April 25, 1939. C. C. CADDEN 2,155,528

BALANCING MACHINE

Filed July 3, 1935 5 Sheets-Sheet 1

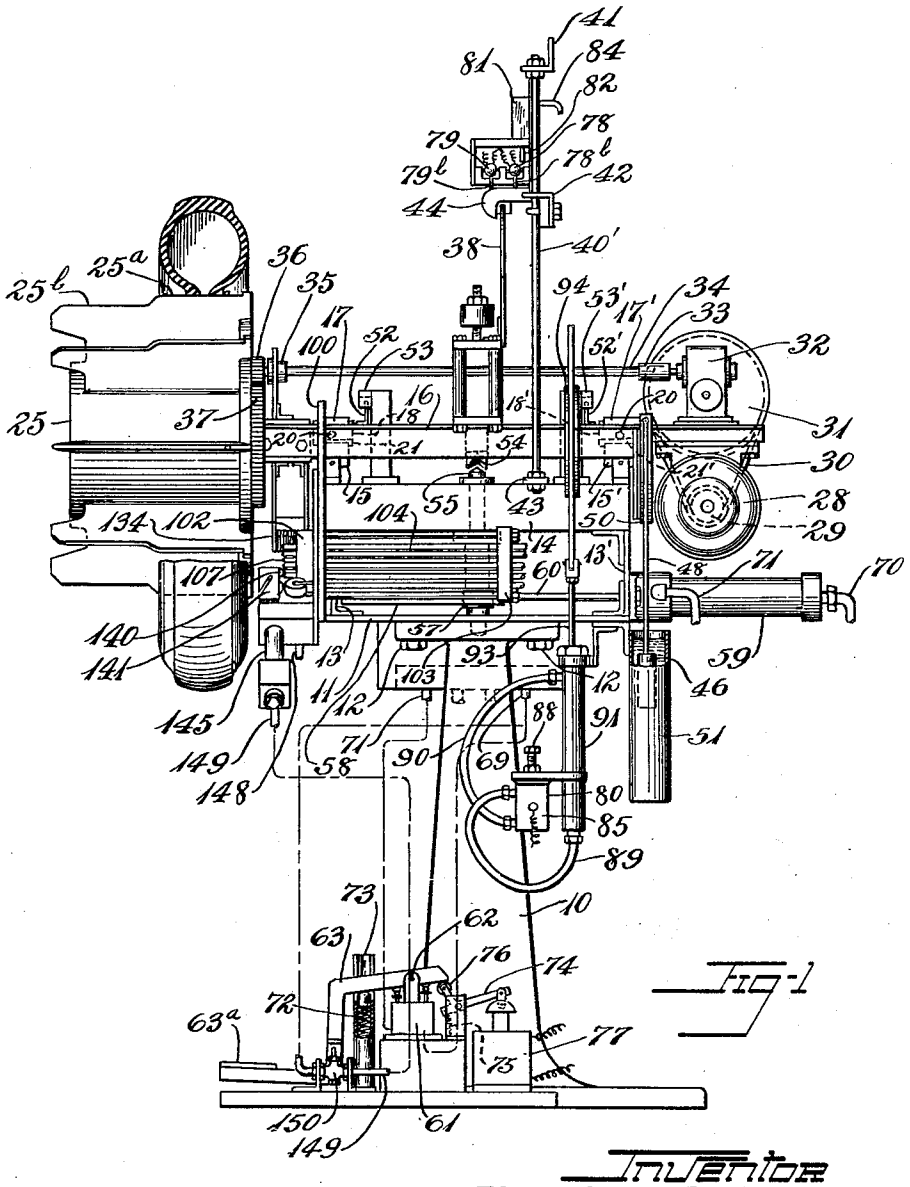


Fig-1

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BALANCING MACHINE

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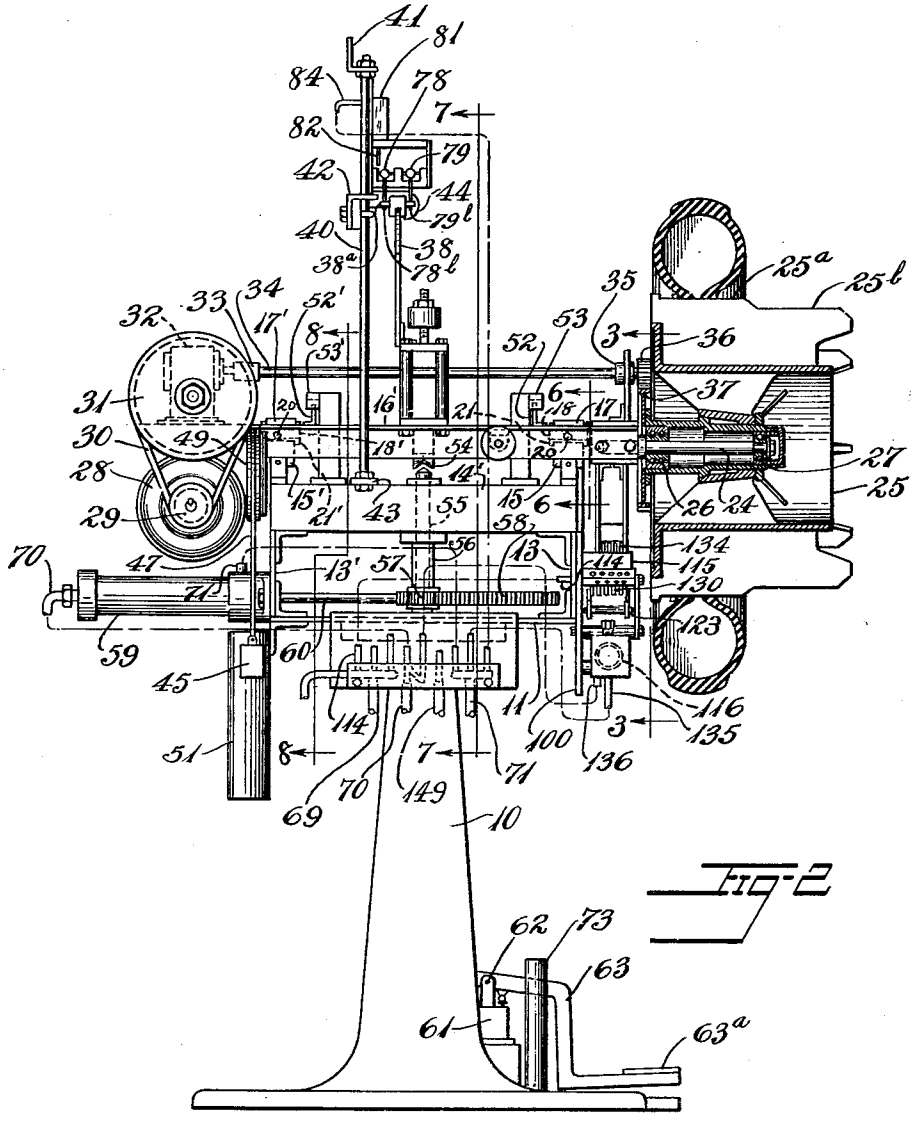


Fig-2

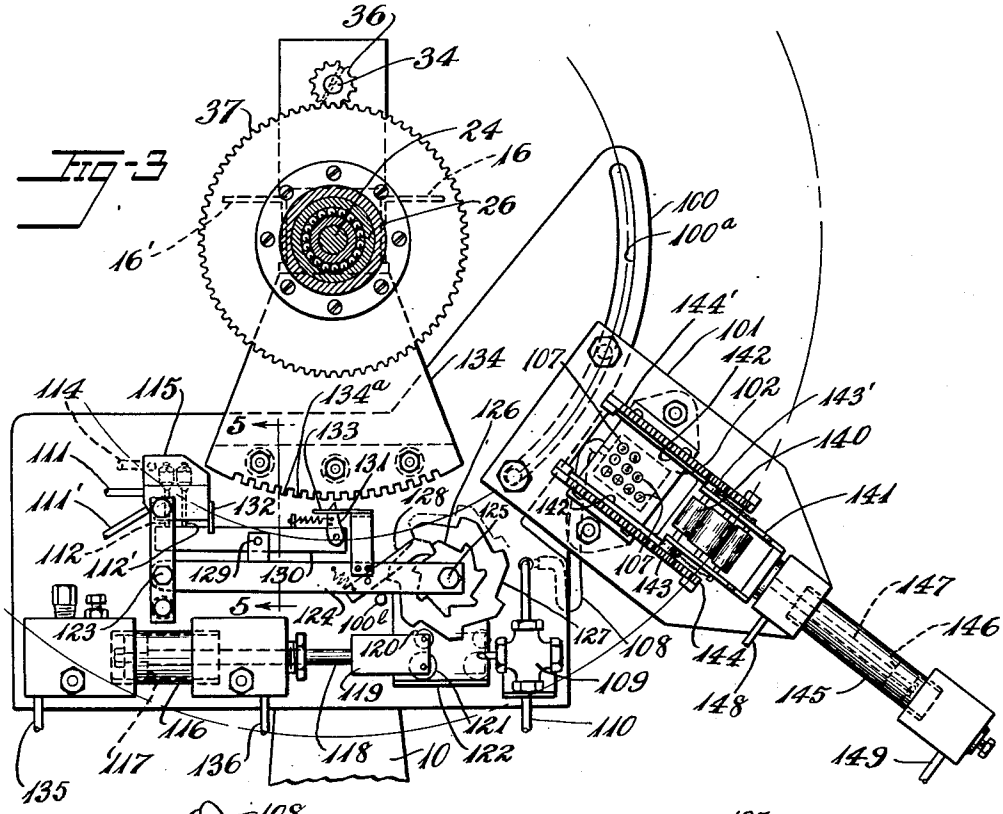
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BALANCING MACHINE

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Fig-3



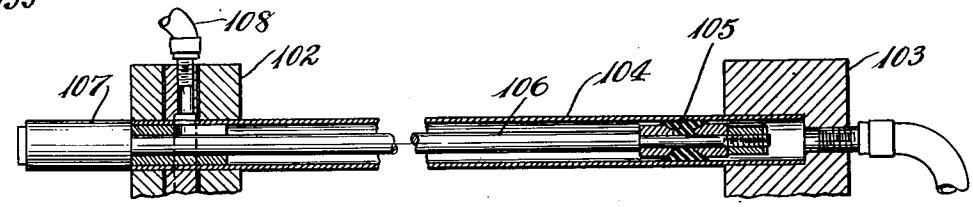




Fig-4

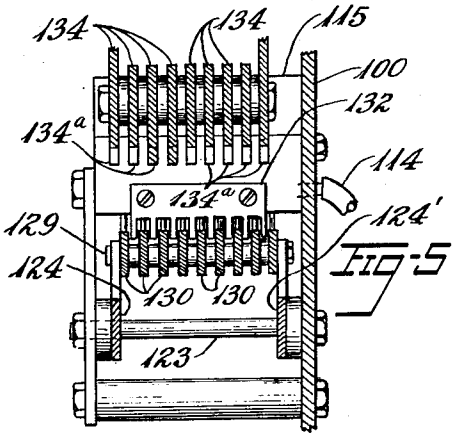



Fig-5

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BALANCING MACHINE

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Fig-6

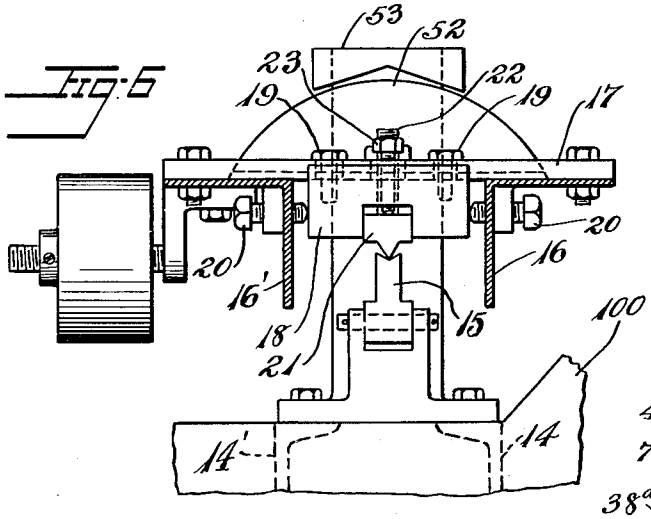



Fig-7

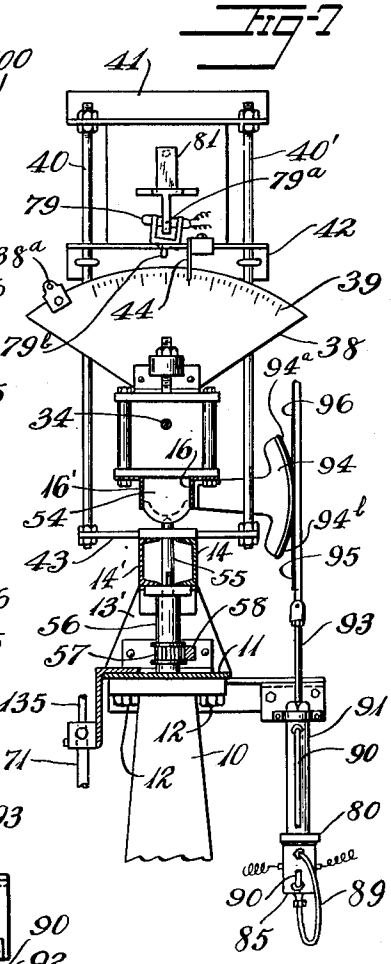
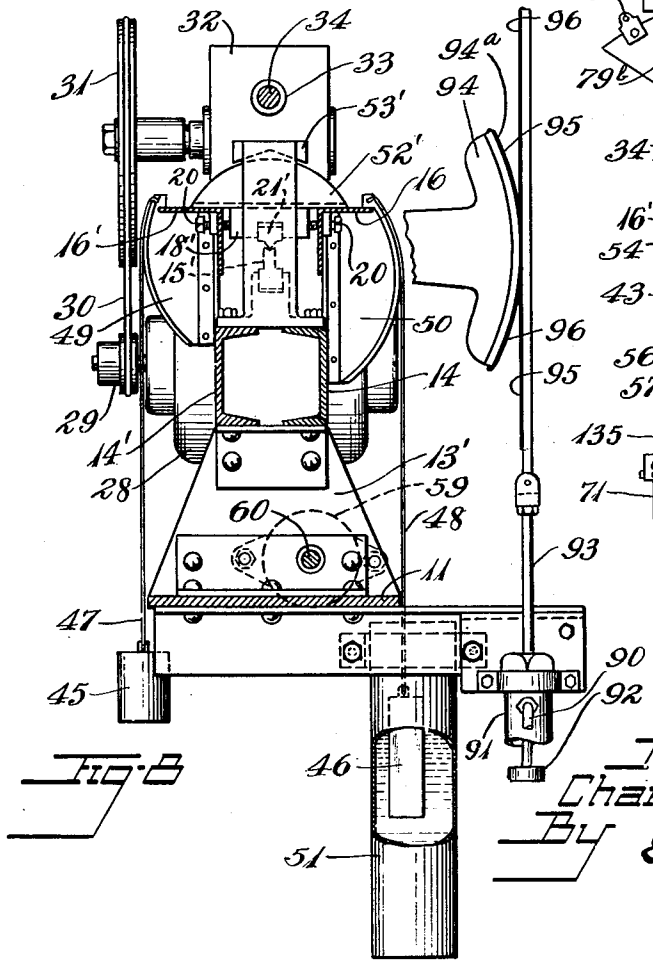



Fig-8

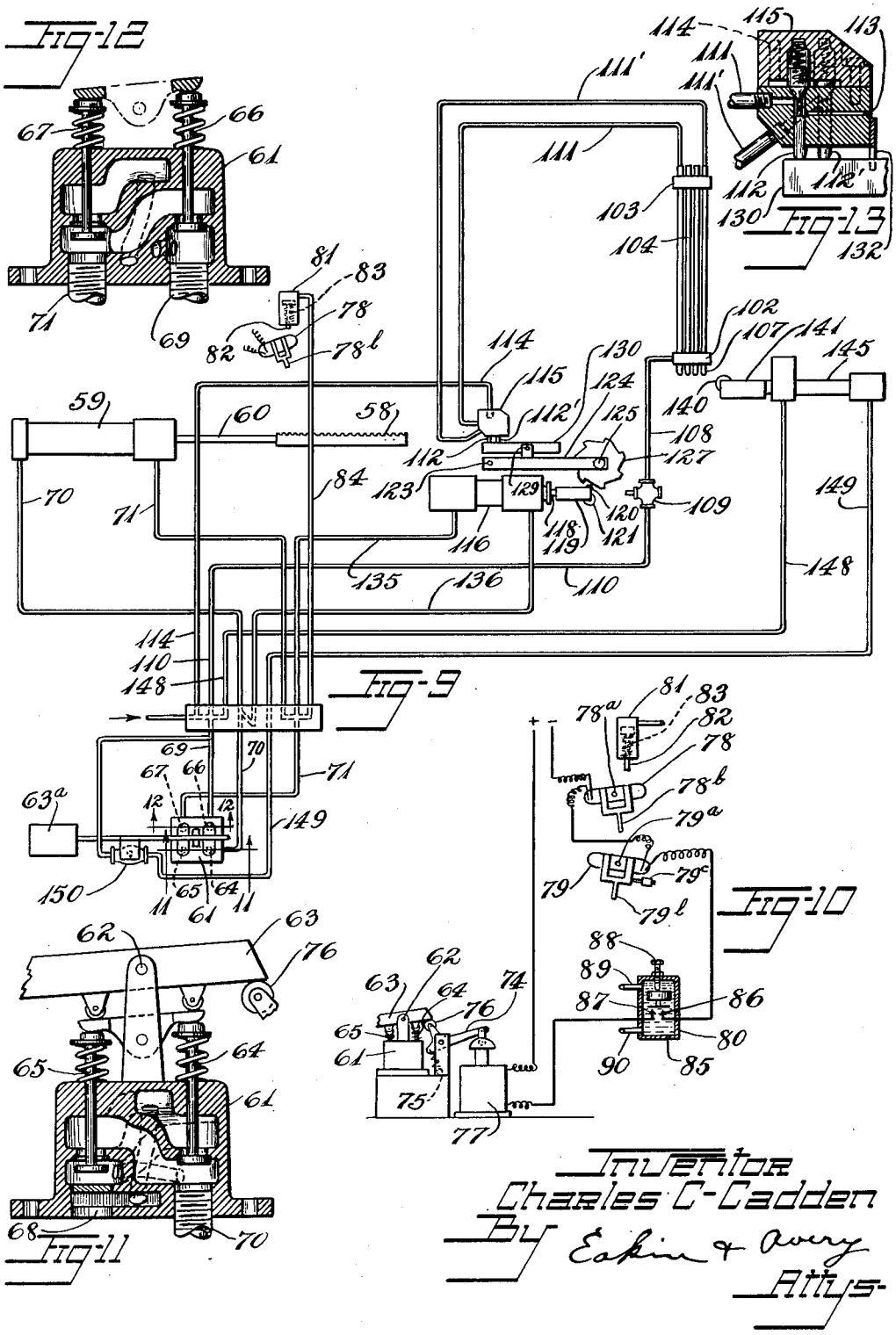



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Patented Apr. 25, 1939 2,155,528

# UNITED STATES PATENT OFFICE

2,155,528

## BALANCING MACHINE

Charles C. Cadden, Akron, Ohio, assignor to The B. F. Goodrich Company, New York, N. Y., a corporation of New York

Application July 3, 1935, Serial No. 29,667

16 Claims. (Cl. 73—51)

This invention relates to apparatus for determining the balance of annular objects and is especially useful in determining the balance of pneumatic tires.

The principal objects are to provide accuracy and efficiency in the determination of the characteristics of unbalanced forces, to provide for marking the position where mass must be added to balance the object, and to provide for automatic marking of the object at such location with the amount of the mass to be added.

Other objects will appear from the following description and the accompanying drawings.

Of the drawings:

Fig. 1 is a side elevation of the machine in its preferred form with a pneumatic tire casing thereon, parts of the tire and the machine being broken away.

Fig. 2 is a similar view of the opposite side of the machine.

Fig. 3 is a sectional detail view taken on line 3—3 of Fig. 2, parts being broken away.

Fig. 4 is a detail sectional view of one of the printing elements and its actuating mechanism, parts being broken away.

Fig. 5 is a sectional detail view taken on line 5—5 of Fig. 3, showing the construction of the printing selector mechanism, parts being broken away.

Fig. 6 is a detail sectional view taken on line 6—6 of Fig. 2, showing one of the knife edges and the beam construction.

Fig. 7 is a sectional elevation taken on line 7—7 of Fig. 2, parts being broken away.

Fig. 8 is a similar sectional view, taken on line 8—8 of Fig. 2, parts being broken away.

Fig. 9 is a diagram showing the air piping and associated mechanism.

Fig. 10 is a wiring diagram showing the electrical circuit and its controlling contact members.

Fig. 11 is a detail sectional elevation taken on line 11—11 of Fig. 9, showing the construction of one of the valves, parts being broken away.

Fig. 12 is a similar sectional view taken on line 12—12 of Fig. 9.

Fig. 13 is a sectional detail view of the valve block which controls selection of the marking plungers.

Referring to the drawings, the machine in its preferred form comprises a pedestal 10 which supports a horizontally disposed plate 11, secured thereto by bolts 12. A pair of brackets 13, 13' secured to the plate 11 at its extremities supports a pair of parallel, horizontally disposed rails 14, 14'. A pair of V-blocks 15, 15' are mounted upon the rails 14, 14' with their V-surfaces in alignment. Suitable adjusting means are provided for aligning these bearing surfaces.

The beam which supports the tire to be balanced is constructed so as to permit rotation of the tire and is preferably made as follows:

A pair of horizontally disposed rails 16, 16' are connected together in parallel spaced relation by tie-members 17, 17', to which blocks 18, 18' are secured for adjustment laterally of the beam by screws 19, (see Fig. 6) which pass through slots in the tie members. Adjusting screws 20, passing through the rails 16, 16', and bearing against the blocks 18, provide lateral adjusting means. A pair of hardened knife edges 21, 21' are held in vertical slots in the blocks 18 by screws 22 and may be vertically adjusted in said slots by means of set screws 23. A spindle 24 is fixed to the beam at the front of the machine in vertical alignment with the knife edges and preferably with its axis coincident with said knife edges. A chuck 25 for centering and supporting the annular object to be balanced is mounted in anti-friction ball-bearings 26, 27 carried by the spindle.

To provide for rotating the object on its axis, an electric motor 28 is fixed to the beam. It carries a pulley 29, which, through a belt 30, drives a pulley 31 fixed to one spindle of a speed reducing unit 32, of the worm gear type. The other spindle of the speed reducer is frictionally connected by a length of rubber tubing 33 to a shaft 34 journaled in a bearing 35 supported by the beam. Shaft 34 has fixed thereon a pinion 36 which meshes with a gear 37 carried by the chuck 25. The leads (not shown) to the motor 28 are made of flexible wire, or the terminals of the motor may dip in mercury wells to avoid friction.

While rotation of an off-balance tire or other annular object will cause the beam to oscillate and indicate off balance even with the axis of the annular object above or below the line passing through the knife edges as long as the axis is vertically in alignment with the knife edges, it has been found that when the axis of rotation of the object is coincident with the knife edges, the amount of deflection of the beam will be in exact proportion with the amount of off-balance of the object.

To provide for the testing of annular objects of different sizes, the chuck 25 may be formed with a series of concentric seating portions 25a, 25b.

In order to indicate the deflection of the beam,

the beam is equipped with a sheet metal sector 38 fixed thereto and having graduations 39 engraved on its face. A stationary frame, supported by rails 14, 14', and comprising rods 40, 40', and cross pieces 41, 42, and 43, carries a stationary index finger 44.

In order to damp the oscillations of the beam, mechanism is provided which comprises a pair of weights 45 and 46 suspended by tapes 47 and 48 from opposite ends of the beam. The tape 47 which supports weight 45 is attached to a segmental drum 49 carried by the beam and having a tape supporting face arcuate in shape and struck from the knife edges as a center, so that the moment exerted by the weight 45 is always constant.

Tape 48, which supports weight 46, is similarly attached to a segmental drum 50, attached to the beam, but this drum surface follows an Archimedean spiral so that when the beam is at zero position the moment exerted by weight 46 is equal to that exerted by weight 45, but when the sector 38 swings to the left (see Fig. 7) the moment due to the weight 46 is gradually increased and when it swings to the right is gradually reduced by an equal increment for each degree of beam deflection. To provide for further damping of the vibration of the beam the weight 46 is suspended in a cistern 51 filled with machine oil or other liquid. The liquid not only frictionally damps the vertical movement of the weight, but effectually prevents lateral swinging of the weight due to change in the leverage. As the weights 45 and 46, when the beam is at zero position, have the same radial disposition from the knife edges, weight 46 is so proportioned that its weight minus its buoyancy equals the weight of the weight 45.

In order to prevent injury to the knife edges, and to prevent shifting of the beam when an article to be balanced is placed on the device, beam-arrest mechanism is provided as follows: A pair of plates 52, 52', having arcuate upper edges, whose center of curvature is at the line passing through the knife edges, are fixed to the beam in position to engage V-blocks 53, 53', supported by rails 14, 14', when the beam is raised. A block 54, fixed to the beam, is formed on its lower side with an arcuate grooved surface of V-shaped cross-section. A jack-screw 55 is slidably journaled in a stationary sleeve 56, fixed to the rails 14, 14' below the block 54, and has a pointed end adapted to enter the V-groove therein and raise the beam from the knife edge bearings when the screw is elevated. An internally threaded pinion 57 engages the threaded jack-screw and is engaged by a rack bar 58. An air cylinder 59, of the double acting type is mounted on plate 13' and is provided with a piston and piston rod 60 to which rack 58 is attached. When air is admitted to one end of the cylinder 59 the jack screw 55 is raised and, engaging the block 54, raises the beam from its bearings. When air is admitted to the opposite end of the cylinder the jack is lowered, releasing the beam. It may be noted that the chuck 25 may be rotated continuously, independent of the beam-arrest mechanism. As the chuck is rotated at a very slow velocity (about 6 R. P. M.) articles may be placed on the device and taken off without stopping the rotation of the motor. This is important, as accurate results are obtained with constant speed of rotation and stopping and starting of the motor would not be conducive to accurate results.

While the device as just described may be used successfully, additional advantages may be obtained by additional mechanism whereby the operation of the device is made more or less automatic. Such additional mechanism may include means for automatically arresting the beam at its point of maximum oscillation and means for automatically marking the light side of the tire or other annular object, including means for automatically marking at such position on the object the amount necessary to be added to such position to balance the object.

These mechanisms are preferably operated by compressed air and the beam arrest just described is utilized not only to arrest the beam when placing an object to be balanced on the device, but also to arrest the beam at its position of maximum deflection.

To operate the beam arrest and also to supply air under compression to the other mechanisms a Ross valve 61 such as is illustrated and described in U. S. Letters Patent of Ross, No. 1,486,303 is mounted on the base of the machine. This valve comprises a casing on which is pivotally mounted, as at 62, a lever 63. This lever controls the positions of four poppet valves, 64, 65, 66, 67, which are normally spring-pressed against seats formed in the valve. The valve 61 is provided with an exhaust port 68 and a compressed air supply pipe 69, and air pipes 70 and 71 leading therefrom to opposite ends of cylinder 59. The valves are so connected that when lever 63 is in the position shown in Figs. 1, 2, 10, 11, and 12, with the pedal 63a depressed, air from the supply line may pass through pipe 70 and pipe 71 is connected to the exhaust 68, thereby causing the rack 58 to move to the right (Fig. 9) and releasing the beam. When lever 63 is moved in the opposite direction, as hereinafter described, pipe 70 is connected to the exhaust 68, and pipe 71 to the supply 69 and the beam is arrested.

A compression coil spring 72, mounted in a spring barrel 73, normally holds the lever 63 with its pedal 63a in raised position. A latch 74, urged by a tension spring 75, carries a roller 76 adapted to engage under the lever 63 in its depressed position and to hold it in such position while the beam is oscillating. A solenoid 77 is adapted when energized, as hereinafter described, to withdraw roller 76 and thereby release lever 63 whereupon, under influence of spring 72, the valve lever 63 is reversed to cause arrest of the beam.

In order to accomplish release of the lever 63 at the point of maximum deflection, regardless of the location of the heavy point on the object when the machine is started, the following mechanism is provided: Three circuit closing members 78, 79, and 80, are all arranged in series in the same circuit with the solenoid 77. (See Fig. 10.) Circuit closers 78 and 79 are pivotally mounted on bar 42 near the graduated sector 38, and are of the mercury tube type. They are pivoted at 78a and 79a respectively and are provided with depending actuating arms 78b and 79b.

Circuit closer 78 is balanced upon its pivot so as to stay in any position to which it is tipped. Circuit closer 79 is weighted, as at 79c, so as to normally close its contacts. A pin 38a, mounted on the rim of sector 38, is adapted to contact with arms 78b and 79b, and rock the circuit closers on their pivots as it contacts with them. A small air cylinder 81 is located above circuit closer 78 and encloses a piston plunger 82, adapted to be projected against circuit closer 78, to set it in open position, and a coil spring 83 to retract the plunger. An air supply pipe 84 connects the cyl-

inder 81 to the pipe 71 so that when the beam is arrested the circuit closer 78 is automatically set at open position but when the beam is set on its knife edges the circuit closer is free to rock on its pivot.

Circuit closer 80 is normally open and comprises a closed cylinder 85 in which a float is suspended above a pair of contacts 86, 87, by an insulating fluid, such as oil. An adjusting screw 88 limits movement of the float. A pair of conduits 89, 90 connect the top and bottom, respectively of the float chamber to the bottom and top, respectively, of a vertical cylinder 91. A piston 92 on a rod 93 causes the oil to circulate through pipes 89, 90 at each deflection of the beam, the oil flow in one direction (when the beam sector swings to the right in Fig. 7) causing the float to close the contacts 86, 87.

In order to actuate the rod 93 an arm 94, on the beam, has an arcuate surface 94a. Inextensible bands 95, 96, attached to opposite ends of the arcuate surface, extend therealong and are attached to rod 93 to move it, the arrangement being equivalent to a rack and sector free from back lash.

By the arrangement of three circuit closers, in series, one half of a complete revolution of the tire is assured before the beam is arrested at the proper position, no matter which way the beam is first deflected. Assuming that the beam, first swings to the right in Fig. 7, the circuit closer 78 having been left in open position, float switch 80 will be closed by the flow of fluid therethrough, and as the sector 38 moves to the right, pin 38a contacts with arms 78b, 79b, closing circuit closer 78 and opening circuit closer 79 at the same time so that the circuit to the solenoid is not completed. As the beam starts to the left, the reversal of flow of oil through chamber 80 opens that contact and contactor 79 is closed by weight 79c. Circuit closer 78 remains closed. When the beam reaches maximum deflection to the left, flow of oil in chamber 80 ceases and as the beam starts back the flow of oil reverses closing circuit closer 80 and completing the circuit through the solenoid. This releases lever 63, valve 61 is reversed so as to connect pipe 70 to the exhaust and pipe 71 to the air supply, actuating the beam arrest to stop the beam at its position of maximum deflection. At the same time air is supplied to cylinder 81 to reset circuit closer 78 in open position.

Should the beam move to the left in the first movement, as contactor 78 is open, no closing of the circuit will occur on such first movement. As the beam then starts to the right, the operations described above will follow.

In order to mark the tire at a position opposite to the point where the unbalanced mass may be considered as being concentrated, and to print the tire at this position with a designation of the degree of off-balance, the following mechanism is provided: A bracket 100 fixed to rails 14, 14', is formed with an arcuate slot 100a, concentric with the tire or other article to be tested. To this bracket, a printing device 101 is adjustably attached by bolts which enter the arcuate slot. The printing device comprises a pair of headers 102, 103 which support in closely grouped, parallel relation a plurality of air cylinders 104, each of which encloses a piston 105, a rod 106 connected thereto, and a type faced marker 107. The forward ends of the cylinders 104 are all connected through the header 102 in a single flexible tube 108, which communicates, through a whistle valve 109 and a pipe 110, with air line 69 so that entrance of compressed air to the cylinders 104 above the pistons is controlled only by the valve 109. The rear ends of cylinders 104 are connected to individual, flexible tubes 111, 111', each of which is normally connected through an individual valve 112, 112', (see Fig. 13) to the atmosphere through a vent 113 and may, by movement of such valve, be connected to a common air line 114 communicating with pipe 69. Valves 112, 112' are mounted in close arrangement in a valve block or manifold 115 below which all of the valve plungers project. Each valve 112, 112', comprises a cylindrical body, a conical head, and a reduced neck therebetween. Each valve is held seated in an individual seat in block 115 by an individual coil spring with its conical head shutting off communication between the common air passage 114 and its pipe 111, 111', and its reduced neck portion permitting communication between its pipe 111, 111', and the common passage 113, open to the atmosphere. For compactness the valves are arranged in two rows as shown. The arrangement is such that as each valve is raised against its spring, its stem closes communication between passage 113 and its pipe 111, 111', and opens communication of such pipe to the common air passage 114.

Means are provided for simultaneously operating a plurality of the valves selectively depending upon the mass effecting off-balance of the tire. The selector mechanism is as follows: An air cylinder 116 of the double acting type, encloses a piston 117, connected to a piston rod 118, carrying a cross-head 119. Cross head 119 carries a pair of anti-friction rollers 120, 121. Roller 121 is adapted to support and guide the head along suitable guides 122. The cylinder is mounted on bracket 100. Mounted upon the same bracket is horizontally disposed pin 123. A pair of arms 124, 124' are pivoted at one end on the pin 123, and their free ends support a shaft 125 on which a pair of ratchet wheels 126, 127, are rotatably mounted but fixed to each other.

A pawl 128 pivoted to arm 124 engages ratchet wheel 126 and permits rotation only in a clockwise direction (see Fig. 3). Arms 124, 124' rest on a pin 100b in position to be lifted by contact of roller 120, the arrangement being such that when the cross head is projected away from the cylinder, roller 120 raises arm 124, the ratchet wheel resisting rotation and acting as a cam, and during retroaction of the cross head, roller 120 engages a tooth of ratchet wheel 127 causing rotation thereof without raising arms 124, 124'. Arms 124, 124' also support a shaft 129 on which a plurality of arms 130 are pivoted individually. Each arm 130 has one end underlying a valve 112 and its other end supporting a pawl 131. Arms 130 are guided by a comb 132 fixed to valve body 115, and each pawl is guided through a similar comb 133.

Fixed to the beam of the device are a plurality of sectors 134, each of which is directly above a pawl 131. The arcuate edges of these sectors are formed with teeth 134a with intervening or flanking spaces. If one of the pawls 131 engages the top of a tooth 134a when arm 124 is raised, its opposite end will raise a corresponding valve 112 admitting air to its corresponding cylinder 104 and causing the type fitted plunger 107 to be projected against the article being tested. If, however, the pawl fails to be below a tooth

134ª when arm 124 is raised the corresponding valve will not be operated.

Sectors 134 have their teeth so arranged that a single tooth on one is over the pawl when the beam deflection is that due to one inch-ounce of unbalanced mass, a single tooth on another corresponds to two inch ounces deflection, etc. Another sector has a tooth for each half inch ounce position with spaces therebetween. Still another sector has teeth corresponding to each odd fractional deflection by one-quarter inch ounce. The pistons 107 are equipped with corresponding type numerals.

In order to retract the type plungers 107, valve 109, previously described, is so mounted upon bracket 100 that when cross-head 119 is advanced to its limit it contacts with the whistle valve plunger admitting air simultaneously to the cylinders 104 at their forward ends.

Cylinder 116 is operated as follows: A pipe 135 is connected to the rear end of the cylinder and supplies air from pipe 71 so that cross-head 119 is projected simultaneous with arrest of the beam. This assures printing of the off balance mass on the article being tested when the beam is at rest at the position of greatest deflection. A pipe 136 connects the forward end of cylinder 116 to pipe 70 so that retraction of cross-head 119 is simultaneous with release of the beam.

Means are provided for inking the type faces of the printing plungers as follows: An inking roller 140 is rotatably mounted in a carriage 141 adapted to slide upon rails 142. Pinions 143, 143' fixed to the ink roll engage racks 144, 144' mounted along the rails 142 and insure rotation of the ink roll as it passes over the type. A cylinder 145 mounted upon bracket 101 encloses a piston 146 connected to carriage 141 by a piston rod 147. A pipe 148 connects the forward end of the cylinder to air line 69, so that this end of the cylinder is always under pressure. A pipe 149 connects the rear end of the cylinder through a whistle valve 150 to air line 69. Due to difference in area of the two sides of the piston, the piston rod being large as compared to the cylinder bore, when air is admitted to both sides of the piston, the unbalanced pressure advances the piston causing the ink roller to pass over the type. The whistle valve 150 is located beneath the lever 63 so that when the treadle 63ª is depressed it momentarily opens the whistle valve and advances the ink roller over the type. When the operator's foot is removed lever 63 raises until it contacts with roller 76, but this is sufficient to close the whistle valve and the inking mechanism is then retracted.

In the operation of the machine with the beam arrested and the article supporting spindle rotating at a very slow velocity, preferably about 6 R. P. M., a tire or other article to be balanced is placed on the chuck 25. Treadle 63ª is then depressed momentarily causing the ink roll to apply ink to the type, retracting the cross head 119, and simultaneously releasing the beam. The latch 74 locks the treadle lever 63 in this position and the beam proceeds to oscillate with the tire or other article rotating at a constant velocity. When the maximum point of deflection of the beam is attained the closing of the electric contacts, as heretofore described, actuates the solenoid 77 and spring 72 raises the treadle lever. This causes immediate arrest of the beam and simultaneous advance of the cross-head 119, thereby opening certain of the valves 112 as determined by the amount of deflection of the beam. The marking plungers are projected against the tire or other object and are immediately retracted as the cross head 119 opens the valve 109. As the cross head 119 is advanced, the contactor 78 is automatically reset for the next article to be tested.

I claim:

1. Apparatus for determining the characteristics of an unbalanced force affecting balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on an axis coincident with the axis of oscillation of the beam, means including an element attached to the beam for indicating the deflection of the beam due to the unbalanced force, and means actuated by movement of said element for arresting the beam at its deflected position.

2. Apparatus for determining the characteristics of an unbalanced force affecting balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on an axis parallel to and in the vertical plane of the fulcrum of the beam at a uniform velocity, means including an element attached to the beam for indicating the deflection of the beam due to the unbalanced force, and means actuated by movement of said element for automatically arresting the beam at its deflected position.

3. Apparatus for determining the characteristics of an unbalanced force affecting the balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on an axis coincident with the axis of oscillation of the beam at a uniform velocity, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, and means actuated by movement of said element for automatically arresting the beam at its deflected position.

4. Apparatus for determining the characteristics of an unbalanced force affecting balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on its axis, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, means actuated by movement of said element for automatically arresting the beam at its deflected position, and means also actuated by movement of said element for automatically marking the object to indicate the position where added mass is required to balance the object.

5. Apparatus for determining the characteristics of an unbalanced force affecting balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on an axis coincident with the axis of oscillation of the beam, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, and means actuated by movement of said element for automatically marking the object to indicate the position where added mass is required to balance the object.

6. Apparatus for determining the characteristics of an unbalanced force affecting the balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on an axis coincident with the axis of

oscillation of the beam at a uniform velocity, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, means actuated by movement of said element for automatically arresting the beam at its deflected position, and means also actuated by movement of said element for automatically marking the object to indicate the position where added mass is required to balance the object.

7. Apparatus for determining the characteristics of an unbalanced force affecting balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on its axis, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, means actuated by movement of said element for automatically arresting the beam at its deflected position, means also actuated by movement of said element and controlled by the amount of deflection of said beam for automatically marking the object to indicate the position where added mass is required to balance the object and the amount of such mass.

8. Apparatus for determining the characteristics of an unbalanced force affecting balance of a rotatable object about its axis, said apparatus comprising a balanced beam, means carried thereby for supporting and rotating the object on an axis coincident with the axis of oscillation of the beam, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, means actuated by movement of said element and controlled by the amount of deflection thereof for automatically marking the object to indicate the position where added mass is required to balance the object and the amount of such mass.

9. Apparatus for determining the characteristics of an unbalanced force affecting the balance of a rotatable object about its axis, said apparatus comprising a balance beam, means carried thereby for supporting and rotating the object on an axis coincident with the axis of oscillation of the beam at a uniform velocity, means including an element attached to said beam for indicating the deflection of the beam due to the unbalanced force, means actuated by movement of said element for automatically arresting the beam at its deflected position, means also actuated by movement of said element and controlled by the amount of deflection thereof for automatically marking the object to indicate the position where added mass is required to balance the object and the amount of such mass.

10. Balancing apparatus comprising a balance beam supported for response to the unbalanced force of an off-balance article rotatably associated therewith, means for indicating the deflection of the beam, and means controlled by the swing of the beam for automatically arresting the beam at a determinate position in its deflection.

11. Balancing apparatus comprising a balance beam structure responsive to the unbalanced force of an off-balance article rotatably associated therewith, a support for the beam structure including a fulcrum and bearing and means for arresting the beam structure at varying positions in its deflection, said means comprising a stopping surface and means controlled by the swing of the beam structure for automatically separating the fulcrum from its bearing and engaging a part of the beam structure with the stopping surface.

12. Balancing apparatus comprising a balance beam, means including a fulcrum and bearing therefor for supporting the beam, and means controlled by the swing of the beam for automatically separating the fulcrum from its bearing at a determinate position in the swing of the beam.

13. Balancing apparatus comprising a balancing device responsive to the unbalanced force of an off-balance article rotatably associated therewith, means for rotatably supporting an article for such response, and means controlled by the balancing device for automatically marking the article to indicate its position of off-balance and the amount thereof.

14. Balancing apparatus comprising a balancing device responsive to the unbalanced force of an off-balance article associated therewith, means for rotatably supporting an article for such response, means for indicating the amount of off-balance of the article, means controlled by the balancing device for arresting the indicating means at the position of maximum deflection thereof, and means for automatically delaying the operation of the arresting device until the object has rotated at least one-half revolution.

15. Balancing apparatus comprising a balancing device responsive to the unbalanced force of an off-balance article rotatably associated therewith, means controlled by the balancing device for automatically registering the amount of off-balance of the article, and means also controlled by the balancing device for automatically marking the article to indicate thereon the amount of off-balance thus registered and the position thereof on the article.

16. Balancing apparatus comprising a balancing device responsive to the unbalanced force of an off-balance article rotatably associated therewith, means for rotatably supporting an article for such response, a plurality of movable printing elements for marking on the article the amount of off-balance, and selector means controlled by the deflection of the balancing device for selectively moving said printing elements to the article to mark the same with the amount of off-balance.

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