

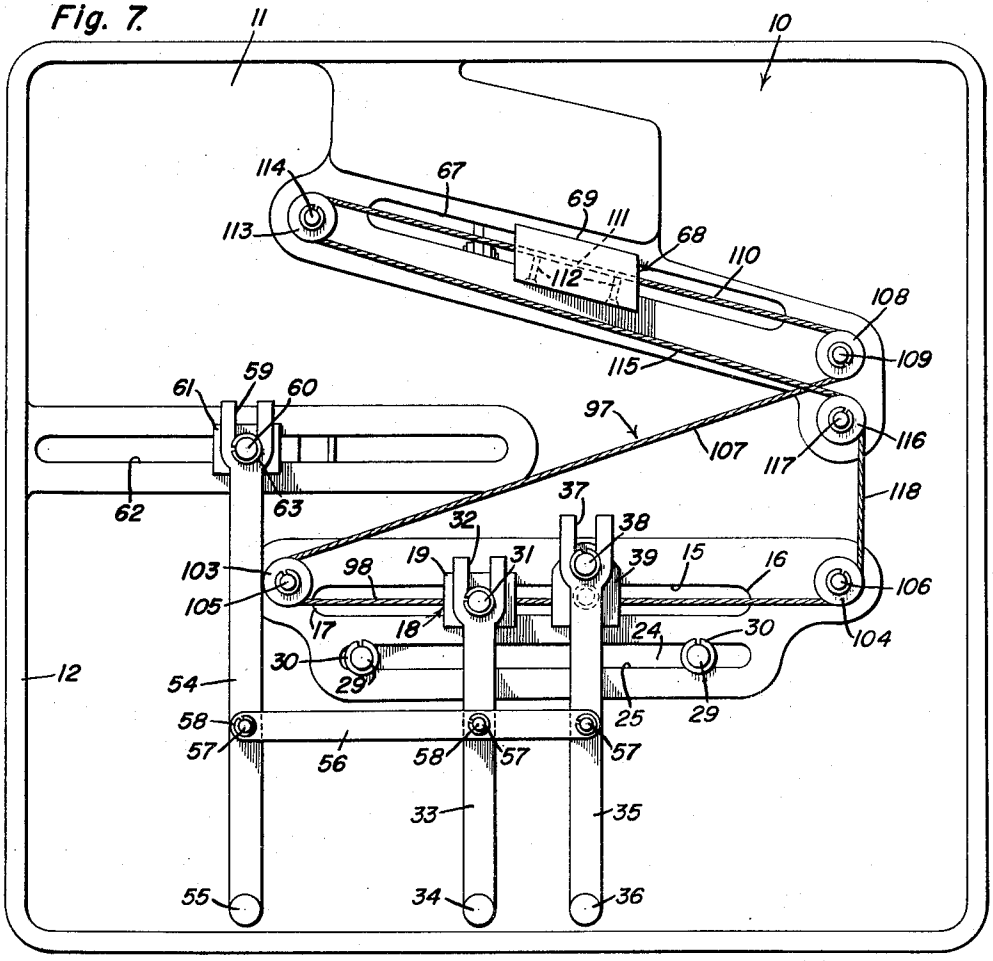


Fig. 8.

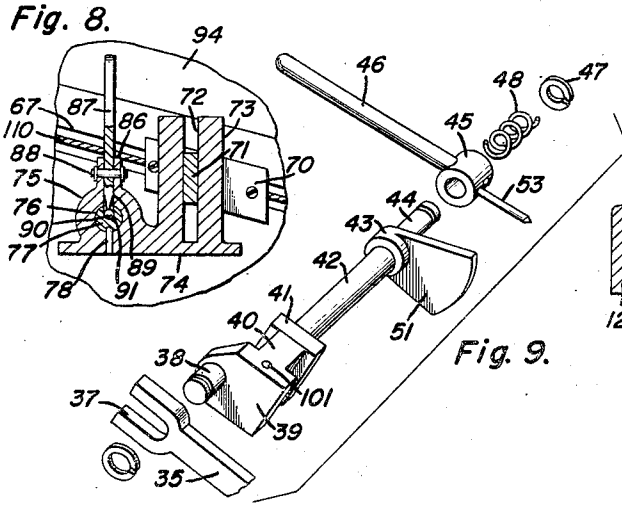
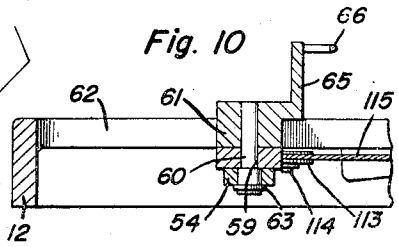


Fig. 9.

Fig. 10



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UNITED STATES PATENT OFFICE

2,657,463

FOOT-MEASURING MACHINE

Burdell D. Spencer, Oxon Hill, Md., assignor to the United States of America as represented by the Secretary of the Army

Application March 5, 1952, Serial No. 274,992

10 Claims. (Cl. 33—3)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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The invention described herein, if patented, may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

My invention relates to a foot-measuring machine.

A primary object of the invention is to provide a device or machine for taking several critical correlated measurements of the foot, substantially simultaneously, and thereby facilitating accurate and scientific fitting of footwear.

A further object of the invention is to provide a foot-measuring machine capable of making several correlated foot measurements, and yet not being unduly complicated or difficult to operate.

A further object is to provide a foot-measuring machine which is extremely compact and simplified in construction, sturdy and durable, and relatively inexpensive to build.

A further object is to provide a foot-measuring machine which measures the length and width of the foot, taking into consideration other critical measurements such as instep height, toe length and girth or thickness of the foot, so that the final footwear size measurements indicated by the machine are substantially ideal for any particular foot which is measured.

A still further object is to provide a device of the above-mentioned character which will greatly facilitate rapidly measuring the feet of service personnel and the like by unskilled technicians.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this application, and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a plan view of a foot-measuring machine embodying my invention, part broken away,

Figure 2 is a vertical section taken substantially on line 2—2 of Figure 1, parts in elevation,

Figure 3 is a transverse vertical section taken on line 3—3 of Figure 1, and rotated 90 degrees,

Figure 4 is a similar section taken on line 4—4 of Figure 1, and rotated 90 degrees,

Figure 5 is a fragmentary vertical section similar to Figure 4 but taken in the opposite direction to the arrows of line 4—4 to further illustrate the slope of an inclined cam surface, and rotated 90 degrees,

Figure 6 is a fragmentary vertical section taken on line 6—6 of Figure 1,

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Figure 7 is a bottom plan view of the machine,

Figure 8 is a horizontal cross section on line 8—8 of Figure 5, and rotated 90 degrees,

Figure 9 is an exploded perspective view of an instep gage rod and associated elements,

Figure 10 is a fragmentary vertical section taken on line 10—10 of Figure 1, and,

Figure 11 is an enlarged fragmentary side elevation of a scale bearing plunger.

In the drawings, where for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 10 designates a generally flat rectangular base or support plate, adapted to rest upon a floor or other suitable flat support. The support plate 10 is horizontally disposed in use, and includes a substantially flat horizontal body portion or web 11 and a relatively narrow depending marginal vertical flange 12, integral therewith to maintain the body portion 11 spaced from the floor or the like. The support plate 10 is preferably formed as an aluminum casting, or the like, although any suitable material may be employed.

A fixed upright heel abutment 13 is rigidly mounted upon an elevated ledge 14, preferably formed integrally with the support plate 10 near one marginal side of the same. The thickness of the ledge 14 approximates the thickness of the heel of an average man's shoe, and the abutment 13 projects above the ledge 14 for a sufficient distance to firmly engage the rear of the heel of a foot to be measured by the machine.

A straight longitudinal guide slot 15 is formed in the support plate 10 near its transverse center, and this slot has its rear end 16 terminating a substantial distance forwardly of the heel abutment 13, and the slot 15 is arranged near and slightly beyond one side of the heel abutment 13. The forward end 17 of the slot 15 terminates a substantial distance rearwardly of the forward end of the support plate 10, and the slot is arranged generally centrally of the support plate, although spaced somewhat laterally from its theoretical longitudinal center line through the center of the heel abutment 13. An adjustable block or key 18 is mounted within the slot 15 for longitudinal sliding movement, and has lower guide elements or shoulders 19 which engage the bottom of the support plate and prevent upward displacement of the block 18 within the slot. A gage element or head 20 is detachably rigidly secured to the block 18 for movement therewith, and the gage element 20 slidably contacts the top of the support plate 10 upon opposite sides of the slot 15. The gage element 20 is provided in its

inner side with a concave recess 21 for engagement with the big toe ball joint of the foot, see Figure 1. An upstanding handle extension 22 is formed upon the gage element 20 to facilitate shifting the same longitudinally of the slot 15. A pointer 23 is likewise integrally formed upon the gage element 20 for coaction with a length-size indicating scale 24, adjustably mounted within a longitudinal slot 25 formed in the support plate 10 near and parallel to the slot 15. The scale 24 bears foot length or size graduations 26, covering the range of standard footwear sizes, and the scale is preferably graduated in full and half sizes, as shown. A transverse scribe line 27 is provided upon the scale 24 near its rear end, for alignment with either of two scribe lines 28, provided upon the support plate 10 at longitudinally spaced points along the slot 25. The scribe line 27 is aligned with the forwardmost scribe line 28 when the foot is to be measured for heavy duty or work-type footwear, requiring a lesser toe clearance, and with the rearmost scribe line 28 when the foot is to be measured for a dress-type oxford, or the like, requiring a greater toe clearance, due to the more pointed toe construction. The scale 24 is held within the slot 25 by means of depending pins 29 or the like, rigidly secured thereto near its opposite ends, and extending through the slot 25 to the bottom of the plate. Snap rings 30 or the like are mounted upon the pins 29 below the support plate 10 to prevent upward displacement of the pins and scale 24. The scale 24 preferably has a fairly snug sliding fit within the slot 25, so that it will remain in the selected adjusted position but can readily be shifted longitudinally of the slot 25 manually.

The block 18 carries a short depending extension pin 31, integral therewith and extending below the support plate body portion 11, and slidably engaging within a slot 32 formed in the inner end of a first horizontal transverse arm 33, having its outer end pivoted at 34 to the bottom of the support plate 10 for horizontal swinging movement beneath the plate. A second transverse arm 35 is arranged rearwardly of the arm 33 and parallel therewith, and has its outer end pivoted at 36 to the bottom of the support plate 10, so that the arm 35 may swing horizontally below the support plate. The arm 35 is somewhat longer than the arm 33 and is provided in its inner end with a slot 37, slidably receiving a depending vertical pin extension 38, integrally secured to a lower flat slide 39, in turn preferably formed integral with a block or key 40, slidably mounted within the slot 15, rearwardly of the block 18. The lower slide 39 is disposed below the body portion 11 and slidably engages the same, and prevents upward displacement of the block 40 from the slot 15. An upper slide 41 is detachably rigidly mounted upon the block 40, above the body portion 11 and slidably engages the same upon opposite sides of the slot 15. The upper slide 41 prevents downward displacement of the block 40 in the slot 15. Since the pivot 36 for the arm 35 is in longitudinal alignment with the pivot 34, and the arm 35 is longer than the arm 33, as previously stated, the slot 37 and depending pin extension 38 are arranged beyond the inner side of the slot 15, as shown, while the depending pin extension 31 is disposed at the center of the slot 15.

An upstanding vertical member or post 42 has its lower end rigidly secured within an opening of the block 40, Figure 3, and extends above the support plate 10 for a substantial distance. Near the top of the post 42, the same is provided with an enlarged integral shoulder 43, carrying a reduced upstanding extension 44, likewise integral with the post 42. A sleeve 45 is rotatably mounted upon the extension 44 and engages the shoulder 43. A horizontal transverse gage rod 46 is rigidly secured within an opening of the sleeve 45 and extends beyond the inner side of the slot 15 and across the instep of the foot to be measured. The gage rod 46 is spaced a substantial distance forwardly of the heel abutment 13, and the gage rod is adapted to swing horizontally above the support plate 10 when the sleeve 45 rotates. The reduced extension 44 is provided near its top end with a groove receiving a snap ring 47, against which the upper end of a compressible coil spring 48 bears. The lower end of the spring 48 engages the sleeve 45 to hold the same against the shoulder 43. A spring-pressed ball detent 49 is carried by the sleeve 45 and engages within a notch 50, formed in the reduced extension 44, at a point diametrically opposite the gage rod 46, Figure 3. A horizontal scale plate 51 is integrally secured to the sleeve 43 and extends transversely beyond the outer side of the slot 15, and has an arcuate graduated scale 52 provided thereon near its outermost end, for coaction with a horizontal pointer 53, rigidly secured to the rotatable sleeve 45 at a point diametrically opposite the gage rod 46 and below the ball detent 49.

A third transverse horizontal arm 54, longer than the first and second arms 33 and 35, is disposed beneath the support plate 10 and has its outer end pivotally secured at 55 to the bottom of the support plate in longitudinal alignment with the pivots 34 and 36. The transverse spacing between the arms 33 and 54 is materially greater than that between the arms 33 and 35, as shown. The three arms 35, 33 and 54 are permanently connected in parallel relation by means of longitudinal connecting links or bars 56, arranged above and below the arms 35, 33 and 54, and pivotally secured thereto by vertical pins 57, held against vertical displacement by snap rings 58 or the like. The connecting links 56 form with the arms 35, 33 and 54 a pantograph linkage, the operation of which will be described. Whenever any one of the three arms 35, 33 and 54 swings horizontally beneath the support plate 10, the other arms travel with it through the same angle and remain parallel. The innermost end of the arm 54 terminates substantially at the longitudinal center line of the foot being measured, and in substantial alignment with the heel abutment 13, as shown in Figure 1. The inner end of the arm 54 has a slot 59, slidably receiving a depending pin 60, rigidly secured to a block or key 61, slidably mounted in a longitudinal slot 62, formed in the support plate 10 near the forward end of the same. The slot 62 is parallel to the slot 15 and spaced laterally of the same, and the slot 62 is disposed near the longitudinal center line of the foot to be measured and directly forwardly of the heel abutment 13. The rearmost portion of the slot 62 overlaps the forwardmost portion of the slot 15, as shown, while the slot 25 is substantially longitudinally coextensive with the slot 15. The block 61 and pin 60 are held against upward displacement by a snap ring 63 or the like, secured to the pin 60 below the arm 54, Figure 10. Above the top surface of the support plate 10, the block 61 has lateral flanges 64 which slidably engage the top of the base plate on opposite sides of the slot

62 to prevent downward displacement of the block 61.

An upstanding transverse vertical toe abutment or wall 65 is preferably formed integral with the block 61 at the rear end of the same, and this abutment 65 is arranged at right angles to the slot 62 and extends beyond the opposite sides of the same, and is disposed in alignment with the heel abutment 13, Figure 1. A horizontal transverse gage wire 66 is carried by the abutment 65 and spaced rearwardly thereof, in parallel relation thereto. The abutment 65 and gage wire 66 travel with the block 61 longitudinally of the slot 62, in response to horizontal swinging movement of the arm 54. The gage wire 66 is secured to the top of the abutment 65, as shown, and is therefore spaced above the base plate 10 sufficienly to accommodate the toes of the foot beneath it.

It may now be seen that when the gage element 20 is shifted longitudinally in the slot 15, the blocks 40 and 61 and their associated elements will also move longitudinally within the longitudinal slots 15 and 62. The extent of longitudinal movement of the elements connected with the arms 35, 33 and 54 will be different, since these arms have different lengths. This mode of operation and its significance will be further amplified. The elements of the machine thus far described are concerned with measuring the length of the foot preparatory to providing footwear of the proper length size.

Means are also provided to measure the width of the foot, taking into consideration its girth or thickness near the ball of the foot. Such means are coordinated with the foot-length measuring elements of the machine and all of the critical foot measurements are correlated and made substantially simultaneously, as will be seen.

The support plate 10 is further provided near its side remote from the pivots 36, 34 and 55 with a generally longitudinal straight slot 67, spaced laterally from the slot 15 and outwardly of the side of the heel abutment 13 remote from the slot 15. The slot 67 is disposed at an acute angle to the longitudinal center line of the foot and slot 15. The amount of this angle represents the amount of variation of foot width with variations in foot length measured on the scale 24. Slidably mounted within the slot 67 is a block 68 provided below the support plate 10 with lateral flanges or shoulders 69 which extend beyond the opposite sides of the slot 67. A slide plate 70 is detachably rigidly mounted upon the block 68 above the support plate 10 and extends upon opposite sides of the slot 67, so that the block 68 is held against vertical displacement. An upstanding transverse T-shaped key element 71 is integrally secured to the slide plate 70 and projects above the same for engagement within a T-shaped groove 72 formed in a carriage 73, slidably engaging the key element 71 and slide plate 70. The carriage 73 is provided at its inner end with an upstanding vertical abutment or wall 74 of substantial length and preferably formed integral therewith. This abutment 74 is parallel to the slot 15 and arranged at right angles to the toe abutment 65 and heel abutment 13. The abutment 74 is adapted to engage the outer side of the foot rearwardly of the small toe and substantially opposite the gage element 20.

Near the forward end of the vertical abutment 74 an upstanding sleeve 75 is integrally secured to the same, and this sleeve has a vertical bore 76, slidably receiving for vertical reciprocation a plunger 77, held against rotation by a pin 78, slidably engaging a keyway or slot in the side of the plunger 77, Figure 4. The plunger 77 has an upper reduced extension 79, integral therewith, and a vertically movable collar 80 is slidably mounted upon the extension 79, and is constantly urged upwardly by a compressible coil spring 81, surrounding the extension 79 between the collar 80 and a shoulder 82 formed upon the plunger 77. Upward movement of the collar 80 is limited by a snap ring 83 or the like secured to the top of the extension 79. The spring 81 normally holds the collar 80 against the snap ring 83. A horizontal transverse foot thickness or girth gage rod 84 is rigidly secured within an opening formed in the side of the collar 80, and this gage rod extends over the foot at the ball joint. The plunger 77 and gage rod 84 are arranged laterally opposite the gage element 20, as shown in Figure 1. The collar 80 is preferably provided at a point diametrically opposite the gage rod 84 with an operating extension or handle 85, integral therewith for use in shifting the gage rod 84 downwardly into contact with the top of the foot.

The upstanding sleeve 75 is provided upon its outer side with a pair of spaced vertical lugs 86, integral therewith, and an elongated curved transverse cam follower or lever 87 is pivoted at 88 between the lugs 86. A vertical passage or slot 89 is formed in the side of the sleeve 75 between the lugs 86, and leads into the vertical bore 76. The cam lever 87 carries an inner ball end 90, engaging within a small opening 91 formed in the adjacent side of the plunger 77 near the lower end of the same, Figure 4, and the ball end of the cam lever 87 operates within the vertical slot 89. A compressible coil spring 92 is mounted within the lower end of the bore 76 and has its upper end engaging the bottom of the plunger 77 to urge the same upwardly. The bottom of the sleeve 75 may slidably contact the top of the support plate 10, as shown.

The cam lever 87 has its outer depending portion 93 slidably contacting a flat inclined cam surface 94, formed upon the support plate 10 beyond the outer side of the slot 67 and extending from substantially the forward end of this slot to a point near and rearwardly of its longitudinal center, Figure 1. The cam surface 94 is disposed at a compound angle of inclination to the horizontal support plate 10, and the cam surface slopes downwardly toward the forward or toe end of the support plate in the longitudinal direction, and downwardly toward the slot 15 in the transverse direction, see Figures 3, 4 and 5. The cam surface 94 is, however, flat, smooth and in the plane, and preferably generally rectangular in shape, as shown in Figure 1. The precise compound angle of inclination of the cam surface 94 is predetermined from compilations of foot measurements of both the width and thickness of the foot near the ball joint. The spring 92 urges the plunger 77 upwardly and maintains the depending portion 93 of the cam lever in contact with the cam surface 94 at all times. The area of the cam surface is sufficient to engage the cam lever 87 in all adjusted positions of the block 68 within the slot 67. The reduced extension 79 carries a visible foot width indicating scale 95, calibrated in foot width sizes ranging from "A" to quadruple "E," with the wider foot width sizes arranged near the uppermost end of the scale 95, Figure 5. A notch 96 is preferably formed in the top of the collar 80 for alignment with the par-

ticular graduation on the scale 95 when the gage rod 84 has been shifted into contact with the top of the foot. The reading of the foot width on the scale 95 is made by aligning the top surface of the collar 80 with the particular graduation of the scale 95, but the foot width designation or letter is read through the notch 96. This foot width reading is made after the gage rod 84 is shifted downwardly into firm contact with the top of the foot, as previously stated. When the extension 85 is released, the spring 81 returns the collar 80 to the top of the reduced extension 79.

Driving connecting means including an endless flexible cable 97 are provided near and below the support plate 10. One horizontal run 98 of the cable 97 extends longitudinally of the slot 15 directly below the same and through a small opening 99 formed longitudinally in the block 18, Figure 4. The run 98 of the cable is fixedly secured to the block 18 by a clamping setscrew 100, engaging within a horizontal screw-threaded opening formed in one side of the block 18. The run 98 also extends through a clearance opening or passage 101 formed in the slide 39. The cable run 98 is freely slidable within the opening 101, and must be, since the blocks 18 and 40 move for different distances within the slot 15.

The cable 97 is trained about grooved pulleys 103 and 104 near the ends of the slot 15, which pulleys are journaled freely on vertical depending stub shafts 105 and 106, rigidly secured within openings formed in the bottom of the support plate 10. A diagonal run 107 of the cable extends across the bottom of the support plate 10 and is trained about a grooved pulley 108, journaled upon a depending shaft 109, fixedly secured within an opening in the bottom of the support plate. A further run 110 of the cable extends longitudinally beneath the slot 67 and through an opening or passage 111 formed in the block 60, wherein the run 110 is fixedly clamped by setscrews 112, or the like. The cable 97 passes about another grooved pulley 113 near the forward end of the slot 67 which is journaled upon a fixed depending shaft 114, rigidly secured within an opening formed in the bottom of the support plate 10. A further run 115 of the cable, substantially parallel to the run 110 is trained about a grooved pulley 116, arranged near the pulley 108, and likewise journaled upon a fixed vertical shaft 117, rigidly mounted within a vertical opening formed in the bottom of the support plate 10. The pulley 116 is at an elevation slightly below the pulley 108, Figure 2, so that the runs 107 and 115 may cross without interference. The final short transverse run 118 of the cable leads back to the pulley 104, as shown in Figure 7. The entire cable 97 operates in a horizontal plane close to the bottom of the plate body portion 11, as shown.

In the operation of the machine, the several critical foot measurements are correlated and can be made substantially simultaneously for accurately and scientifically determining the size of footwear most suitable for the particular individual. The machine measures the length of the foot from the heel to the ball joint of the big toe, while the heel is resting upon the ledge 14 which typifies the heel of a shoe. This important measurement is reflected in a direct size reading on the scale 24, when the gage element 20 is shifted into engagement with the ball joint of the big toe, as shown in Figure 1.

However, the proper length of the footwear cannot be finally determined by this single measurement alone, as the several other critical measurements must be considered. If the foot has an abnormally high or low instep, the length size may have to be adjusted to compensate for this. Accordingly, when the gage element 20 is positioned against the ball joint of the foot, the pantograph linkage including the arm 35 will cause the block 40 to assume an adjusted position in the slot 15. If the particular foot has a high instep, the gage rod 46 will contact the instep and cause the pointer 53 to swing to the right or counterclockwise along the scale 52, Figure 1. If the pointer 53 moves beyond the right hand end of the scale 52, for a given position of the pointer 23, the next half size larger scale reading on the scale 24 must be selected, in order to bring the needle 53 back onto the scale 52, which scale represents the maximum variation in instep height permissible for a given length size reading on the scale 24. The gage element 20 is therefore shifted forwardly in the slot 15 to bring the pointer 23 into alignment with the next larger scale marking 26 which will cause the pointer 53 to move back onto the scale 52. If the foot has an exceptionally low instep, the gage rod 46 will be spaced from the instep for a given setting of the gage element 20, and after the gage element is in contact with the ball joint of the foot, the gage rod 46 should be swung manually to the right or clockwise, Figure 1, until it contacts the instep. When this is done, and if the pointer 53 moves beyond the left hand end of the scale 52, the gage element 20 must be shifted rearwardly in the slot 15 to bring the pointer 23 adjacent to the next smaller scale designation 26 which will cause the pointer 53 to move back onto the scale 52. The ideal condition is shown in Figures 1 and 2, wherein the gage rod 46 just contacts the instep, when the gage element 20 is properly engaging the ball joint of the foot, and the pointer 53 is at the middle of the tolerance scale 52.

Still another measurement must be made by the machine in finally determining the proper length size for the footwear on the scale 24. This measurement is toe clearance, as evidenced by the location of the vertical abutment 65 and gage wire 66, relative to the toes. These elements move whenever the gage element 20 moves in the slot 15, because of the action of the pantograph linkage including the arm 54. For a given setting of the gage element 20, the position of the abutment 65 will indicate the longest allowable toe length. In other words, the longest toe may just touch the abutment 65 but when so touching must not be cramped or uncomfortable. For the same setting of the gage element 20, the forwardmost edge of the wire 66 indicates the shortest allowable toe length, and if the forward end of the longest toe does not extend at least to the forward side of the wire 66, the next smaller designation 26 on the scale 24 must be selected which will bring the forward end of the toe at least to the forward side of the wire 66 and preferably between this wire and the abutment 65, as ideally shown in Figure 1. To do this, the gage element 20 is of course adjusted rearwardly in the slot 15. If the toes are cramped against the abutment 65 for a given setting of the gage element 20, the gage element must be moved forwardly in the slot 15 until the longest toe just touches or clears the abutment 65, and the pointer 23 will then indicate the true reading on the csale 24 which will report the ideal length size of footwear for the given foot. In some

cases, a compromise will have to be made between the ideal position of the gage element 20 with respect to the ball joint of the foot, the ideal position of the gage rod 46 and the ideal position of the abutment 65. A final setting of the gage element 20 will be made in any event which will come closest to satisfying the conditions indicated on the scale 52 and by the elements 65 and 66, together with the gage element 20, and this final setting of the gage element 20 will indicate on the scale 24 the proper length size for the footwear.

After the final adjustment of the gage element 20 for establishing the proper length size, the width of the footwear is determined by sliding the vertical abutment 74 into comfortable contact with the outer side of the foot and lowering the gage rod 84, until the same contacts the top of the foot adjacent to the ball joint, as shown in Figure 2. The width size is then read directly from the scale 95, by noting which scale graduation coincides with the top edge of the collar 80, Figure 5.

When indicating the proper width at the scale 95, for a given setting of the gage element 20, the machine automatically compensates for variations in the thickness or girth of the foot at the ball joint. When the gage element 20 is adjusted in the slot 15, the block 68 is simultaneously shifted in the same direction in the slot 67, because of its connection with the gage element 20 through the cable 97. The angle of the slot 67 with respect to the slot 15 represents the amount of variation of foot width with variation in length. A longer foot is normally expected to be wider and also thicker than a shorter one since the foot usually grows in all directions, but this is not always the case, and a long foot may be unusually narrow or wide and also unusually thick or thin at the ball joint.

In any event, for a given setting of the gage element 20 the block 68 assumes a position in the slot 67 and the abutment 74 is shifted into contact with the adjacent side of the foot before the gage rod 84 is lowered by means of the extension 85.

If the foot is unusually wide, a wider width size must be selected and this width must be indicated on the scale 95. This means that the abutment 74 must be moved laterally an increased distance from the gage element 20. When this is done, by sliding the carriage 73 outwardly on the key element 71, the cam lever 87 will have its outer end elevated and its inner ball end 90 lowered, due to the inclination of the cam surface 94. This will lower the plunger 77 within the bore 76, and also lower the scale-bearing extension 79 relative to the collar 80 which remains stationary due to the engagement of the gage rod 84 with the top of the foot. The lowering of the extension 79 will cause a wider width graduation near the top of the scale 95 to become aligned with the top edge of the collar 80, and this will indicate the width size which must be selected for the given foot having the given length size indicated by the pointer 23.

This correct width reading takes into consideration the thickness or girth of the foot through engagement of the gage rod 84 with the top of the foot, as previously stated. When the foot is unusually thick, the gage rod 84 will assume a higher position relative to the extension 79, and the top of the collar 80 will be aligned with a wider width graduation on the scale 95, and this is proper, since a foot of greater thickness or girth at the ball joint should be provided with a wider shoe. Conversely, for a given setting of the abutment 74, if the foot is unusually thin and flat at the ball joint, the gage rod 84 and collar 80 will assume a lower position on the extension 79, and the top of the collar 80 will be aligned with a narrower width graduation on the scale 95. This is correct since a thinner foot or one having less girth at the ball joint should have a correspondingly narrower size of footwear. It is thus seen that for a given setting of the gage element 20, which results in a given longitudinal adjustment of the abutment 74, and after this abutment is shifted into contact with the side of the foot, the machine automatically furnishes a width size reading which is proper for the particular width of the foot at the ball joint, as well as for the particular thickness or girth of the foot at this region.

When the foot is unusually narrow for a given length size on the scale 24, the abutment 74 must be shifted inwardly toward the slot 15, and when this is done the outer end of the cam lever 87 is lowered, due to the inclination of the cam surface 94, and its inner ball end 90 is elevated, causing a corresponding elevation of the scale 95 relative to the top of the collar 80, which remains fixed due to the engagement of the gage rod 84 with the top of the foot. Since the narrower width graduations on the scale 95 are at lower points on the scale, a narrower width graduation will be aligned with the top of the collar 80, and this will be the proper width size for the given foot, taking into consideration its girth or thickness, as previously described.

The machine also automatically compensates for another factor, namely that for increases in length size of footwear, there is normally an increase in the width and thickness of the foot. Whenever the gage element 20 is shifted forwardly in the slot 15 to indicate a longer length size, the block 68 is also shifted forwardly in the slot 67. The cam surface 94 has a compound angle of inclination, as previously described, and also slopes downwardly toward the forward or toe end of the machine. This arrangement results in a lowering of the outer end 93 of cam lever 87 when the block 68 moves forwardly with the gage element 20. The inner ball end 90 of the cam lever is thereby raised, as is the scale-bearing extension 79. This brings a narrower width graduation near the lower end of the extension 79 into alignment with the top of the collar 80, which is proper, since the gage rod 84 has not been raised or lowered. If the gage element 20 is shifted rearwardly in the slot 15 to indicate a smaller length size, the block 68 will also be shifted rearwardly in the slot 67 and due to the inclination of the cam surface 94, the outer end of the cam lever 87 will be raised and the scale bearing extension 79 is lowered. This will result in a wider width size reading on the scale 95, which is proper for a shorter shoe length, the gage rod 84 still remaining at the same elevation.

It is to be noted that the gage rod 84 is always in substantial alignment with the gage element 20, for all adjusted positions of the latter. Actually a very slight error in this alignment is present, due to the slight angularity of the slot 67. This error is proportional to the sine of the angle between the slots 15 and 67, and is very small since the angle is small and may be neglected.

The machine thus selects accurately and scientifically the proper length size and width for the footwear and an ideal fit for a given foot is

obtained. Obviously, apparatus must be provided for measuring the left foot in an identical manner, if it is desired to measure both feet when fitting the footwear. If this is desired, the mechanism for measuring the other foot may be mounted upon the same support plate 10, which may be extended to accommodate the duplicate mechanism. This mechanism will be identical with that shown and described in connection with the right foot, except that the abutment 74, and associated elements will be reversed transversely with respect to the gage element 20 and associated linkage. In other words, the mechanism shown in Figure 1 will be inverted for measuring the left foot but the construction of the various parts and their mode of operation is identical. If desired, the machine for measuring the left foot may be entirely separate from the machine for measuring the right foot, and separate support plates 10 may be provided.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described my invention I claim:

1. A foot-measuring machine comprising a support plate having a first abutment mounted thereon for engaging the heel of a foot, a gage element connected with the support plate and movable toward and from the first abutment and adapted to engage the foot forwardly of the first abutment, there being a length-size scale upon the support plate for coaction with the gage element to determine the length size of the foot, a movable abutment disposed substantially opposite the gage element and connected with the gage element and movable longitudinally and transversely of the foot when the gage element is moved, a vertically reciprocatory element carried by the movable abutment and bearing a foot width measuring scale, the support plate having a cam surface formed thereon near said movable abutment, and cam follower means connected with the vertically reciprocatory element and engaging the cam surface and causing reciprocation of the reciprocatory element when the movable abutment moves longitudinally or transversely of the foot.

2. A foot-measuring machine comprising a support plate having a first abutment for engagement with the heel of a foot, adjustable length-size indicating means connected with the support plate and adapted to engage the foot forwardly of the first abutment, a longitudinally and transversely movable abutment connected with the support plate near one side of the foot and movable in response to movement of the length-size indicating means, a vertically reciprocatory element connected with the movable abutment and having a foot width indicating scale thereon, a substantially horizontal gage rod connected with the vertically reciprocatory element and movable vertically with relation thereto and adapted to contact the top of the foot, and cam operated means connected with the vertically reciprocatory element to move the same vertically relative to the gage rod in response to longitudinal or transverse movement of the movable abutment.

3. A foot-measuring machine comprising a support plate having an abutment to be engaged by the heel and having a first slot near one side of the foot and extending longitudinally thereof, a gage element connected with the first slot for movement longitudinally thereof and adapted to engage the ball joint of the foot, there being a length-size indicating scale upon the support plate near the gage element for cooperation therewith to indicate the length size of the foot, the support plate having a second slot near the opposite side of the foot and arranged at an angle to the first slot, a member connected with the second slot for movement longitudinally thereof, driving connecting means between the member and said gage element, a movable abutment connected with the member for movement therewith longitudinally of the second slot and shiftable transversely of the member toward and from the gage element, a vertically reciprocatory element connected with the movable abutment and having a foot width scale thereon, the support plate having an inclined cam surface near said member, and a cam follower connected with the vertically reciprocatory element to operate the same when the member moves longitudinally within the second slot and when the movable abutment is shifted transversely of the member.

4. A foot-measuring machine comprising a support plate to receive the foot and having a first longitudinal slot near one side of the foot and a foot-length measuring scale extending longitudinally of the slot, a gage element connected with and adjustable longitudinally of the first slot and adapted to indicate on the scale the length size of the foot when the gage element contacts the ball joint of the foot, the support plate having a second longitudinal slot near the longitudinal center line of the foot, a toe-clearance gage connected with and adjustable longitudinally of the second slot and adapted to indicate the proper toe clearance in foot wear, an instep gage connected with the first slot rearwardly of said gage element and adjustable longitudinally of the first slot and including a part to contact the instep and indicating the relative height of the instep, a pantograph linkage disposed below the support plate for movement in a substantially horizontal plane and connecting the gage element, toe-clearance gage and instep gage so that such elements will move in unison longitudinally of the foot, an adjustable foot width measuring device connected with the support plate and spaced laterally of the gage element and movable longitudinally and transversely of the foot, and driving means including a cable between said gage element and last-measuring device to cause the device to move in unison with the gage element, toe clearance gage and instep gage, the cable being arranged below the support plate and operating in a substantially horizontal plane.

5. A foot-measuring machine comprising a support plate to receive the foot and having an abutment to engage the heel of the foot and being provided with a first longitudinal slot near one side of the foot, the support plate having a scale thereon and extending longitudinally of the first slot, a gage element connected with the first slot and movable longitudinally thereof and adapted to indicate on the scale length size of footwear when the gage element registers with the ball joint of the foot, the support plate having a second longitudinal slot spaced laterally of the first slot, a toe-clearance gage connected with the second slot for movement longitudinally thereof, an element connected with the first slot for movement longitudinally thereof and spaced from the gage element, an upstanding post se-

cured to the last-named element, a substantially horizontal instep gage rod pivotally connected with the post and extending over the instep for contact therewith, a pantograph including pivoted arms, linkage connecting the gage element below the support plate, toe-clearance gage and said element for movement in unison in the first and second longitudinal slots, the support plate having a third generally longitudinal slot arranged at an angle to the first and second slots, a carriage engaging the third slot and shiftable longitudinally thereof, driving connecting means between the carriage and gage element, and automatically adjustable foot width measuring means connected with the carriage and operable in response to movements of the carriage.

6. A foot-measuring machine comprising a support plate to receive the foot and having an abutment to engage the heel and provided with a first longitudinal slot forwardly of the abutment and extending near one side of the foot, there being a foot-length measuring scale upon the support plate near the first slot, a gage element connected with the first slot for movement longitudinally thereof and adapted to engage the ball joint of the foot and to indicate on the scale the length size of the foot, the support plate having a second longitudinal slot spaced laterally of the first slot, a toe-clearance gage connected with the second slot and movable longitudinally thereof, a member engaging the first slot rearwardly of the gage element and movable longitudinally of the first slot, a first arm pivotally connected with the support plate below the support plate and connected with the gage element, a second arm pivotally connected with the support plate below the support plate and connected with the toe-clearance gage, a third arm pivotally connected with the support plate below the support plate and engaging the member, a connecting link for the first, second and third arms and causing them to move in unison so that the gage element, toe-clearance gage and said member will move in unison within the first and second slots, an upstanding post carried by the member and having a scale-bearing extension, a substantially horizontal gage rod pivotally mounted upon the upstanding post and adapted to indicate on the scale bearing extension the relative height of the instep for a given setting of the gage element, and means connected with the support plate to measure the width of the foot.

7. A foot-measuring machine comprising a support plate having an abutment to be engaged by the heel and provided with a first longitudinal slot extending near one side of the foot to be measured, there being a foot-length measuring scale upon the support plate near the first slot, a gage element slidably mounted within the first slot and movable longitudinally thereof and adapted to engage the ball joint of the foot and to indicate on the scale the length size of the foot, the support plate having a second longitudinal slot spaced laterally of the first slot, a toe-clearance gage slidably mounted within the second slot, a member slidably mounted within the first slot rearwardly of the gage element, a movable instep-gaging device carried by the member and adapted to indicate the relative height of the instep, depending pin extensions secured to the gage element, toe-clearance gage and member and projecting below the support plate, forked arms pivoted to the bottom of the support plate for swinging movement beneath the same and engaging the depending pin extensions, a connecting link for the forked arms and permitting the same to oscillate in unison and cause the gage element, toe-clearance gage and said member to move in unison within the first and second slots, the support plate having a third slot, a carriage connected with the third slot for movement longitudinally therein, foot width indicating means connected with the carriage and operated by movement of the carriage, and an endless cable connecting the gage element and carriage for movement in unison in the same direction and disposed below the support plate.

8. A foot-measuring machine comprising a support plate to receive the foot to be measured, movable means connected with the support plate to measure the length of the foot, the support plate being provided near one side of the foot with a diagonal slot, a member engaging the slot and movable longitudinally thereof, a movable abutment element carried by the member and movable transversely of the foot and member, a vertically reciprocatory plunger connected with the abutment element and having a foot width scale provided thereon, a collar mounted upon the plunger for reciprocation relative thereto and having an edge for coaction with the scale of the plunger, a substantially horizontal gage rod carried by the collar and adapted to extend over the foot to gage the thickness thereof, the support plate having an inclined cam surface arranged near a side of the diagonal slot, a vertically swingable cam lever pivoted to the abutment element and engaging the cam surface and connected with the plunger to elevate and lower the same, and a spring connected with the plunger and urging it in one direction and maintaining the cam lever in contact with the cam surface.

9. A foot-measuring machine comprising a support plate having a fixed abutment for engagement with the heel, adjustable foot length measuring means connected with the support plate for indicating the proper length size of footwear, a movable abutment arranged near one side of the foot and connected with the support plate and shiftable longitudinally and transversely of the foot, the support plate having a cam surface near said movable abutment, the cam surface sloping downwardly toward the forward end of the foot in the longitudinal direction and sloping downwardly toward the adjacent side of the foot in the transverse direction, a vertically reciprocatory plunger connected with the movable abutment and having a scale thereon graduated in foot width sizes, the narrower foot width sizes being arranged near the lower end of the scale and the wider foot width sizes being arranged near the upper end of the scale, and a pivoted cam lever connected with the reciprocatory plunger and contacting the cam surface and connected with the reciprocatory plunger to elevate and lower the same in response to movements of the abutment relative to the cam surface in either the longitudinal or transverse directions.

10. A foot-measuring machine comprising a support plate to receive the foot and having a fixed abutment for engaging the heel of the foot, a foot length measuring scale carried by the support plate and extending longitudinally of the foot near one side of the same, the support plate having guide means near the scale and extending longitudinally thereof, a gage element connected with the guide means and movable lon-

gitudinally thereof and adapted to engage the foot forwardly of the heel, the gage element coacting with the scale to indicate the length size of the foot, means connected with the gage element and support plate and movable in response to movements of the gage element and adapted to indicate instep height and toe clearance for the foot, movable foot width measuring means connected with the support plate and including a reciprocatory plunger having a foot width scale thereon, said movable means having a gage part for coaction with the foot width scale of the plunger, cam means connected with the plunger to move the same in opposite directions for causing a particular graduation of the foot width scale to be aligned with said gage part, and driving connecting means between said gage element

and movable foot width measuring means, whereby adjustment of the gage element will cause simultaneous adjustment of the foot width measuring means and said plunger.

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