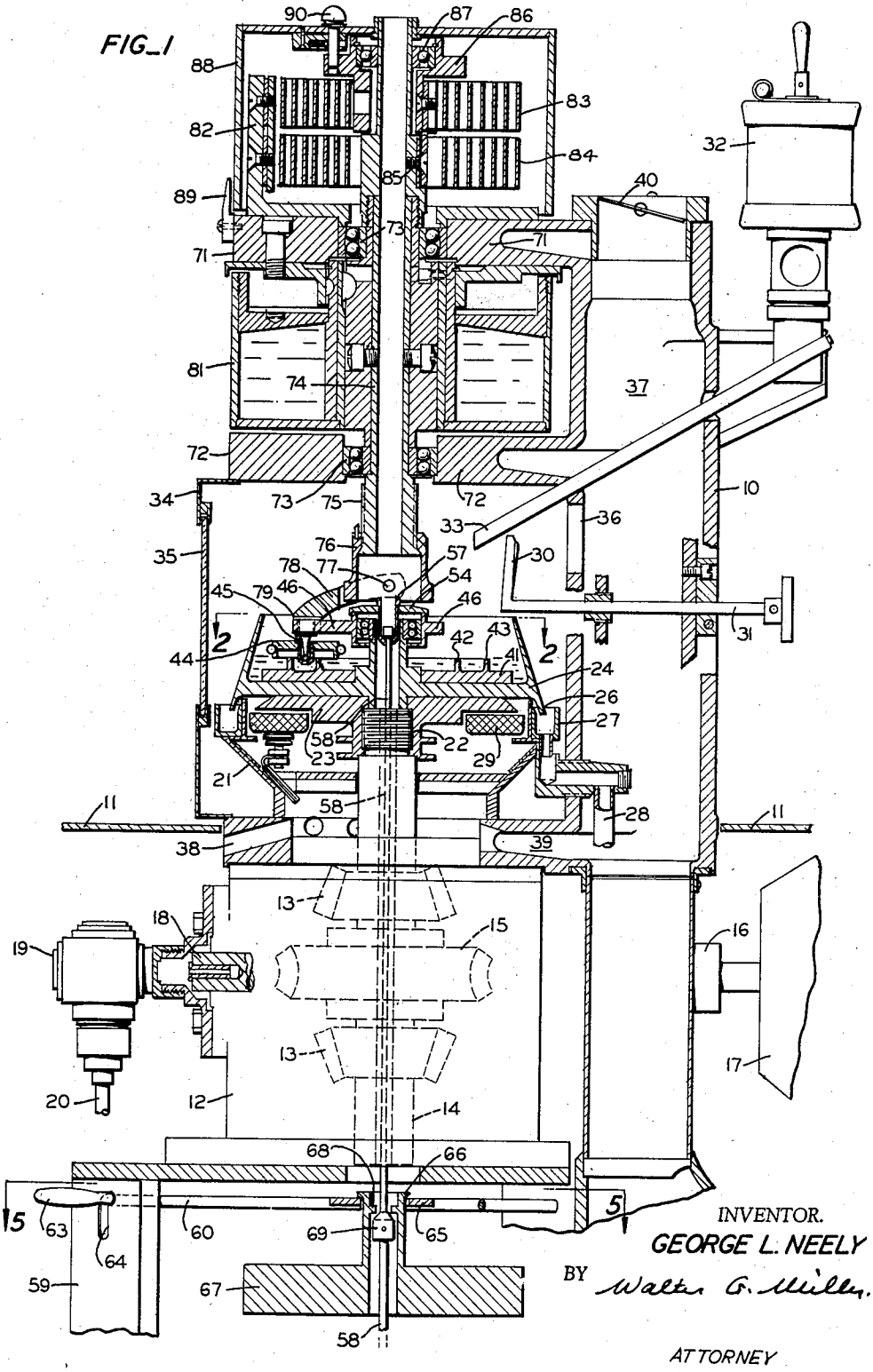
Oct. 20, 1959 G. L. NEELY 2,909,056

KINETIC OILINESS TESTING MACHINE

Filed May 20, 1958 3 Sheets-Sheet 1

FIG_1



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KINETIC OILINESS TESTING MACHINE

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FIG_2

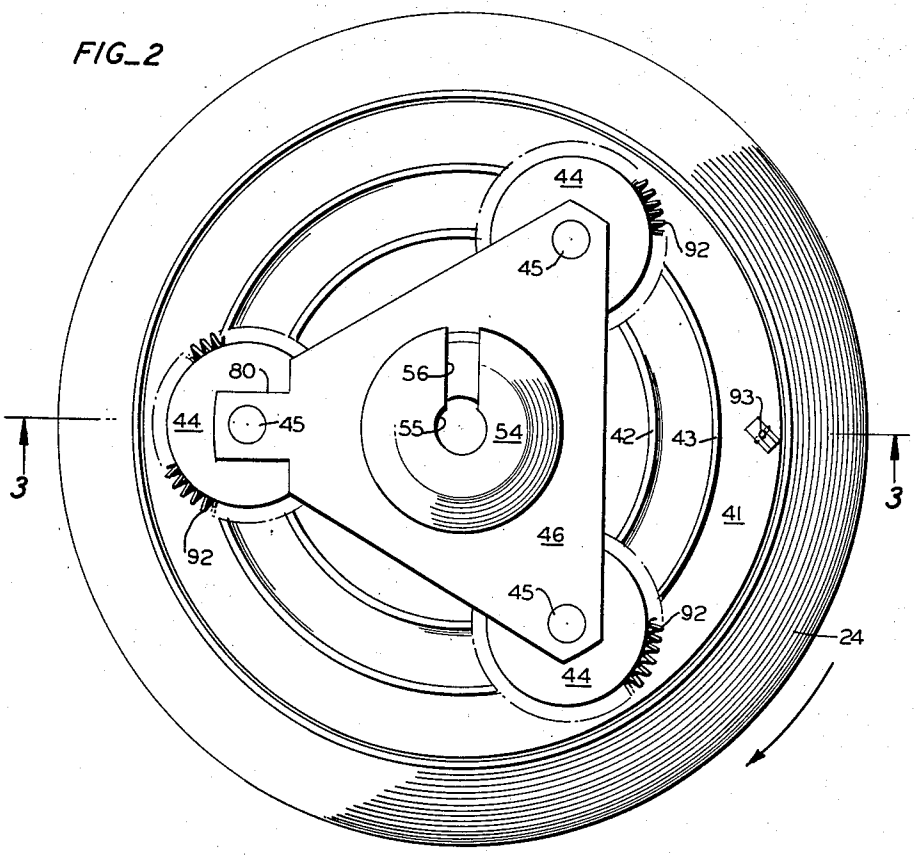


FIG_3

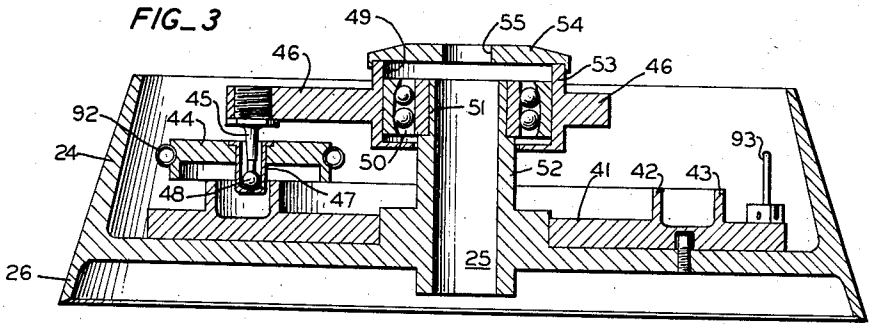
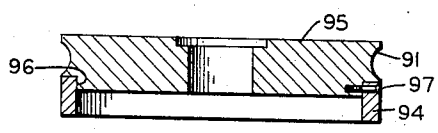


FIG_4



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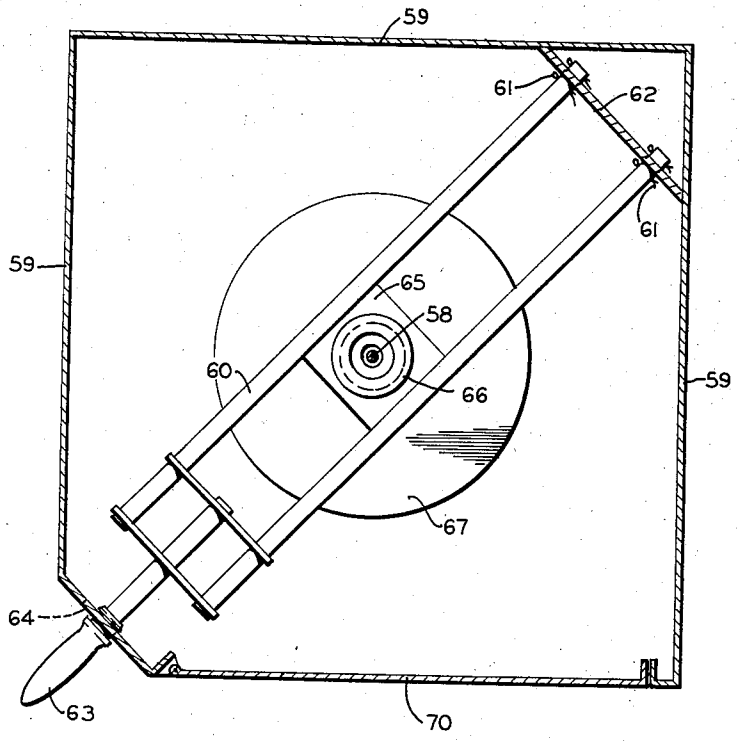
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Oct. 20, 1959 G. L. NEELY 2,909,056

KINETIC OILINESS TESTING MACHINE

Filed May 20, 1958 3 Sheets-Sheet 3

FIG_5



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United States Patent Office

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KINETIC OILINESS TESTING MACHINE

George L. Neely, Berkeley, Calif.

Application May 20, 1958, Serial No. 736,555

13 Claims. (Cl. 73—10)

This invention relates to a friction or wear testing machine and particularly to one which is adapted to test the oiliness of a lubricant under controlled conditions of rubbing materials, speed, temperature, and pressure, and in a manner that avoids consideration of the effect of viscosity of the lubricant, and has for a principal objective an improved arrangement of parts that will place the load-varying weights below the heated rubbing surfaces and also will insure continuous rotation of the friction elements under all speed and load conditions.

It is an improvement over the devices of my earlier joint patent with E. E. Edwards, No. 2,020,565, dated November 25, 1935, entitled "Friction Testing Machine," and the disclosure of that patent is incorporated herein by reference. Essentially, the earlier arrangement consisted of a vertical frame, at the lower end of which was a horizontal, variably rotatable annular metal friction element or plate having two upstanding narrow tracks concentric with the axis of rotation of the friction element. Means were provided for heating the friction element and the lubricant covering the tracks. A stationary vertical solid column or spindle extended upwardly through the annular plate and was provided with a bearing for an upper circular plate having three downwardly extending pivot bearings. Between each of the pivot bearings and the two upstanding concentric tracks on the lower plate was a downwardly concave friction button whose lower rim rested flat on the tracks and was rotated by the unbalanced torque induced by the friction between the circular rim and the rotating track surfaces.

In the previous arrangements of Patent 2,020,565, adjustments in weight or load on the upper annular plate and friction buttons, to vary the force exerted by the buttons through the lubricant film against the tracks, were made by manually placing separate metal disc weights in a pile on top of the upper plate. In one embodiment the torque or drag of the buttons due to the frictional contact with the lower rotating track was transmitted upwardly through a central frame, loosely pinned or keyed to the upper plate, to be resisted by a radial leaf spring acting against a stationary outer column. In the other embodiment of the previous arrangements, the upper plate, carrying the friction buttons, was positively rotated, and the lower track was supported in a lower bearing and also was restrained from rotation by a radial leaf spring. In both arrangements, however, the loading weights were above the friction buttons and the mounting means therefor, and were also in the heated zone above the lubricant. Under conditions of lubricant testing involving high temperatures 400° to 800° F., it was difficult to make changes in weights without protective gloves and awkward weight-handling equipment.

In addition, to change or to clean friction buttons or the plate carrying the concentric tracks on which they rubbed, it was necessary to practically dismantle the entire machine, which was time-consuming. Also, and particularly in the first-named embodiment described above, the least misalignment of the central bearing for the upper annular plate carrying the friction buttons would cause the superposed pile of weights to wobble and sway and resulted in uneven weight distribution on the buttons and indication of the machine.

The present invention has been developed and demonstrated to avoid the difficulties just enumerated, and, in addition, to be much more versatile in the ranges of loads that may be imposed, as it is adapted to utilize weights that are separately controllable and mounted below the operating surfaces, away from the heated and vaporized lubricant zones. In addition, means have been provided for variably and controllably resisting the torque produced by the drag of the friction buttons on the tracks, particularly at low relative speeds of track and button rotation. Furthermore, a greatly simplified means has been provided for insuring individual rotation of the concave friction buttons around their individual axes, as will be further apparent below.

It is an object of this invention to provide a simplified arrangement of a kinetic oiliness testing machine, to render it more sensitive and readily controlled, and also to facilitate assembly and disassembly of the friction elements as is frequently required for cleaning when different lubricants are tested in succession.

Another object is to provide a kinetic oiliness testing machine in which the friction elements are enclosed to be usable in a controlled gas atmosphere, and with provisions for venting the enclosure to remove gas or vaporized lubricant to an exhaust system.

These and other objects and advantages will be further apparent from the following description and the attached drawings, which form a part of this specification and illustrate a preferred embodiment of the invention.

In the drawing,

Figure 1 is a vertical sectional view of the principal parts of the improved device in their assembled and operative relations.

Figure 2 is a plan view on line 2—2 of Figure 1, showing the subassembly of the load-imposing head resting on the friction buttons in place on the annular track, with the improved button rotation-inducing means.

Figure 3 is a vertical sectional view on line 3—3 of Figure 2 showing the relation of the buttons, track and lubricant-retaining cup.

Figure 4 is a vertical sectional view of an alternative arrangement of a friction button body with a rim of different material secured thereto.

Figure 5 is a horizontal sectional view on line 5—5 of Figure 1, illustrating a preferred arrangement of the uppermost of a plurality of weight-imposing and weight-releasing means for the rod which extends downwardly from the load-carrying head.

Referring to the drawings and particularly to Figure 1, reference numeral 10 designates a vertical hollow metal support column projecting upwardly through a horizontal plate 11, which forms the top of a housing for the drive mechanism and loading weight accumulating means of the machine. At one side of column 10 below plate 11 is a conventional worm gear housing 12, in which are upper and lower bearings 13 for a vertical hollow shaft 14 to which is secured a worm gear 15. At one side of gear 15 is a horizontal shaft 16, adapted to be rotated by a variable speed drive mechanism generally designated 17, with an appropriate worm engaging worm gear 15. Alternatively, helical or spur gear reductions could be used for this purpose. This outer end 18 of shaft 16 is provided with a speed indicator connector 19, having a shaft 20 leading to a conventional speed indicator of any desired type, to indicate the rate of rotation of shaft 16,

and more particularly that of vertical shaft 14 and its associated friction elements.

The top of vertical hollow shaft 14 projects upwardly through an outwardly diverging cone 21, which forms the floor of a heating chamber, and is right-hand threaded at 22 to a circular base plate 23 on which rests a frusto-conical metal cup 24, having a central bore 25 aligned with the bore of hollow shaft 14. Cup 24 is also provided with an outwardly and downwardly tapering skirt 26 extending into an annular lubricant overflow trough 27, from which excess lubricant may be conducted through conduit 28 to any suitable disposal means.

An annular electric heating element 29 surrounds the lower outer face of base plate 23 to heat the friction elements and the lubricant being tested. Element 29 is supplied with electric current from any suitable source under the control of conventional means responsive to a thermocouple element 30, which is slidably and rotatably mounted on a horizontal rod 31 to be selectively immersed in lubricant inside of a frusto-conical cup 24. In Figure 1, the thermocouple element is shown in its retracted or withdrawn position, for convenience of illustration. At one side of support column 10 there is positioned a drip feed oiler 32 with an outlet conduit 33 to supply lubricant to the friction elements in cup 24, which will be described in further detail below.

Desirably, the heating chamber formed by cone 21 and the frusto-conical cup 24 with its associated friction elements are enclosed by a vertically hinged metal shield generally designated 34, provided with a transparent viewing window 35, and an electric light (not shown) so that the operation of the friction elements may be observed. Under conditions of high temperature operation, sufficient lubricant may be vaporized to cause objectionable fumes, which are exhausted from the housing through ports 36 and the space 37 within hollow column 10 by a suitable blower exhauster. Ports 38 below the heating chamber admit cooling air from the housing below plate 11 and serve to cool shaft 14 and its gears. This is also vented through ports 39 to space 37. The reduced pressure in space 37 may be controlled by butterfly valve 40 at the top of column 10.

Resting on the upper face of cup 24 and keyed to it so as to be rotated by hollow shaft 14 is a circular plate or friction element 41, having an upstanding inner track 42 and an upstanding outer track 43, of the predetermined material, e.g., cast iron, bronze, steel, or the like, whose frictional or wear properties are desired to be investigated under controlled conditions in connection with a specific lubricant. Reference may be made to my earlier Patent No. 2,020,565 for a detailed discussion of the characteristics and graphic layout of these tracks and the three friction buttons generally designated 44 which co-operate with them. Each button is adapted to rotate about a downwardly extending pin 45 secured in loading head 46, spaced equally around a circle which lies between tracks 42 and 43 as shown. Desirably, each button has a downwardly extending hardened steel bearing cup 47 having a 120° concave seat for an anti-friction element such as a miniature ball bearing or, as in this case, a polished steel, Carboloy, or synthetic sapphire ball 48. To retain the ball in place, the bottom of pin 45 also has a 120° cancave seat of hardened steel. It is advantageous to have the center of the ball 48 substantially in the plane of contact of tracks 42 and 43 and buttons 44, as shown in Figure 3.

For this disclosure, and referring specifically to Figures 2 and 3, it is believed adequate to state that the diameters of the tracks 42 and 43 of the diameter of the button 44 should be such that the four coplanar areas of contact between each button and the two tracks are equally loaded, of substantially the same area, and well separated to facilitate a plane contact and proper rotation of the buttons. Following is a table of actual dimensions which have been found to be satisfactory.

	Inches
Outside diameter inner track 42	2.990
Inside diameter inner track 42	2.882
Outside diameter outer track 43	4.000
Inside diameter outer track 43	3.875
Outside diameter button rim 44	1.250
Inside diameter button rim 44	1.125
Diameter of circle for pins 45	3.250

The center of loading head 46 (Figure 3) is provided with a cylindrical recess 49 for an anti-friction bearing 50, preferably a self-aligning ball bearing, the latter being supported in an appropriate groove 51 at the upper end of the inner hollow boss 52 of the frusto-conical cup 24. The inner face of recess 49 is smoothly finished so that bearing 50 will freely assume a position in the recess at such a point that loading head 46 is merely aligned to be coaxial with friction element 41 and cup 24 and will not transmit any appreciable upward or downward force to cup 24. Extending upwardly around recess 49 of loading head 46 is a circular rim 53 on which is accurately centered a cap 54 provided with a central bore 55, from one side of which is a transverse slot 56 extending to the periphery of the cap. A hollow thimble 57 is adapted to seat in bore 55 and to support the outwardly beveled head of a loading rod 58 which extends freely downwardly throughout the bore 25 of cup 24 and also throughout and below the bore of shaft 14. Sufficient travel is provided for rod 58 so that when it is lifted slightly, thimble 57 may be lifted from its seat in bore 55 and cap 54 may be moved sideways out of engagement with the rim 53 of loading head 46, while thimble 57 remains in place at the upper end of the rod. This will permit the loading head 46, friction buttons 44, and friction element 41 to be removed from cup 24, or if desired, the entire lubricant cup 24 and its contents removed from base plate 23 for cleaning, inspection, or replacement.

Below gear housing 12 there are provided a plurality of vertically superposed weight control means (Figure 5) of identical construction and constituting a graded series of weights which may be selectively coupled to rod 58 or detached therefrom, as will now be described. A generally square sheet metal frame 59 extends downwardly below housing 12 and, at the level where each weight is to be supported, is provided with a weight-lifting frame 60, each pivoted at 61 to a horizontal rod 62 and having an outwardly extending handle 63, the latter projecting through an inverted J-slot 64 in the outer corner of frame 59. An apertured plate 65 is placed in each lifting frame 60 and supports the outwardly beveled upper end of hollow sleeve 66 secured to each weight 67. Within each sleeve 66 is an internal flange 68 which is adapted selectively to rest upon a tapered sleeve 69 pinned to loading rod 58, when that lifting frame handle 63 is lowered to the bottom of its inverted J-slot. This transmits the downward force of each weight to the loading rod 58. To raise the weight 67 from the rod 58, the handle 63 is lifted and moved sideways into the laterally offset portion of the slot, as shown in Figure 1, thus lifting the weight 67 and disengaging flange 68 from the sleeve 66 of loading rod 58. By appropriate selection of combinations of weights 67 controlled by the several superposed weight control means, the loading rod 58 will exert the desired downward force upon head 46 and, through pins 45 and ball bearings 48, upon buttons 44, to the lubricant on friction element 41. Desirably, a door 70 is provided at one side of frame 59 to provide access to weights 67 and rod 58.

Referring now to Figure 1, there will be described the torque or friction drag indicating means at the top of the machine, aligned with and above the friction element, buttons, and loading head just discussed. The support for these means comprises a pair of brackets 71 and 72 extending transversely from the vertical support column

10, and each provided with an anti-friction bearing 73 for a rotatable hollow shaft 74. The lower end of the shaft has a left-hand thread 75 for a collar 76, to which is pivoted at 77 a forked or bifurcated arm 78, the outer end 79 of which is selectively movable vertically about pivot 77. The outer end 79 of arm 78 is also bifurcated and is adapted to be dropped downwardly to straddle the squared portion 80 of loading head 46 (Figure 2) and to transmit torque from head 46 to shaft 74. When collar 76 is loosened and rotated to lift arm 78, sufficient vertical clearance is provided above head 46 and cap 54 to disengage loading rod 58 (after the weights 67 have been lifted out of engagement with that rod) by the procedure given above, so that the friction element and buttons, or cup 24 and its entire contents, may be taken out of the machine for cleaning, inspection or replacement.

Above the lower bracket 72, and secured between the stationary bracket and shaft 74, is a conventional movable vane-type adjustable oil-filled dashpot generally designated 81 for absorbing oscillations of shaft 74 due to varying friction conditions in the rubbing surfaces to which it is selectively connected as just described. The details of this dashpot form no part of this invention, and, as such devices are well known in measuring instruments, needs no description herein.

Above the upper bracket 71 is mounted a spring support bracket 82 to which the outer ends of two substantially identical spiral steel springs 83 and 84 are secured. The inner end of the lower spring 84 is secured at 85 to the hollow shaft 74. The inner end of upper spring 83 is secured to a bushing 86 journalled by an anti-friction bearing 87 to the top of shaft 74. A hollow indicating drum 88 is secured to the upper end of shaft 74 and encloses both springs 83 and 84, the drum being free to move through the same degree of rotation as does shaft 74 under the restraint of spring 84 and dashpot 81. Under conditions of light loads on the friction surfaces, the single spring 84 is adequate to exert a resilient restraining force on shaft 74 and keep its rotation from exceeding the circumference of drum 88. Angular movement of that drum is indicated by an appropriately graduated scale around its lower edge, as related to an indexing marker 89 on the outer end of upper bracket 71.

When heavier loads or friction and lubrication conditions require, the second or upper spring 83 may be connected in parallel with spring 84, just discussed, by a spring restrained detent member 90 in the top of drum 88, which selectively engages the bushing 86 and the drum 88 and makes both springs effective to resist rotation of shaft 74.

The operation of the arrangement just described is believed to be clearly apparent to one skilled in this art from the foregoing description and the attached drawings. It has been found to give a much wider range of operating conditions and more reproducible and accurate results than the devices of my previously issued Patent 2,020,565. Generally, it will be found that the friction buttons 44 will be continuously rotated by the relative friction forces exerted upon them by the continuously rotating tracks 42 and 43 on friction element 41. With the dimensions given above, it will be found that the track will make about three revolutions for each revolution of the friction buttons.

Under some circumstances, however, the buttons 44 may fail to rotate, due to slight imperfections or burrs at their edges, extreme loading, or other causes. In order to prevent the sliding and damage that would then occur, it is desirable to provide them with a concave groove 91 (Figures 3 and 4) into which may be freely snapped or tightly secured an encircling helical wire spring 92 of such resiliency that its adjacent turns will be slightly spaced apart to form resilient loops as shown. At one side of friction member 41, outside of tracks 42 and 43, at an appropriate radius, is placed a horizontally

pivoted pin 93, which may be selectively stood upright, as shown, or pivoted to lie horizontally. In its upstanding position, pin 93 will engage the outer edge of one or more passing loops of spring 92 and thereby urge the button 44 on which it is mounted to rotation about its bearing pin. The curvature of the circular spring and the angularity of the adjacent wire loops will be found to permit smooth and shock-free impulses to rotation, without stubbing or tendency to sidewise displacement of the buttons 44. These latter may be of a single piece of the desired material, e.g., cast iron, bronze, plastic, steel, or the like, but it may also be desirable, as in Figure 4, to make the rim 94 of a different material than the body 95, as by shrinking or pressing it into a circumferential groove 96, and retaining it by a pin 97. This is particularly true if a hard and brittle material, such as Carboloy, is to be used.

Although three circumferentially spaced rotatable buttons are described in this illustrative example, it will be apparent that a greater or lesser number could be used so long as at least one is provided to be positioned with its rim in contact with both tracks of the rotating friction element so as to be rotated thereby about its own central bearing. This bearing is necessarily displaced radially from the axis of rotation of the friction element, as will be apparent from Figure 1, so that the frictional drag between the button and the tracks, in the presence of the lubricant, will tend to impart a measurable torque or angular rotation to the button positioning means. This latter means is also adapted to impose a controlled downward force on the button and is desirably connected by a horizontally pivoted radial arm to the torque opposing means which is coaxial with the rotating friction element. The load imposing weights are preferably outside of and below the heated zone or chamber in which the friction element, button or buttons, and the lubricant are positioned. Obviously, if only one button is used, the same unit loading on the tracks could be imposed by fewer or smaller weights than if more were employed, as in this example.

In conclusion, it will be understood that, while a single example of this invention has been illustrated and described, numerous modifications and changes could be made without departing from its essential features. Accordingly, all such changes that come within the scope of the appended claims are intended to be embraced thereby.

I claim:

1. An oiliness testing machine comprising a rotating friction element provided with two annular tracks, lubricant supply means for said friction element and said tracks, means for contacting three equally spaced, independently axially rotatable circular friction buttons on said tracks, said last-named means comprising a rotatable head aligned with the axis of rotation of said friction element and having an axial bore, elongated means seated in said bore and extending downwardly below said rotating friction element, means for selectively adding and subtracting weights to said elongated means beneath said friction element to vary the contact pressure between said friction buttons and said tracks, means for indicating the torque imposed upon said head by said buttons, a frusto-conical cup surrounding said friction element, and a trough beneath the lower outer edge of said cup to receive excess lubricant passing over the top and outer face of said cup.

2. An oiliness testing machine according to claim 1 with the addition of temperature responsive means adapted selectively to be positioned in lubricant retained inside of said cup and outside of said tracks.

3. A kinetic oiliness testing machine comprising a continuously rotatable friction element provided with two upwardly extending annular tracks, means for controllably rotating said element, a plurality of friction buttons, each having a downwardly directed rim, means

journalled on said rotating element for rotatably positioning each of said buttons with its rim in contact with both of said tracks at a predetermined distance from the axis of rotation of said element, a resilient helically coiled member encircling each of said buttons, and an upstanding pin on said element outside of said tracks adapted successively to engage the coils of said helical members to impart rotation to said buttons about their axes.

4. A friction button for a kinetic oiliness testing machine having a rotatable friction element provided with annular tracks and a pin carried by said element adjacent the outermost track, said button comprising a circular body portion having an axial bore for receiving a bearing element, an outer rim extending from one face of said circular body, to contact said tracks, and means providing a succession of resilient loops surrounding said body and adapted to be engaged periodically by said pin for imparting rotation of said button about its bearing element.

5. A friction button according to claim 4 in which said rim is of a different material than said body and is secured against relative rotation in a groove in one side of said body.

6. A friction button according to claim 4 in which said last-named means is a helical spring removably mounted in a concave groove encircling said body.

7. A friction button according to claim 6 in which said helical spring comprises a resilient metal wire under sufficient tension to retain it in said groove on said button.

8. A friction testing machine comprising a vertically journalled gear having a hollow shaft, variable speed means for rotating said gear, a rotatable friction element removably mounted on the upper end of said shaft, two circular tracks on said element, a removable head journalled at the top of said element, a plurality of concave friction buttons journalled at equally spaced circumferential positions on said head, each button having a downwardly directed rim adapted to engage the top of said tracks, torque indicating means aligned with the upper end of said hollow shaft, a coupler for selectively connecting said torque indicator to said head, said coupler being retractable upwardly to permit removal of said friction element, a rod selectively engageable at its upper end with said head, and extending downwardly throughout and below said hollow shaft, and means for selectively loading the lower portion of said rod.

9. A friction testing machine according to claim 8 with the addition of a lubricant feed means for said tracks and said buttons, a heater for said friction element and the lubricant thereon, a housing surrounding said friction element, head, buttons and coupler, and means for controllably withdrawing gaseous materials from said housing.

10. An oiliness and friction testing machine comprising a friction element rotatable about a vertical axis and having concentric tracks on its upper surface, means for rotating said element, coaxial torque indicating means above said element, at least one concave friction button having a downward directed rim adapted to engage the top of said tracks, said button being rotatable about a central bearing, means for imposing a downward force on said bearing and for positioning said button with respect to said tracks, and horizontally pivoted means connecting said torque indicating means to said force imparting means, for transmitting the frictional drag between said button and said tracks to said torque indicating means.

11. An oiliness and friction testing machine according to claim 10 in which said horizontally pivoted means are supported by said torque indicating means and extend radially therefrom.

12. An oiliness and friction testing machine comprising a frame, a friction element rotatable about a vertical axis in said frame and having two concentric tracks, means for rotating said element, at least one concave friction button having a downwardly directed rim adapted to engage the top of said tracks to be rotated thereby, said button having a central bearing, means engaging said bearing for positioning it with respect to said tracks and for imposing a downward force thereon, resilient torque opposing means axially aligned with said friction element, horizontally pivoted means connecting said last-named means and said bearing positioning means, the angular deflection of said pivoted means and said torque-opposing means with respect to said frame being an indication of the frictional drag between said button and said tracks.

13. An oiliness and friction testing machine comprising a frame, a friction element rotatable about a vertical axis in said frame and having two concentric tracks, means for rotating said element, at least one adjustably loaded concave friction button having a central bearing and a downwardly directed rim adapted to engage the top of said tracks to be rotated thereby about said bearing, a horizontally pivoted arm supported in said frame and connected to said central bearing of said button, torque opposing means in said frame connected to said horizontally pivoted arm and means for indicating the force exerted against said torque opposing means by the frictional drag between said rotating button and said rotating tracks.

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