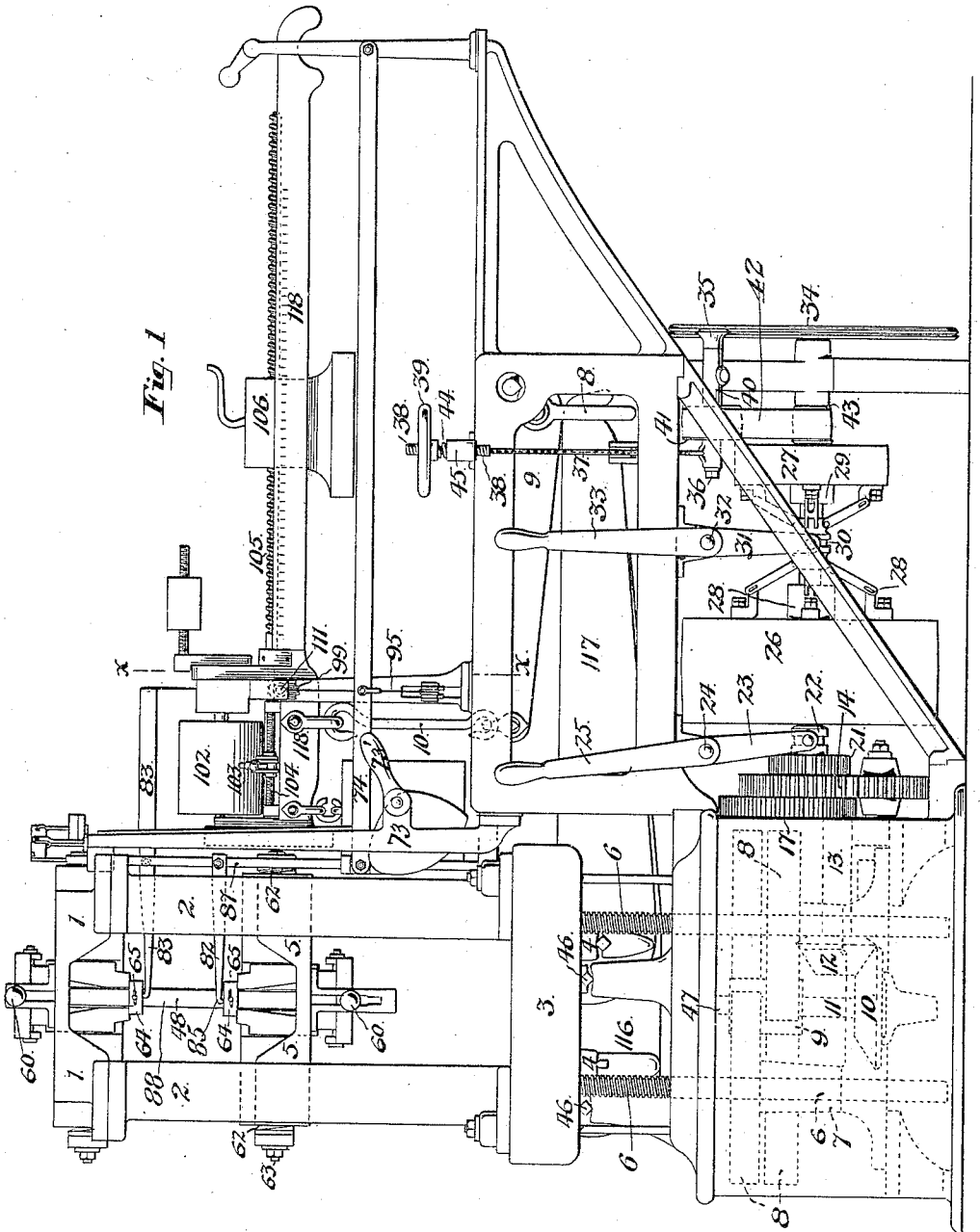
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T. OLSEN.

RECORDING TESTING MACHINE.

No. 445,476. Patented Jan. 27, 1891.

Fig. 1



Witnesses:
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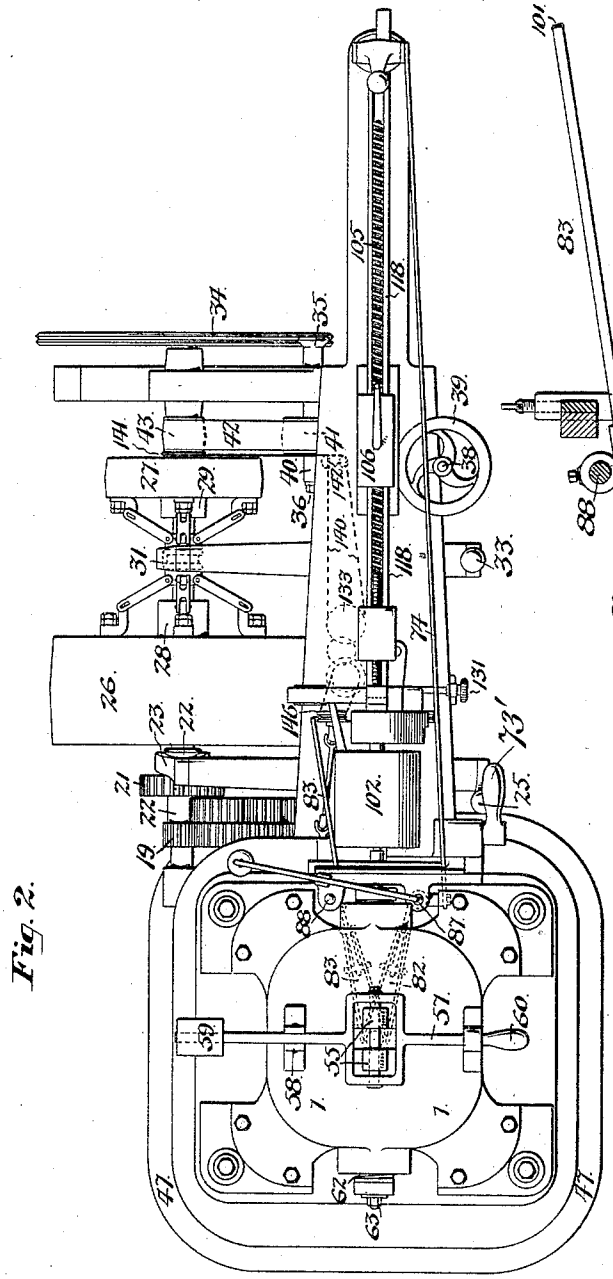


Fig. 2.

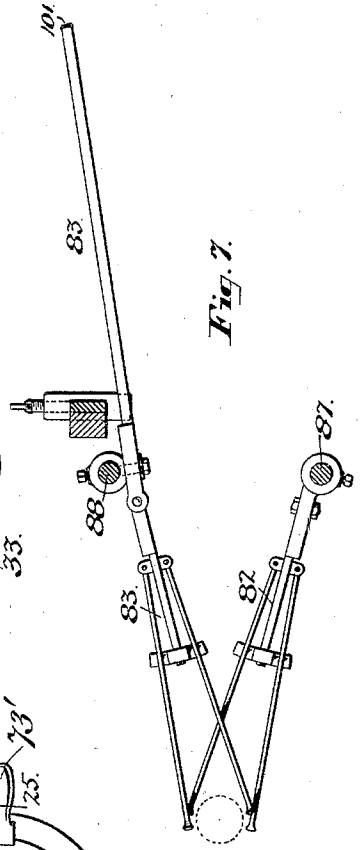


Fig. 7.

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Fig. 3.

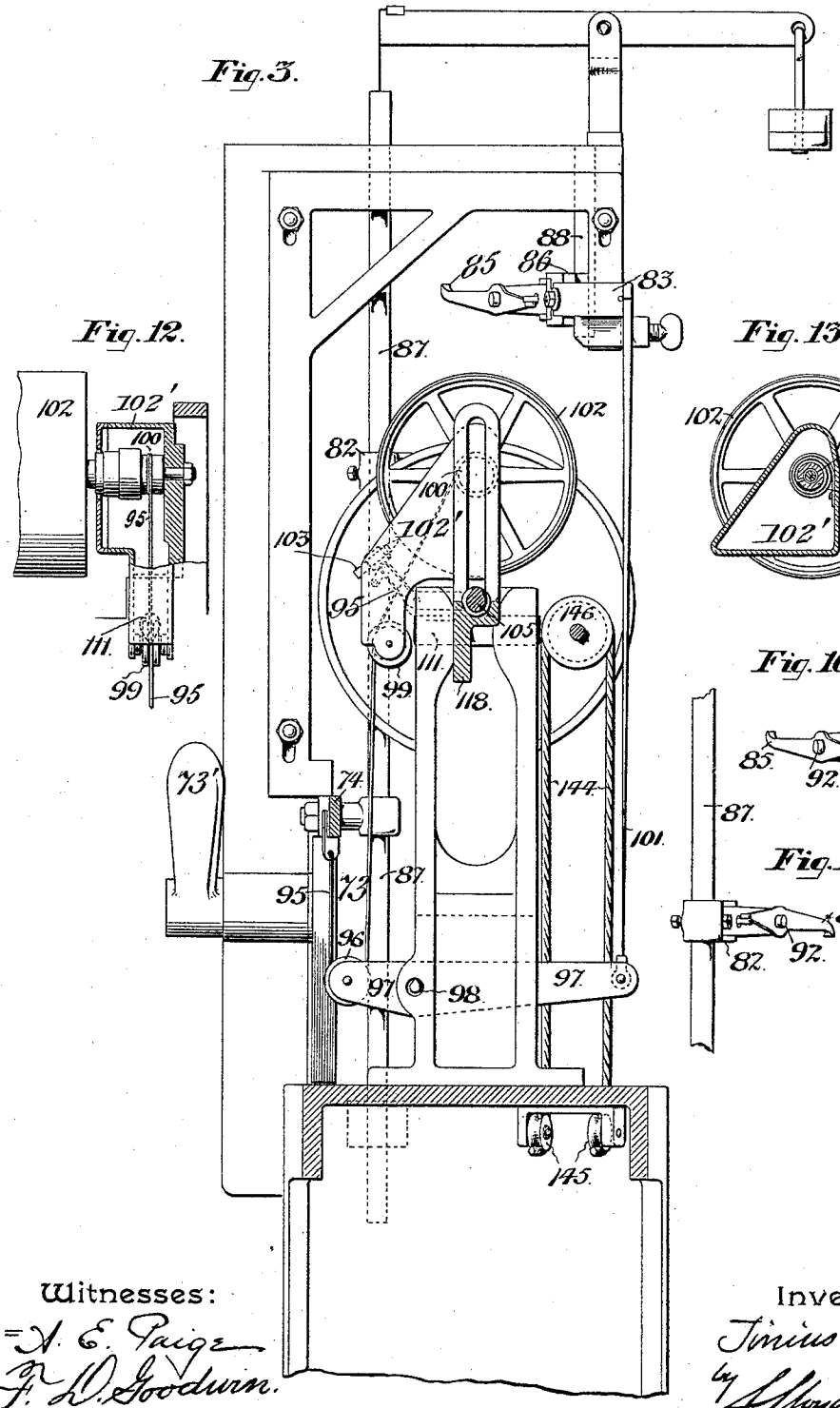


Fig. 12.

Fig. 13.

Fig. 10.

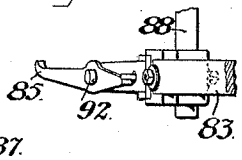


Fig. 11.

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Fig. 30

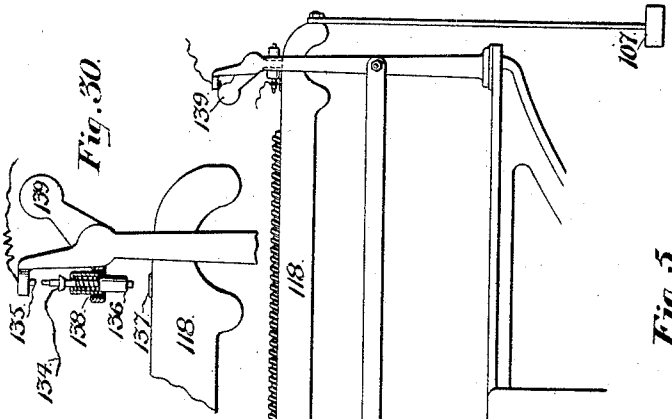


Fig. 5.

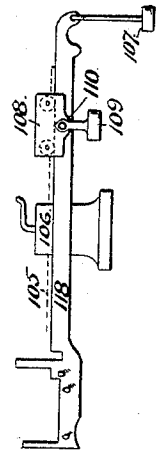
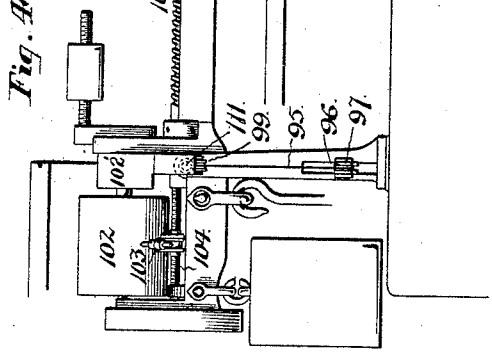


Fig. 4.



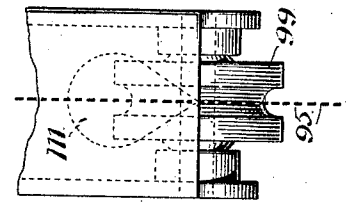


Fig. 6.

Fig. 28.

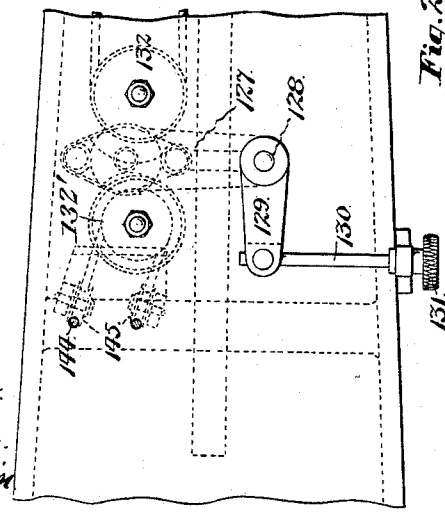
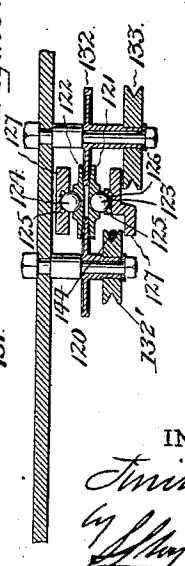


Fig. 29.



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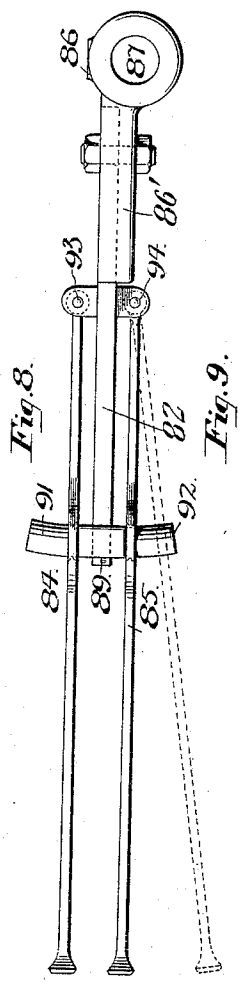


Fig. 8.

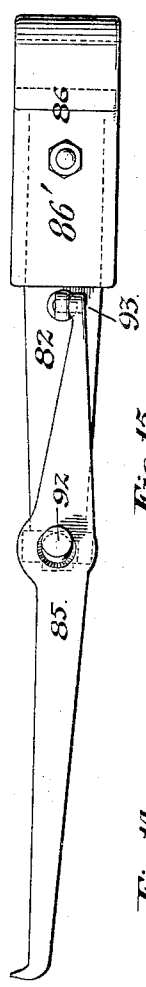


Fig. 9.

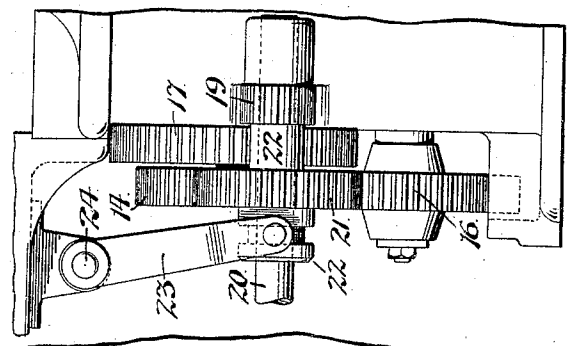


Fig. 16.

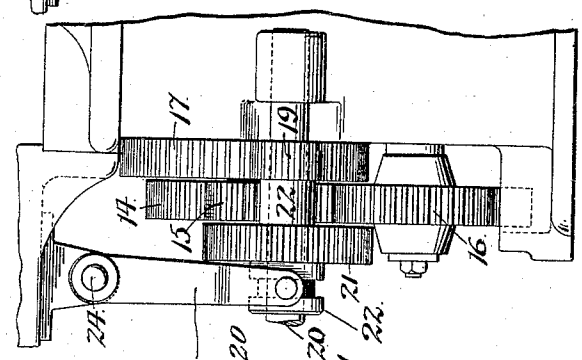


Fig. 15.

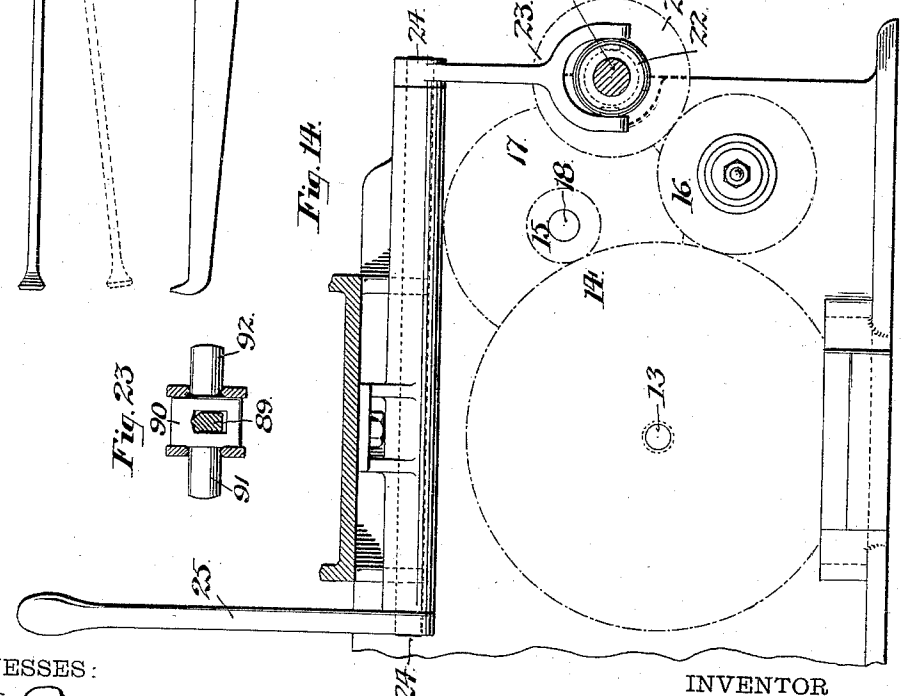


Fig. 14.

Fig. 23.

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RECORDING TESTING MACHINE.

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Fig. 19.

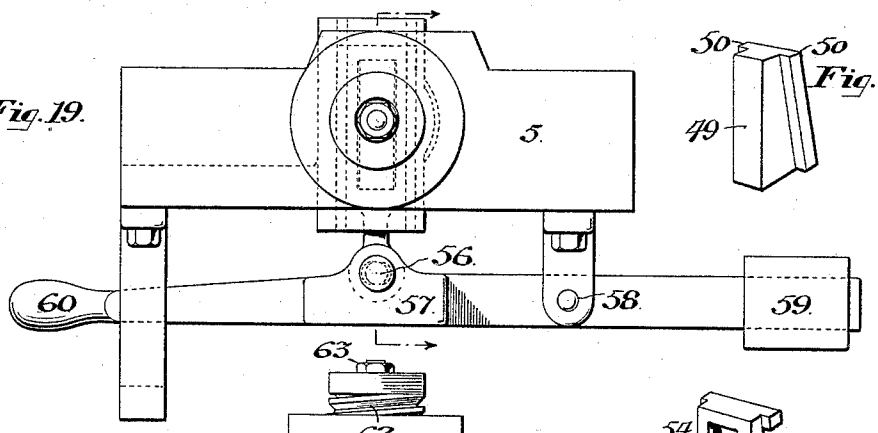


Fig. 20.

Fig. 21.

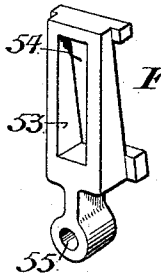
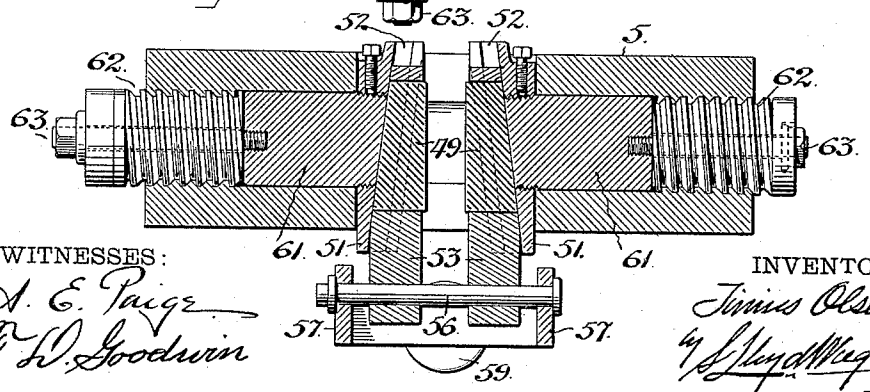


Fig. 18.

Fig. 22.

Fig. 17.



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RECORDING TESTING MACHINE.

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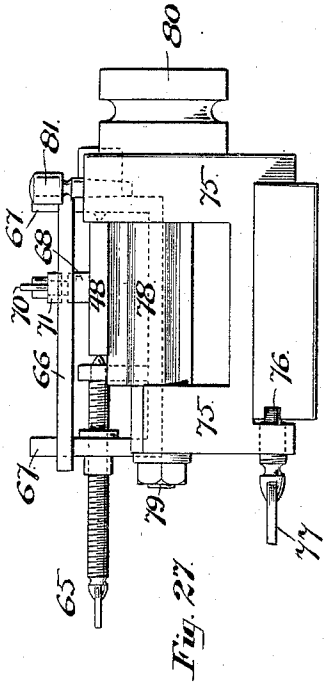


Fig. 27.

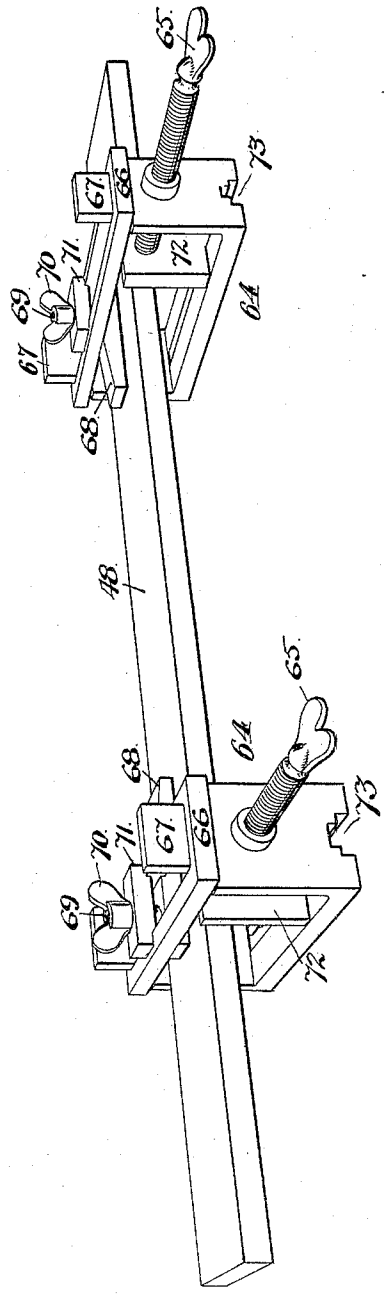


Fig. 24.

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T. OLSEN.

RECORDING TESTING MACHINE.

No. 445,476. Patented Jan. 27, 1891.

Fig. 25.

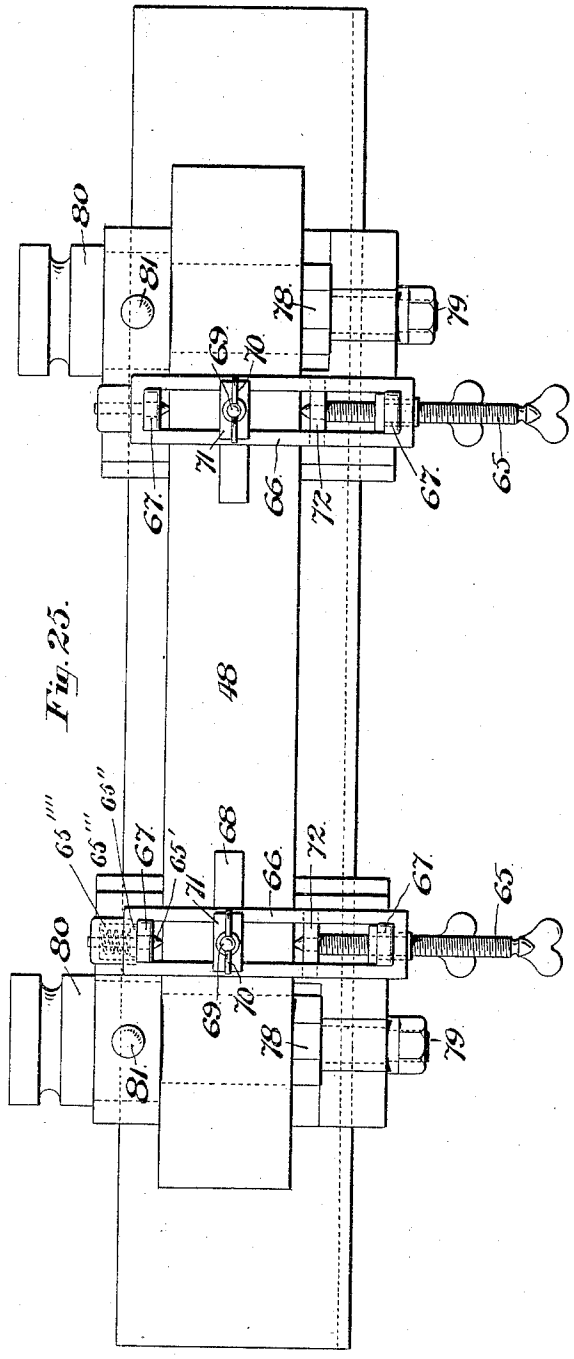
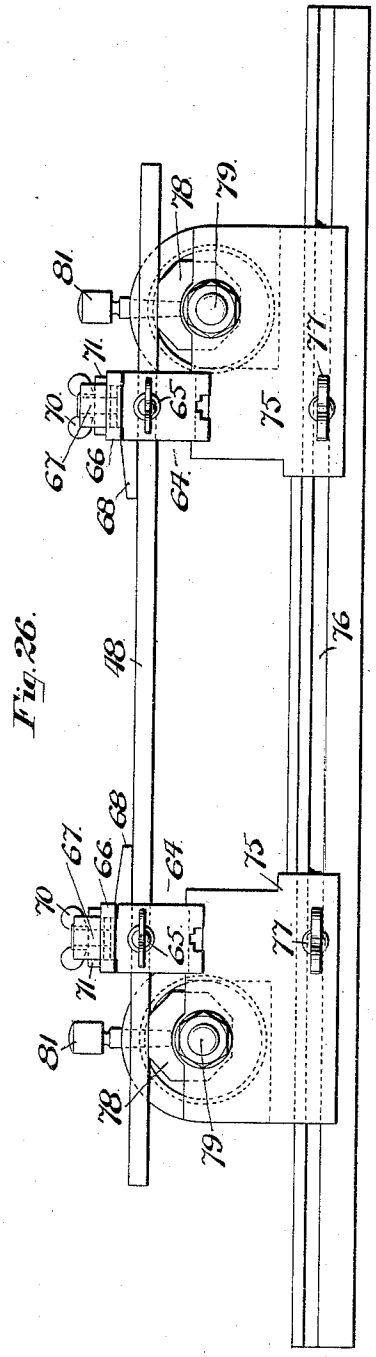


Fig. 26.



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UNITED STATES PATENT OFFICE.

TINIUS OLSEN, OF PHILADELPHIA, PENNSYLVANIA.

RECORDING TESTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 445,476, dated January 27, 1891.

Application filed May 23, 1890. Serial No. 352,827. (No model.)

To all whom it may concern:

Be it known that I, TINIUS OLSEN, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Testing-Machines; and I do hereby declare the following to be a sufficiently full, clear, and exact description thereof to enable others skilled in the art to make and use the said invention.

This invention relates to certain improvements in the testing-machine for which Letters Patent of the United States, respectively dated June 1, 1880, and March 12, 1889, and numbered 228,214 and 399,549, were granted to me.

The objects of this present invention are a better and more quickly-applied gripping device for holding the specimens under test, greater and easier and more universally applicable facilities for transmitting the distortion of specimens under test to the measuring and recording apparatus, the avoidance of inaccuracies in previous machines consequent upon changes of form and dimensions during the testing operation, a greater celerity in working the machine, and a ready adaptability of the same machine to specimens of large and small dimensions and to material of greater and lesser tenacity; also, devices for attaching the measuring-instruments to specimens, for expediting work and regulating adjustably the rate of automatic weighing of the increased strain, and providing an automatic alarm for any accidental interruption of the working of the weighing mechanism. These several desiderata are accomplished by mechanisms hereinafter fully described, and illustrated in the accompanying drawings, in which—

Figure 1 shows a front elevation of a testing-machine embodying this invention; Fig. 2, a top or plan view thereof. Fig. 3 is an enlarged vertical section of a portion of the invention shown in Fig. 1 in the plane indicated by the dotted line *x x* in Fig. 1, showing the parts involved in the mechanism for transmitting motion from the calipering devices to the recording-cylinder. Fig. 4 is a detached front view of the weighing-beam, showing a modification adapted to testing of small and light specimens of the poise portion of the weighing-beam. Fig. 5 is another modification for the same purpose as Fig. 4. Fig. 6 shows an enlarged view of the balancing-pivot of the weighing-beam and the pulley for transmitting motion to the recording apparatus. Fig. 7 is a detached plan view of the calipering mechanism for measuring the extension of material under test. Figs. 8 and 9 are respectively a plan and a side view of the calipering parts drawn on an enlarged scale. Figs. 10 and 11 are respectively elevations and detached views of the calipering devices for measuring extensions. Fig. 12 is a partial section of the parts involved in attachments of the calipering mechanism to the recording drum or cylinder. Fig. 13 is a section presenting the same in elevation and end view. Fig. 14 shows an outlined end elevation of the gearing for transmitting motion from the driving-power to the extending or stretching mechanism of the machine, showing the mechanism for changing from a slow movement with great force to a quicker motion with less force. Figs. 15 and 16 show rear views of the same in different positions of adjustment—to wit, for fast motion and for slow motion. Fig. 17 shows the mechanism for gripping specimens at the upper end. Fig. 18 is a plan view of the mechanism for gripping specimens. Fig. 19 is a vertical section of said mechanism. Figs. 20, 21, and 22 show in detached views the jaws and holders thereof for gripping specimens. Fig. 23 shows the fulcrum for equalizing the action of the two arms of the calipers shown in Figs. 7 and 8. Fig. 24 shows a perspective view of a device for clamping the specimens so as to apply the calipers for measuring the changes of form in the direction of the line of force. Fig. 25 shows an apparatus in plan view for expeditiously applying the clamping mechanism shown in Fig. 24. Fig. 26 shows a front elevation thereof, and Fig. 27 is an end view thereof. Fig. 28 is a detached view of the adjustable gearing for varying the rate of motion of the poise on the weighing-beam; Fig. 29, a section thereof, and Fig. 30 an enlarged detached view of the alarm apparatus for signaling interruptions of the weighing function.

The general construction of the frame-work of the machine and of the levers for multiplying the force from the weighing-beam and the screws for moving the testing-jaws is similar to that shown in the patents above referred to; but, for the purpose of facilitating a clear understanding of the novel parts, they are shown in the drawings and referred to by reference-marks in this specification.

1 is the entablature in which the upper jaws are fitted, which entablature 1 rests upon four columns (marked 2) resting upon a base 3, which rests upon the knife-edged pivots 4 of the force-multiplying levers 116 and 117. (See Fig. 1.) The levers 116 and 117 are supported by fulcrums 46, resting on the base 47.

5 is the lower moving head containing the lower gripping-jaws, and is moved downward and upward by four screws marked 6, operated by nuts 7, turned by gear-wheels 8 in the base of the machine 47. The gear-wheels in the base of the machine are propelled by one pinion 9, moving all of them at the same velocity, so that a uniform motion is imparted to the moving head at all parts, and the parallelism thereof with the upper head or entablature is preserved. The wheels 8 and nuts 7 are shown in dotted lines in Fig. 1. The central vertical pinion 9 is propelled by a beveled wheel 10, fixed upon the lower portion of its shaft 11 and turned by a beveled pinion 12 upon a horizontal shaft 13, provided at its outer end with and turned by a spur-wheel 14, which is driven alternately by a pinion 15 or an idle-wheel 16. The pinion 15 is secured to and turned by a spur-wheel 17 upon its arbor or stud 18, and driven by a pinion 19, fixed upon a sleeve 22, sliding upon and turning with the driving-shaft 20. The sleeve 22 has also fixed upon it a spur-wheel 21, and is susceptible of lengthwise motion on the shaft 20, so that when the said sleeve 22 is in one position, as shown in Fig. 15, the pinion 19 is brought into gear with the spur-wheel 17, which turns said wheel, and with multiplied force and decreased velocity, and turns the pinion 15, secured to the wheel 17. The pinion 15 engages in the teeth of the wheel 14 on the shaft 13 and turns them with increased force, attended with a further reduction of velocity. When said sleeve 22 is moved in the opposite direction, as shown in Fig. 16, the pinion 19 is disengaged from the wheel 17, as shown in Fig. 16, and the spur-wheel 21 engages in the wheel 16, which transmits the motion to the wheel 14 and shaft 13 with a much greater velocity but less multiplication of force than in the adjustment previously described, enabling the operator to adjust the position of the moving head to positions suitable to specimens of different lengths with greater celerity.

The lengthwise motion of wheels 19 and 21 and their connecting-sleeve 22 on shaft 20 is effected by collars formed on the sleeve 22 engaging a forked lever 23, fastened to and operated through a shaft 24 and hand-lever 25 on the opposite end of the shaft, at the front of the machine.

The rotative motion of the shaft 20 is derived from pulleys 26 and 27, which turn freely upon the said shaft 20, unless engaged therewith, which they can only do alternately by the friction-clutches 28 and 29, operated by a sleeve 30, controlled by a forked lever 31 through a shaft 32, operated by hand-lever 33 at the front of the machine. The motion which engages the clutch 28 must previously disengage the clutch 29, and when the lever 31 and sleeve 30 are in intermediate position neither is engaged. The pulley 26 is made large in diameter and of broad face, so as to convey ample power for the testing of the strongest specimens and is driven by a correspondingly strong band and driving-power wheel, while the pulley 27 is of smaller diameter and narrower face and is driven by a narrow band from a pulley having a face traveling at a higher velocity. By the use of these two pulleys great celerity of action is procured in adjusting the machine to the position where the power becomes operative on the specimens under test.

Upon the end of the shaft 20 is secured a grooved wheel 34 of large diameter, so as to turn with it. A very small wheel 35, turning with an arbor 36, imparts motion to the wheel 34 when pressed into the groove, which is done by means of a chain 37, adjusting-screw 38, and nut 39, shaped as a hand-wheel, raising the tilting bearing 40 in (which the arbor 35 turns) at one end and depressing the other end. The arbor 36 receives rotative motion from the band-wheel 41, connected by an endless band 42 with the pulley 43 of small diameter, secured to and turning with the pulley 27. A helical spring 44 is interposed between the nut 39 and the support 45, so that the degree of pressure exerted in engaging the wheel 35 into the wheel 34 can be easily and evenly distributed on the periphery of the wheel 34 by the frictional contact of the wheels, thus procuring a very slowly and evenly applied stress.

The specimen under test (marked 48 in the drawings) is held between gripping-jaws 49. (Shown in Figs. 17, 18, and 19, and separately with its accompanying parts or adjuncts in Figs. 20, 21, and 22.) The jaws 49 themselves are wedge-shaped, as shown in detached views in Fig. 20. The perpendicular side of the wedge is placed against the specimen, and the inclined side, which is provided with projecting flanges 50, fits in a correspondingly-inclined block-slide 51 in the grooves marked 52.

The jaws are supported during the operation of introducing the specimen by a slotted slide 53, fitting through an opening 54 formed in said slides, which slides 53 are provided with eyes 55 fitting on a bolt 56 in a lever 57, balanced upon a fulcrum 58 by a counter-

weight 59. The lever 57 is provided with a handle 60 at the front of the machine, so that the operator can raise and lower the jaws and wedge them upon the specimen under test when the specimen is not under strain, which affords a great facility in the introduction of the specimen. The slides 51 are fitted upon plungers 61, fitted to slide horizontally in the entablature 1 and the moving head 5. The plungers 61 are forced inwardly and supported in position laterally by strong screws 62, fitted in nuts formed in the draw-head 5 and in the entablature 1. The plungers 61 are compelled to follow the return motion of the screw 62 by a screw-bolt 63, fitted centrally through the screw 62 into the plunger 61. By turning the screw 62 different lateral adjustments of the slides 52 and jaws 49 are readily effected to adapt the space between the jaws 49 to different thicknesses of specimens. When strain is applied in the direction of the length of the specimen, the jaws 49 slide toward the converging ends of the slides 52, and are forced more tightly against the specimen, increasing the grip thereon.

When the specimen is introduced, the jaws 49 are, by means of the lever-handle 60 and lever 57, bolt 56, and slide 53, drawn toward the converging ends of the slide 51 and opened. After the specimen is inserted, by a reverse movement of the handle 60 the jaws 49 are closed against the specimen, the jaws remaining, by reason of their balanced condition from the action of the counter-weight 59, in whatever adjustment they may have been placed by hand until the tensile strain is applied, when they are forcibly drawn toward the converging ends of the slides 52, and must firmly grasp the specimen.

Upon the specimen 48 are placed collars or clamps 64, fastened thereon in definite position by pointed set-screws 65, the purpose of which collars or clamps 64 is to measure the amount of the extension which takes place during the test in the length of the specimen between the points of impingement upon the specimen by the set-screws 65 in the two collars or clamps 64.

The construction of the collars or clamps 64 is shown in Figs. 25, 26, and 27, and in Fig. 23 in perspective on an enlarged scale.

The specimens 48 are secured in the clamps 64, between pointed screws 64′ and opposite points 65′, which opposite points 65′ are forced toward the specimen by a helical spring 65‴ in a cavity 65⁗, pressing against the collar 65″, so that the impingement of the points 65′ and the screw-point 65 is with an elastic pressure and reaction, and by such reaction adapts the clamps 64 to any changes of form, such as reduction in breadth or thickness of the specimen during the test.

For facility of applying and removing the specimens, the clamps 64 are made with a detachable cap or side piece or plate 66, fitting over tenons 67 and provided with guiding-plates 68, attached by screws 69, provided with nuts 70 and washers 71, fitting the top of the clamp 66, so that when the top of the clamp, with its guiding-plates, is placed firmly against the specimen and the points of the set-screws 65 entered the sides of the specimen 48 the clamps will, although attached to the specimen by two points only, by the assistance of the guiding-plates 68 retain the desired position on the specimen 48. Other specimens can be quickly brought into the same position without any pains or delay in readjustment by simply letting the caps or side plates 66 of the clamps 64 and the connected guiding-plates 68 rest on the specimen. The correct alignment of the screws 65 with the point 65′ on the opposite side of the specimen in the same clamp is secured by a guiding-block 72, through which the screw 65 passes and fits, said block 72 sliding between the base of the clamp 64 and the cap 66.

In order to apply the clamp easily and at the same time at definite distances upon specimens for any series of tests, an apparatus shown in Figs. 25, 26, and 27 is provided, upon which the base of each of the clamps 64 fits. The clamps 64 have grooves 73 in their under side, which fit upon corresponding ridges or tongues upon sliding blocks 75, which sliding blocks 75 are fitted to slide lengthwise upon a supporting-guide 76, and are held in lengthwise adjustment thereon by set-screws 77. The function of the sliding blocks 75 and guide 76 is to provide a prompt and easy means of locating the clamps 64 at the same definite distances upon the specimens to be tested, and also to afford a ready means of locating the specimens in the clamps 64 with proper relation to the points of impingement of the set-screws 65 to the thickness of the specimens. To effect this latter function in each of the sliding blocks 75, there is fitted, with the axis transverse to the slide 76, a polygonal prism 78, mounted eccentrically upon a shaft 79, and turned by the hand of the operator by knobs 80, and held in rotative adjustment by pins 81, fitting through the blocks 75 in holes in the journal of the eccentric polygonal prism 78. The position of the holes in the journals and the radial distance of the different sides of the prisms from their center of rotation are such that in the several adjustments thereof, when the pin interlocks with the holes in the journal and in the blocks 75, there will be a graduated height from the blocks and the sides of the prisms to furnish the support for different thicknesses of specimens, so as to hold them in position when the clamps 64 rest on the block.

In order that the set-screws 65 shall be in central position upon the edge or side in relation to the thickness of the specimens 48 in the event of having a number of specimens of the same thickness to test in a series, the operator having once adjusted the apparatus for such thickness can promptly apply the clamps to them with the set-screws 65 in the

proper central position. Thus a series of tests can be made with very little detention in adjusting the specimens to the clamps.

When the specimen 48 is placed in the machine, it is held between the jaws 49 in the manner already explained and the calipers 82 and 83 (shown in Fig. 1, and in the enlarged view in Figs. 7 and 8) are placed in contact with the inner sides of the clamps 64. The calipers 82 and 83 consist of arms 84 and 85, pivotally attached by their ends opposite to those resting on the clamping device 64, the clamps 86 fitting upon upright bars 87 and 88. (Shown in Fig. 3.) A projecting arm 86′ extends from the clamps 86 between the arms 84 and 85 of the calipers 82 and 83, and has formed upon it a knife-edge 89, upon which fits a ring of metal 90, provided with an arm upon each side marked 91 and 92, which fit through apertures in the arms 84 and 85, and are curved so as to coincide with the motion in curved lines which the arms 84 and 85 have upon their pivots 93 and 94, by which they are attached to the arms 86′. The pivots 93 and 94, by which the arms 84 and 85 are attached to the arms 86′, are made susceptible of motion vertically as well as horizontally, so that the calipering-arms 84 and 85 can, with the ring 90 and arms 91 and 92, be vibrated upon a knife-edge 89. The calipering-arms 84 and 85 being applied with their end to the clamps 64, with one arm upon each side of the specimen, if any unequal extension of the specimen takes place upon one side more than the other the calipering-arms, turning upon a knife-edge 89, adapt themselves to such change and transmit the movement to the clamp 86, which movement is the mean between the motion of the two arms 84 and 85.

The motion of the calipers is transmitted through the arms 86′ and clamps 86 to the rod 87 and to the link 101. Motion of the rod 87 is transmitted by a lever 74 through the cord 95, (shown in Fig. 3,) passing round a pulley 96 in the end of the lever 97, mounted upon a fulcrum 98, and passes over a second pulley 99, up to a drum or winding-barrel 100. The winding-drum 100 is inclosed and supported in a hollow shell or case 102, which also in its lower part furnishes a support for the pulley or sheave 99. (Shown in Figs. 1, 3, 12, and 13.) The opposite arm of the lever 97 to that bearing the pulley 96 is connected pivotally by link 101 to the counter-arm of the upper caliper 83. This arm of the lever 97 is of such length relatively to the length of the arm bearing pulley 96, as well as to proportions of the arms of the calipering-lever 83, that the motion imparted to the drum 100 is the result of the differences of motion between the two calipers, the drum being always wound tight by a spring 100 (shown in the section in Fig. 13) and the position of the pulley 96 being varied by the position of the upper caliper 83. The rotation of the barrel 100 and the connected recording-cylinder 102, fixed upon the same arbor and turning with it, is always proportioned to the variations of the distance between the calipering-points as controlled by the clamps 64, connected with each other by the specimen 48, to which they are attached.

The location of the lever 97 or link 101 and pulley 99 is in a vertical plane with a balancing-pivot 111 of the weighing-beam, making this transmission of motion to the cylinder 100, and is such as to be unaffected by the oscillation of the weighing-beam 118, to which the bearing of the arbor of the cylinder 100 and recording-drum 102 are attached, and a pencil 103, held in contact with the cylinder 102 or a diagram-sheet attached thereto, graphically records on said diagram-sheet the motions of rotation of the record-cylinder which may take place in consequence of any extension of stretching or other changes of shape of the specimen under test. The pencil 103 is attached to a nut 104′, fitting and moving lengthwise upon a screw 104, which is connected and turned with the screw 105, which shifts the weight 106 upon the weighing-beam 118. The shifting of said poise may be made by the operation of a cord and gearing controlled by electrical contacts and an electro-magnet, in the manner described in my earlier patents heretofore referred to. The combined effect of the lengthwise motion in the direction of the axis of the screw 104 as communicated to the pencil 103 and the motion of the diagram-sheet upon the cylinder 102 is to produce curved lines graphically indicative of the extension and also of the strain under which such extension took place, and thus affords an exact record of the properties of the material of the specimens under test and its strength at every stage of its tests.

In order to facilitate the introduction of the specimens, a cam 73, provided with a handle 73′, by which it can be turned upon its axle with its larger side either upward or downward, is placed under the lever 74. When turned with its larger side up, the lever 74 is raised and the caliper fingers or arms 84 and 85 are retracted from the collars or clamps 64 on the specimen, and when turned in the opposite direction the fingers or arms 84 and 85 rest upon the collars or clamps 64 and participate in their motion with the effect hereinafter described.

As above described, the invention is applied to the recording of tensile distortion of specimens, the same apparatus, however, being equally adapted for recording compression or any other distortion of a specimen in the line of stress it is subjected to.

It is not essential that the recording apparatus be mounted on the beam of the machine.

The calipers and connected levers and rods in connection with the lever 97, pulley 96, and cord 95 may be connected to a recording apparatus independent of the beam, the motion of the poise on the beam or the amount of stress in this case being transferred from the

beam to the recording apparatus in the same manner by a cord over a pulley in vertical plane to the balancing-pivot or by any eqivalent means.

In order to adapt this machine and its system of measuring and recording devices to ready applicability to large and small specimens, it is desirable and sometimes necessary to use a lighter weight or poise than the usual weight 106, (shown in Fig. 1,) and in making such change of weight it becomes necessary to avoid any change in the position of the center of gravity in a vertical direction of the beam 118 and its rigidly-connected parts. If a smaller weight or poise is substituted for the large weight 106, and an additional weight 107, rigidly secured to the end of the beam 118, and located below the level of the beam 118 may be employed, or a weight hung pivotally from knife-edges 110, carried upon a traveling slide or trolley 108 upon the beam 118, so as to preserve the proper level position of the beam when in equilibrium throughout all adjustments of the weights 106 and 108, sliding upon it.

The rigid connection of the weight or counterpoise 107 to the end of the beam is preferable, because it imparts a steadier motion to the beam 118 when in operation.

To enable the poise 106 or 108 to be moved a greater or less distance for each oscillation of the beam 118, there is introduced in the mechanism for propelling the screw 105 a series of adjustable friction-wheels. (Shown in Figs. 28 and 29.) Motion is imparted by an endless band 140, propelled by the grooved pulley 141, and passing over guiding-pulleys 142 to the grooved wheel 133 turns with it a flat disk wheel 132, having a thickened rim. The rim of the wheel 132 is pressed between two wheels 121 and 122, having slightly convex or spherical faces centrally supported and turning upon balls 123 and 124, which rest upon smaller balls 125, rolling in circular grooves 126 in the opposite faces of bracket-arms 127, vibrated upon a fulcrum 128 by a lever 129, operated by a screw 130 and nut 131, controlled by the hand of the operator.

Between the wheels 121 and 122, opposite to the wheel 132, is placed a wheel 120, similar in form to the wheel 132, which has connected with it so as to turn therewith a wheel 132′, which operates an endless band 144, passing over guiding-pulleys 145, transmitting motion to the grooved wheel 146, turning the screw 105, which moves the poise 106 upon the beam 118 in the same manner as in the machines described in the patents hereinbefore referred to. When the central part of the wheels 121 and 122 embrace the rim of the wheel 120, the outer portion of the wheels 121 and 122 embrace the rim of the wheel 132, and the rotation of the wheel 132 is greatly retarded. By changing the position of the wheels 121 and 122 by means of the nut 131, screw 130, lever 129 vibrating the bracket-arms 127, an accelerating effect is produced, and by any intermediate adjustment any desired intermediate rate of motion is secured, thus adapting the rate of increased poise effect to suit the properties of the specimens under test. Such adjustments of the rate of increase of strain are readily effected during the progress of the test without interfering in any manner with the accuracy of the record.

The engagement of the mechanism for moving the weights 106 and 108 upon the beam is controlled by the operation of an electric circuit having in it one electrode 136, placed above and near the end of the beam 118, and another electrode 137, attached to the beam 118 and directly under the electrode 137. These electrodes close the circuit when the strength of the specimen under test exceeds the force of the weights as adjusted on the beam, and the closing of the electric circuit actuates the screw 105, in the manner described in my former Letters Patent hereinbefore referred to.

In order to relieve the operator from the necessity of constantly watching the motion of the beam 118 and connected parts throughout the test, and to indicate to the operator when the machine is moving too fast or the poise is shifting too slowly, and from either of these causes the beam rises to the upper limit of the locking-frame and the machine demands attention, under such conditions I connect with the electrical-contact apparatus an alarm by means of a second pair of electrodes 134 and 135—shown in Fig. 30, where they are shown as attached to the upper end of the electrode 136, which, by contact with the electrode 137 in the beam 118, controls the motion of the screw 105, moving the poise 106 in the manner described in the earlier patents.

The electrodes 134 and 135 make contact only when the beam 118 rises beyond its normal range of vibration, and then an alarm operated by the electric circuit in control of the electrodes 134 and 135 signals for the attention of the operator.

Having described my invention and the operation thereof, what I claim is—

1. In a testing-machine, the compound gearing having an additional idle-wheel 16, in combination with the train of gearing consisting of the wheel 14, pinion 15, wheel 17, pinion 19, and wheel 21, arranged to transmit motion alternatively, as and for the purpose set forth.

2. In the heads of a testing-machine for holding specimens, the gripping-jaws 49, in combination with the blocks 51, slide 53, bolt 56, lever 57, and counter-weight 59, as and for the purpose set forth.

3. The head 5, blocks 51, jaws 49, and plungers 61, fitted through the said blocks 51 and arranged to bear directly on the inclined surface of the jaws 49, in combination with the screws 62, fitted in nuts formed in the head 5 and arranged to operate substantially as set forth.

4. The head 5 and jaws 49, in combination

with the plungers 61 and screws 62 and 63, as and for the purpose set forth.

5. The clamp 64, having screws 65, adapted to impinge upon specimens and provided with tenons 67, in combination with the removable cap-plate 66 for facilitating the introduction of specimens and bracing the clamps against the thrust of the screw 65, substantially as set forth.

6. The guide-plate 68 and clamp 64, having the side plate 66 and screws 65, in combination with the screws 69, nuts 70, and washer 71, constructed and arranged substantially as and for the purpose set forth.

7. The clamp 64, having screws 65, in combination with the guiding-block 72, screw 69, nuts 70, side plate 66, and tenons 67, as and for the purpose set forth.

8. The slide 76, the clamps 64, and blocks 75, fitted adjustably as to distance on the said slide 76 and provided with seats adapted to fit the clamp 64, in combination with the eccentrically-journaled prism 78, angularly adjustable in bearings in the blocks 75, and a mechanism to hold said prisms in angular adjustment for the purpose of facilitating the central application of the clamp upon series of specimens at uniform distances for testing, substantially as set forth.

9. The curved lever-arms 91 and 92, the intermediate knife-edge fulcrum 89, the arm 86′, and the bars 87 and 88, in combination with clamps 86, fitted thereon, having caliper-arms 84 and 85, pivotally attached thereto and balanced upon curved lever-arms 91 and 92, resting upon an intermediate fulcrum 89, supported by the clamp 86, substantially as and for the purpose set forth.

10. In a testing and automatic recording-machine, the combination of the cylinder 102, the clamps 64, the calipers 82 and 83, and connected lever 97, proportioned and arranged as described, for limiting the transmitted motion to the difference of the motion of the calipers as controlled by the clamps 64 on the specimen, substantially as set forth.

11. In a testing-machine, the pulley 99 in vertical plane with the axis of the balancing-pivot, in combination with the drum or winding-barrel 100 and cord 95, connected with and operated by the calipers 82 and 83, substantially as and for the purpose set forth.

12. In a testing-machine, the combination of the caliper 82, sliding bar 87, lever 88, cord 95, pulley 96, pulley 99, drum or winding-barrel 100, lever 97, link 101, lever 88, and calipers 83 for measuring and transmitting the motion proportioned to the changes of space between the two calipers to the recording-cylinder, substantially as set forth.

13. In combination, the beam 118, provided with the pivotally-suspended poise 107, the poise 106, and poise-carriage 108, bearing a pivotally-suspended poise 109, constructed and arranged substantially as and for the purpose set forth.

14. In a testing-machine having a poise automatically moved on the beam, the combination of the friction-wheels 120 and 132 with the adjustable wheels 121 and 122, and a connected power-transmitting gear to vary the rate of motion of the poise, substantially as set forth.

15. The balls 123 and 124, the balls 125, the lever-arms 127, and the convex-faced wheels 121 and 122, supported by said balls 123 and 124, resting and turning upon said smaller balls 125, combined therewith and arranged to roll in grooves 126 in the lever-arms 127, substantially as set forth and shown.

16. In a testing-machine, the electrodes 134 and 135 and a connected alarm-circuit, in combination with the beam 118, arranged to operate with the abnormally-longer oscillations of the beam 118 and to remain inoperative with the normal oscillations thereof, substantially as set forth and shown.

17. The diagram-sheet-holding cylinder 102, the cord 95, and the pulley 99, in combination with the beam 118, constructed and arranged to oscillate and balance upon the fulcrum 111 and to support said sheet-holding diagram-cylinder 102, the calipers 82 and 83, arranged to rest upon and move with the specimen under test, the lever 97, connected therewith and with the said cord 95, guided by the pulley 99, located in the same vertical and horizontal planes as the fulcrum 111 of the beam 118 for the purpose of transmitting motion from the calipers to the diagram-sheet-holding cylinder without affecting the equilibrium of the beam, substantially as set forth.

18. In an automatic testing-machine, the cord 95, the clamps 64, the calipers 82 and 83, arranged to rest upon said clamps and participate therewith in the motions of two portions of the specimen under test, in combination with the lever 97, having a fulcrum 98 and a point upon each side of said fulcrum connected with one of the calipers for the purpose of transmitting indications of differences between the motions of two calipers through said cord 95 and eliminating the coincident motion of both calipers from such indication, substantially as set forth.

19. In an automatic combined testing and recording machine, the weighing mechanisms, the diagram-holding cylinder, the calipers 82 and 83, adapted to rest upon and participate in the motions of two portions of the specimen under test, and the lever 97, connected at points located upon opposite sides of its fulcrum with each of said calipers, in combination with the cord 95, operated by the lever 97 and connected with said diagram-holding cylinder, and a pencil moved and guided in parallel direction with the axis thereof by a mechanism connected to said weighing mechanism for the purpose of graphically recording combined indications of stress and motion between the parts of the specimen, substantially as set forth.

20. In a combined testing and automatic indicating and recording machine, the combi-

nation of the poise or weight 106, beam 118, diagram-holding cylinder 102, the lever 97, and the calipers 82 and 83, adapted to rest upon and participate in the motions of two portions of the specimen under test and connected with said diagram-holding cylinder by the said lever 97 for eliminating the motion of the entire specimen and transmitting only the differences of motion between the calipers with the recording-cylinder, and a pencil connected with the poise or weight 106 on the weighing-beam 118, combined with and controlled by the contact of electrodes operated by the oscillations of the beam 118, substantially as set forth.

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Witnesses:
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