June 19, 1951 T. MELVILLE 2,557,449

ENDURANCE TESTING MACHINE

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FIG. 1.

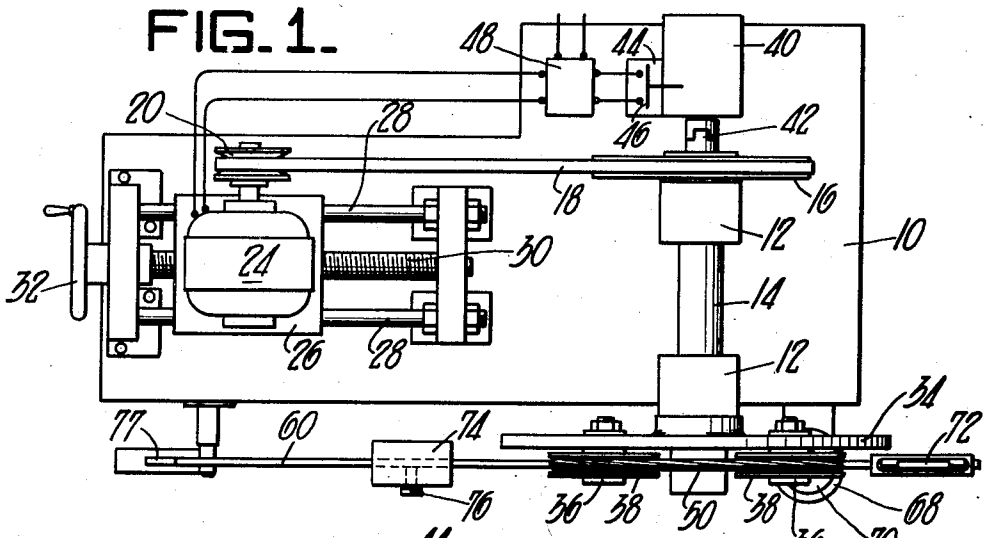
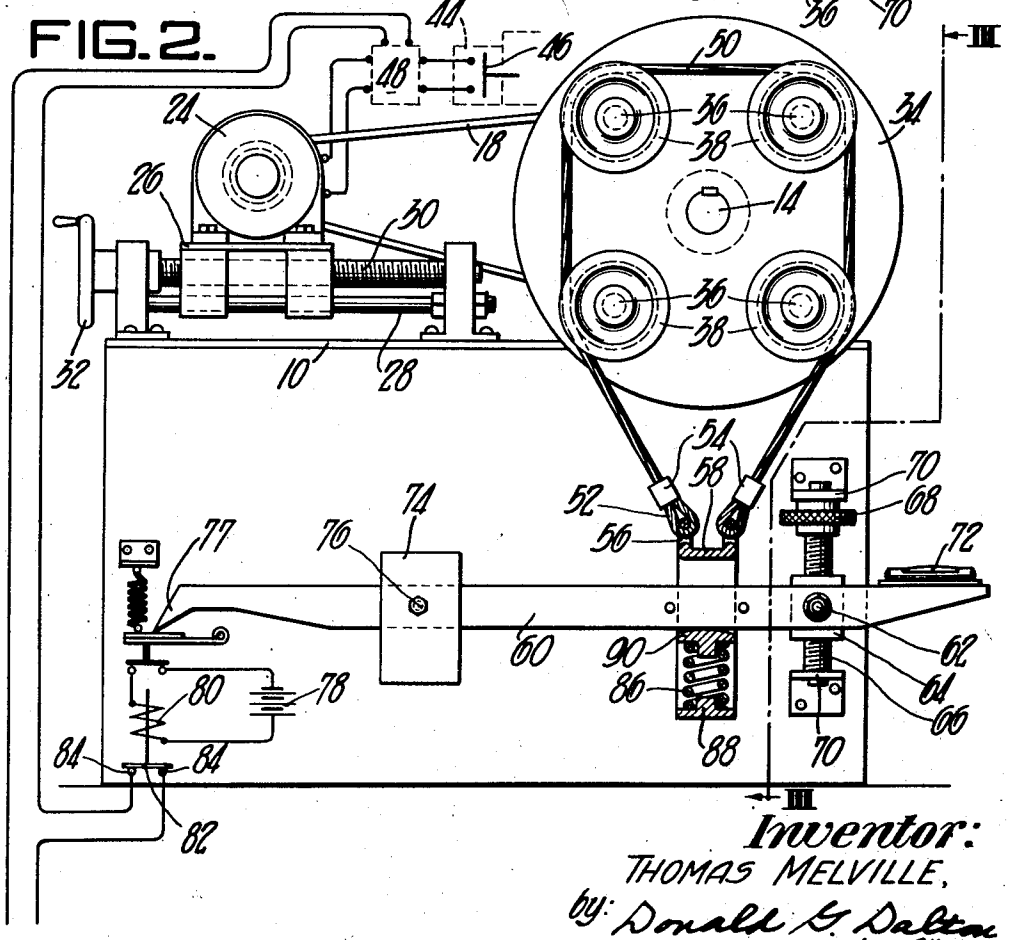


FIG. 2.



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FIG. 3.

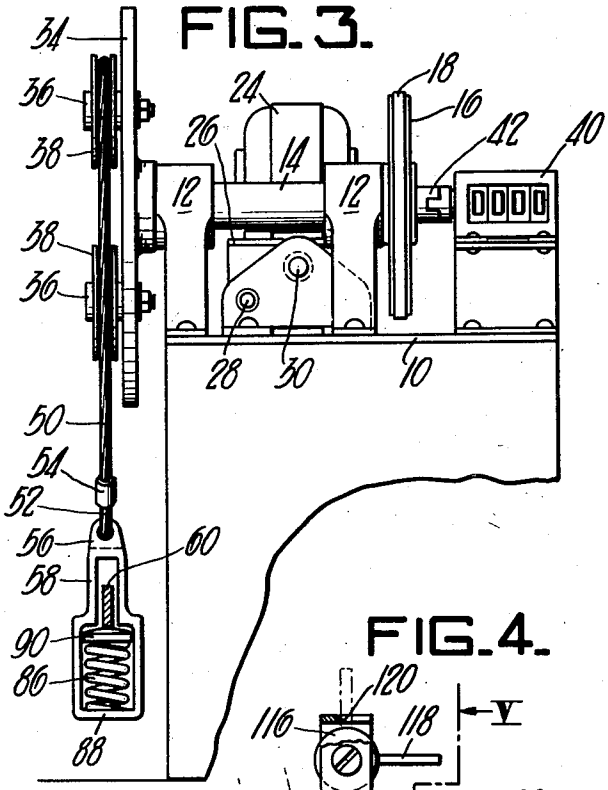


FIG. 5.

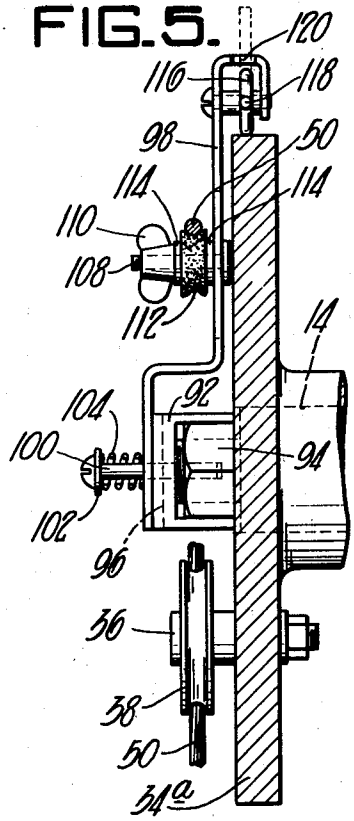
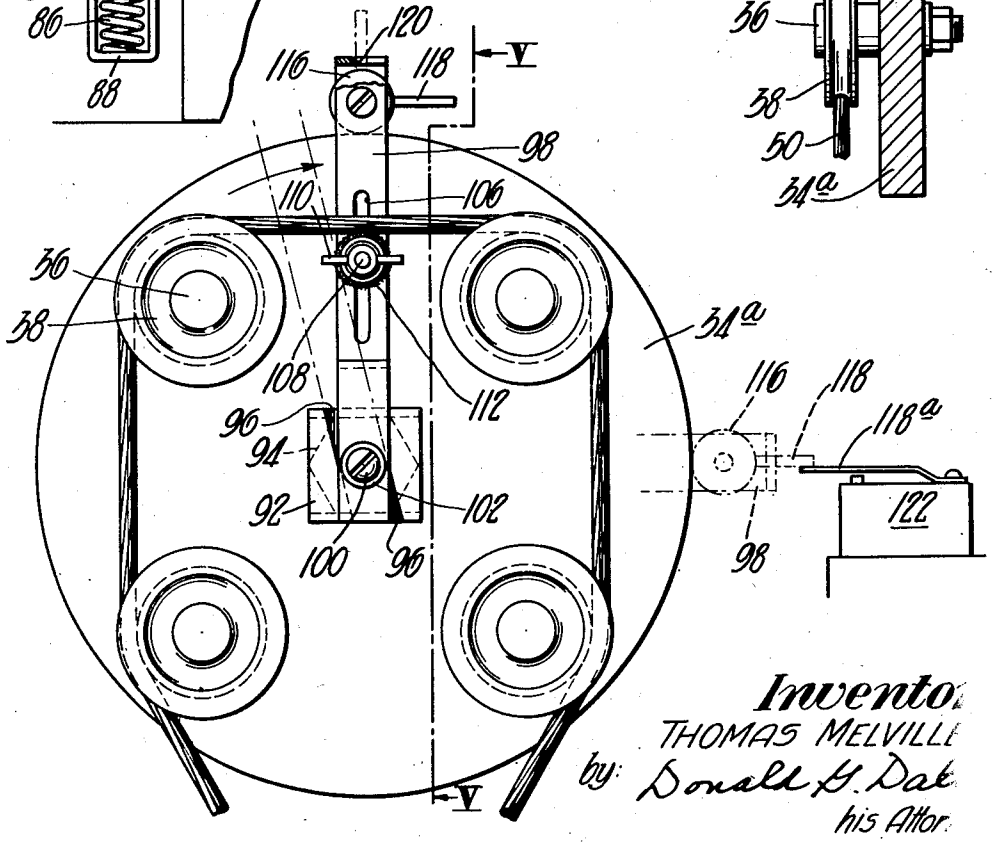


FIG. 4.



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FIG. 6.

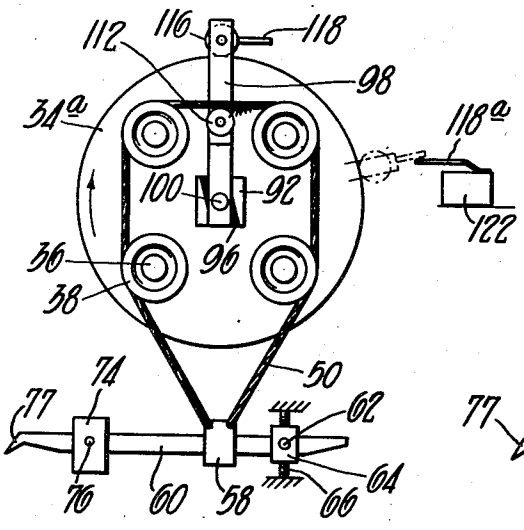


FIG. 7.

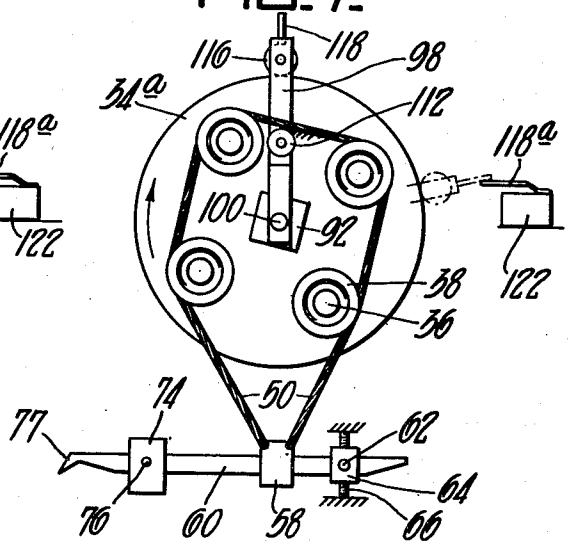


FIG. 9.

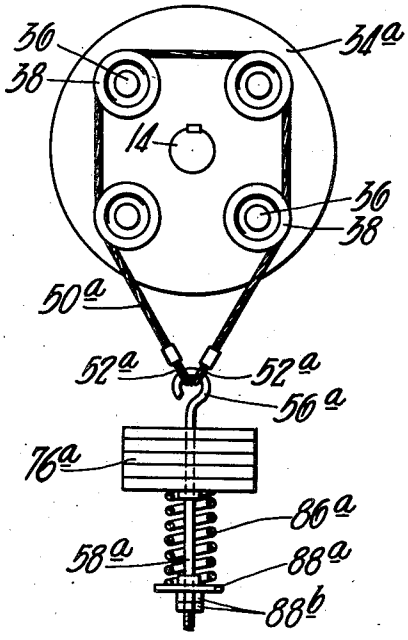
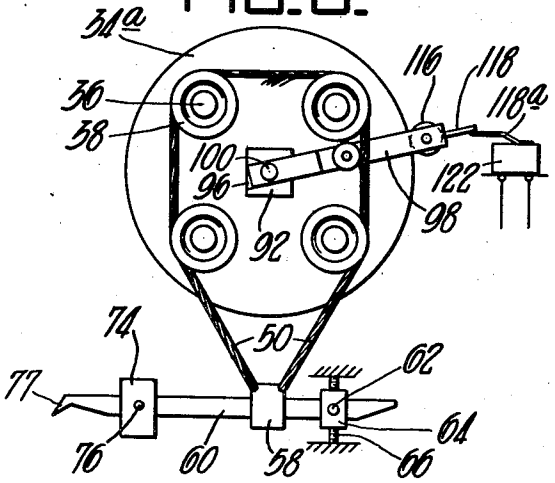


FIG. 8.



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June 19, 1951 T. MELVILLE 2,557,449

ENDURANCE TESTING MACHINE

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FIG. 10.

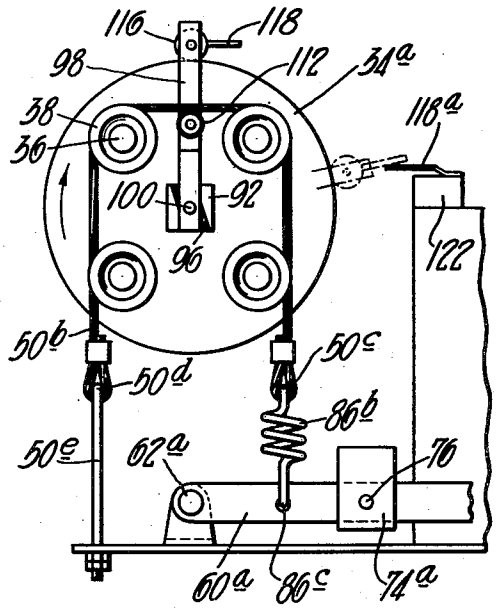


FIG. 11.

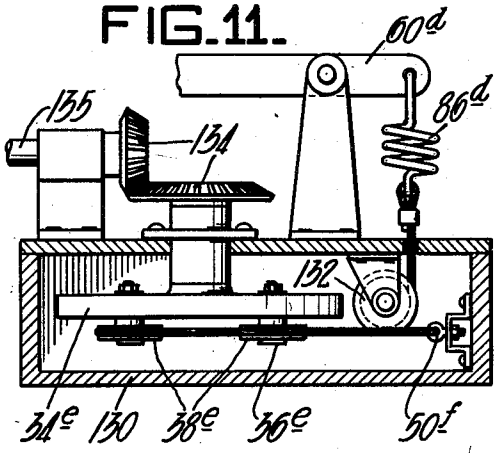


FIG. 12.

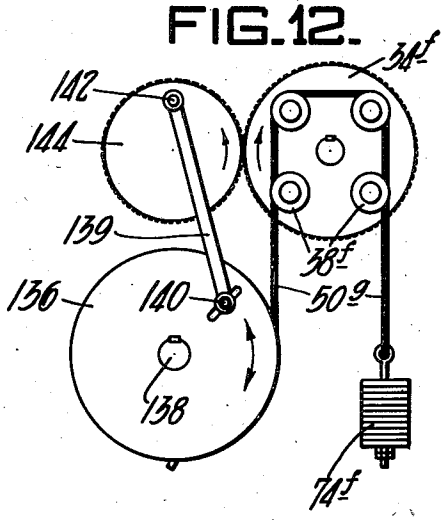
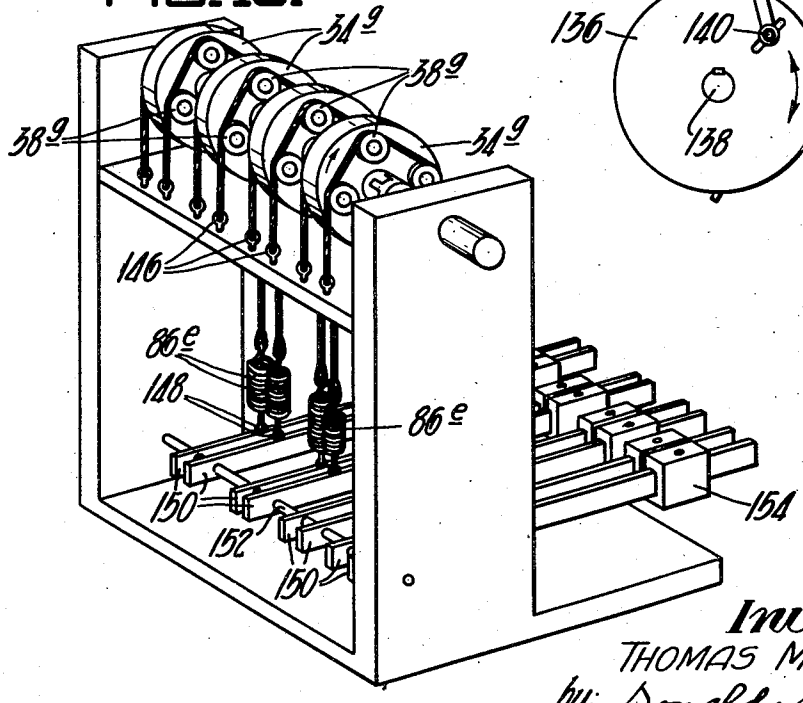


FIG. 13.



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2,557,449

UNITED STATES PATENT OFFICE

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ENDURANCE TESTING MACHINE

Thomas Melville, Cleveland, Ohio

Application January 2, 1947, Serial No. 719,739

5 Claims. (Cl. 73—91)

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This invention relates to a novel method and apparatus for testing the endurance properties of wire rope, cables and the like.

As will appear more fully hereinafter, the novel method involves looping a specimen of rope around a plurality of sheaves journaled on a rotary member and applying a load of predetermined magnitude to the specimen while turning the rotary member through a predetermined number of revolutions, thus subjecting the specimen to a definite number of bendings or flexure stresses, releasing the load from the specimen and disengaging it from the sheaves and finally, either applying to the specimen a tensile stress of a magnitude to determine its safe working strength, or counting the number of strands broken by said predetermined number of bendings.

For a more complete disclosure of all aspects of the invention, reference should be made to the following specification, the accompanying drawings and the appended claims.

In the drawings:

Figure 1 is a plan view of novel apparatus especially designed for carrying out the herein claimed method.

Figure 2 is a front elevation of the apparatus of Figure 1.

Figure 3 is an end elevation viewed from the right of Figure 2.

Figure 4 is a fragmentary detail view illustrating a modification.

Figure 5 is a section on line 5—5 of Figure 4.

Figures 6, 7 and 8 are diagrams illustrating different positions of the apparatus of Figures 4 and 5.

Figure 9 is a detail view illustrating modified means for applying the load to a test specimen.

Figure 10 is a view illustrating a further modification.

Figure 11 is a sectional view showing the application of the invention to the testing of rope or cable in a corrosive atmosphere.

Figure 12 is a diagram illustrating a further modification.

Figure 13 is a perspective view of a modification of the apparatus to adapt the machine for the simultaneous testing of a multiplicity of specimens.

Referring in detail to the drawings, reference numeral 10 represents a base plate supported on a suitable standard as shown. The base plate has secured thereto bearings 12—12 rotatably supporting a shaft 14 carrying a grooved pulley 16 adapted to be connected by a V-belt 18 with a

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variable speed device 20 which may be regarded as comprising two conical pulley parts facing one another so that when separated, the effective belt engaging diameter of the pulley is varied. This drive is a common form of variable speed device, such as a Reeves drive. When the complementary parts of the pulley 20 are adjusted relatively to one another, the motor 24 which is carried on a base 26 will be shifted along parallel guide rods 28 by turning a feed screw 30 working in nut portions secured to the underside of the base 26, the screw being turned by a suitable hand wheel 32. Alternatively, variations in the speed rotation of the shaft 14 can be effected by use of any conventional type of variable speed motor.

The shaft 14 has keyed or otherwise secured thereto a disc 34 carrying a plurality of equidistantly spaced and circularly arranged studs 36 which serve as respective journals for a plurality of grooved sheaves 38. In the machine illustrated, four sheaves 38 are journalled on the rotary disc, these being spaced 90° apart and all rotating on a respective journal stud spaced the same radial distance from the axis of rotation of the shaft 14. More or less than four sheaves 38 may be used, for example, three sheaves spaced 120° apart may be employed or five, six, or eight sheaves may be spaced respectively 72°, 60°, or 45° apart. The greater the number of sheaves employed the less will be each individual bending action and conversely, the fewer sheaves used the greater will be the bending action on the test specimen.

A revolution counter 40 is connected by a conventional form of self-aligning coupling 42 to one end of the shaft 14. This counter includes a known form of mechanism diagrammatically indicated at 44 which is effective to operate a switch 46 so as to open the circuit of a relay 48 for the express purpose of stopping the motor 24 after a predetermined number of revolutions have been imparted to the shaft 14 and disc 34 which moves in unison therewith. As thus arranged, it is manifest that the counter 40 may be set to interrupt the circuit of the motor 24 after the test specimen reeved around the sheaves 38 has been subjected to a predetermined number of bending stresses. From the drawings, it will be understood that in order to test the endurance properties of a specimen of rope, cable, cord or the like, a short length of such material may be severed from the supply reel or coil of rope to be tested. Such a specimen is indicated at 50 in Figure 2. Respective loops 52 are formed in each end of the specimen by means of suitable clamp

fittings 54. The test specimen is reeved around the plurality of grooved sheaves 38 as indicated in Figure 2 and the loops 52 are engaged with anchorages 56 secured to a yoke-like member 58 which straddles a loading beam 60 pivoted on a pin 62 carried by member 64 adapted to be vertically adjusted by a screw 66 having a thumb wheel 68 secured thereto, the screw being provided with fixed collars and being rotatable in fixed lugs 70. The loading beam 60 carries a spirit level 72 for convenience in positioning the beam in a truly horizontal position. Slidably mounted on the loading beam there is a weight 74 carrying a set screw 76. As thus arranged, it will be appreciated that by shifting the weight 74 along the beam 60 the magnitude of the force exerted on the test specimen may be varied.

The mechanism described is adapted to stop the motor 24 after the test specimen has been subjected to a predetermined number of bendings. And in some cases, I also contemplate the provision of means for automatically stopping the motor 24 after the test specimen has been stretched beyond a predetermined amount. As shown diagrammatically in Figure 2, the means for automatically stopping the motor upon the determined stretch of the specimen may take the form of a relay switch which will be operated by a finger 77 on the extreme end of the beam 60 so as to close the circuit of a battery 78 to energize a magnet 80 which will open a switch 82 which normally closes the motor circuit across the contacts 84.

The degree of stressing to which the specimen 50 under test is subjected is dependent upon three variable factors namely, the number of sheaves 38 around which the specimen has reeved, the diameter of the sheaves 38, and the load imposed on the specimen as controlled by the weight 74 or its position on the beam 60. By a different combination of these variables (number of sheaves, diameter of sheaves and load applied) the conditions which the rope or cable under test is adapted to withstand in practice can be readily simulated. To simulate the normal working conditions of rope or cable performance, I consider it desirable to incorporate in the testing apparatus a vibration dampening means. For this reason in the embodiment of the invention, shown in Figure 2, I interpose a vibration dampening spring 86 between the base 88 of the yoke and member 90 on the underside of the beam 60. The use of such vibration dampening means also prevents chattering of the testing machine as the disc 30 rotates at a high speed and also contributes to smoothness in the entire testing operation.

In carrying out a test in accordance with my herein claimed method, after the specimen has been subjected to the desired number of bendings, the load will be removed from the specimen and the specimen unreeved from the sheaves 38, whereupon the loops 52 will be disengaged from the anchorages 56 and the ends of the test specimen will be engaged with the members of a conventional form of tensile strength, testing machine. Sufficient load will be exerted by this machine to strain the specimen to a degree sufficient to cause a permanent set to take place which will usually occur after the elastic limit has been exceeded or of sufficient magnitude to rupture the specimen. In other words, after the predetermined number of bending stresses have been imposed on the specimen, it will be tested in a conventional testing machine in order to evaluate its strength characteristics. Instead of such tensile stretching of the specimen in some cases I contemplate merely counting the number of strands which have been broken after the specimen has been subjected to a predetermined number of bendings by the action of the rotation of the disc 34 in order to evaluate the endurance properties of the specimen.

It is well known that on installations where a rope or cable passes over a sheave that it is important that the sheave be located so as to maintain a small fleet angle at all times. By fleet angle is meant the side angle at which the rope or cable approaches the sheave. It is the angle between the median plane of the sheave groove, as viewed edgewise, and the longitudinal axis or center line of the rope or cable. In order to carry out a test on the endurance testing machine of the invention to determine the effect of fleet angle on a wire rope passing over a sheave, spacers, not shown, may be mounted on the studs 36 between the grooved sheaves 38 and the disc 34 so as to produce a predetermined angle between the rope or cable and a plane passing through the groove of the sheave perpendicular to the rotating axis of the same. With such an arrangement of the apparatus, the method for determining the endurance properties of the rope at various given fleet angles may be readily carried out.

Figures 4 to 8, inclusive, illustrate means whereby the driving motor for the testing machine may be automatically stopped upon breakage of one or more strands of the test specimen. Referring to these figures, the disc 34a carries a bale-like member 92 which straddles the flats of a hexagonal nut 94 secured to the end of the shaft 14. The member 92 has a shallow recess 96 formed therein to accommodate the end of a shut-off arm 98 pivoted on a screw stud 100 which carries a washer 102 between which, and the end of the arm 98, there is interposed a spring 104.

The arm 98 is slotted at 106 to adjustably accommodate a stud 108 carrying a wing nut 110, thus forming an adjustable journal for a circular pad 112 of felt or similar fibrous material mounted between two washers 114 on the stud 108.

Near its outer end, the arm 98 has rotatably journaled therein a wheel 116 which rides on the periphery of the disc 34a. This wheel carries a radially extending pin 118 which when turned through an angle at approximately 90° will occupy the position shown diagrammatically in Figure 7. When in this outward position, the pin 118 enters a notch 120 formed in the outer extremity of the arm 98. With the pin 118 in the extended position of Figure 7, after further rotation of the disc 34a, said pin 118 is adapted to strike an arm 118a of a microswitch such as indicated at 122 in Figures 6 to 8. This switch, when closed by being engaged by the pin 118, is effective to cut off the power current to the driving motor 24. The mechanism as described only comes into operative position upon the breakage of one or more strands of the test specimen. When such breakage occurs, the broken strand will snare the felt, fibrous material of the circular pad 112 and will impart sufficient angular movement to the arm 98 to swing the pin 118 from the position of Figures 4 to 6 to the position of Figure 7, thus continued rotation of the disc 34a will shift the pin 118 into position for coaction of the microswitch as described, thus automatically stopping the motor of the testing device

upon the breakage of one or more strands in the test specimen.

In a modification of Figure 9, I have shown a test specimen 50ª, the ends 52ª of which are engaged with a hook 56ª of a rod 58ª carrying a plurality of weights 76ª, the lower one of which bears on a vibration absorbing compression spring 86ª, whose lower end rests on a washer 88ª bearing on a nut 88ᵇ screwed to the lower extremity of a rod 58ª. It will be understood that the principle of operation of this embodiment of the invention, insofar as the vibration absorption is concerned, is much the same as that shown in Figure 2 and that the magnitude of stress exerted can be readily varied by changing the weights 76ª.

In a modification of Figure 10 I have illustrated a loading beam 60ª pivoted at 62ª carrying an adjustable weight 74ª. In this modification the test specimen 50ᵇ is secured at 50ᶜ to a vibration dampening spring 86ᵇ, one end of which is secured to an end of the test specimen, the other end of which is anchored at 86ᶜ to the beam 60ª. The dead end of the specimen is secured to the hooked portion 50ᵈ of a fixed anchorage rod 50ᵉ secured to the base or any other fixed support.

In Figure 11, I have diagrammatically illustrated means for testing rope specimens or the like in a corrosive atmosphere. Such tests will be carried out by reeving the rope specimen around sheaves 38ᵉ of a disc 34ᵉ located in a substantially gas-tight casing such as indicated at 130. One end of the test specimen will be secured to a fixed anchorage 50ᶠ within the casing. The other end portion will pass around a guide sheave 132 within the casing and will connect with an exterior vibration dampening spring 86ᵈ whose opposite end is connected to a beam 60ᵈ. The motion will be transmitted to the rotary disc 34ᵉ within the casing by means of suitable bevelled gearing 134 powered by a shaft 135 connected with a suitable drive motor whose power circuit may be controlled as hereinabove described.

Figure 12 diagrammatically illustrates a modification employing means for imparting an oscillation to the test specimen. In this modification, the disc 34ᶠ will carry a plurality of sheaves 38ᶠ around which the specimen 50ᵍ to be tested is reeved. A load 74ᶠ is secured to one end of the test specimen and its other end is secured to an oscillating disc 136 secured to a rock shaft 138 which is adapted to be oscillated by means of a pitman 139 whose ends 140 and 142 respectively are secured to studs mounted in the member 136 and in a rotating member 144 which may be regarded as a gear meshing with a gear carried by the shaft supporting the disc 34ᶠ.

Figure 13 diagrammatically illustrates means whereby a multiplicity of test specimens may be simultaneously tested. As shown in this figure there are a plurality of rotatable discs 34ᵍ, each carrying on its opposite faces a plurality of sheaves 38ᵍ around which are reeved the specimens to be tested. One end of each specimen is dead ended for example, by being fastened to eye-anchorages 146. The opposite ends of the specimens are secured to vibration dampening springs 86ᵉ which are secured to eye-members 148 carried by beams 150 pivoted on a fixed cross-rod 152, each beam having adjustably mounted thereon a loading member 154 as shown. With the parts as shown in this modification, the discs 34ᵍ are so constructed and arranged so as to have a free-wheeling mounting on the supporting shaft by interposing a free-wheeling clutch between

each disc and shaft. With such an arrangement one or more discs 34ᵍ can be permitted to be operating while others are at a standstill. The use of the clutches would greatly facilitate obtaining a typical "number of cycles vs. breaking load" curve, such as is frequently used in comparing strength characteristics of different ropes or cables.

In the various embodiments of the invention illustrated, it will be understood that one or more test specimens are adapted to be subjected to a multiplicity of bendings resulting from the rotation of the sheaves 38 through a circular orbit. In their travel through the circular orbit the sheaves ride through the bight of the test specimen, thus all portions of the bight will be repeatedly subjected to a predetermined number of bendings or flexings. In this way the endurance qualities of various sizes and types of rope, cables, cords and the like can be readily evaluated.

In the use of rope or cable for various purposes, it is frequently desirable to employ a particular diameter of sheave bearing a definite relationship to the rope or cable to be reeved thereover. The herein described apparatus lends itself to the testing of the proper size sheaves for use with given cables and the sheaves to be tested may be mounted at the locations indicated for the sheaves 38ª and 38ᵇ hereinabove described.

The drawings and detailed description above are to be construed in an illustrative rather than a limiting sense, since various modifications and substitutions of equivalents may be made by those skilled in the art without departure from the invention as defined in the appended claims. The described apparatus may also be used for testing the comparative desirability of sheave bearings constructed of various suitable materials which may be either metallic or non-metallic for use with given cables and sheaves, the bearings to be tested being mounted at the same locations indicated for the sheaves.

I claim:

1. A machine for testing the endurance properties of wire rope comprising a frame structure, a disc rotatably mounted on said frame structure, motive means for driving said disc, a plurality of circumferentially grooved sheaves mounted on a face of said disc for free rotation and adapted to have a wire rope test specimen reeved therearound, an arm fulcrumed to said frame structure beneath said disc, an attachment device carried by said arm adapted to fix the free ends of the test specimen, and an adjustable weight carried by said arm beyond said attachment device for tensioning the test specimen.

2. A machine for testing the endurance properties of wire rope comprising a frame structure, a disc rotatably mounted on said frame structure, motive means for driving said disc, a plurality of circumferentially grooved sheaves mounted on a face of said disc for free rotation and adapted to have a wire rope test specimen reeved therearound, a bearing carried by said frame structure below and to one side of the disc axis and being adjustable toward and away from said disc, an arm fulcrumed to said bearing and extending beneath said disc, a yoke carried by said arm and provided with attachment means adapted to fix the free ends of the test specimen, vibration dampening means between said yoke and said arm, an adjustable weight carried by said arm beyond said yoke for tensioning the test specimen, and means for auto-

matically stopping said motive means after a test has progressed beyond a predetermined point.

3. A machine for testing the endurance properties of wire rope comprising a frame structure, a disc rotatably mounted on said frame structure, motive means for driving said disc, a plurality of circumferentially grooved sheaves mounted on a face of said disc for free rotation and adapted to have a wire rope test specimen reeved therearound, a bearing carried by said frame structure below and to one side of the disc axis and being adjustable toward and away from said disc, an arm fulcrumed to said bearing and extending beneath said disc, a yoke carried by said arm and provided with attachment means adapted to fix the free ends of the test specimen, vibration dampening means between said yoke and said arm, an adjustable weight carried by said arm beyond said yoke for tensioning the test specimen, and an electric switch engageable by said arm after elongation of the test specimen by a predetermined length for automatically stopping said motive means.

4. A machine for testing the endurance properties of wire rope comprising a frame structure, a disc rotatably mounted on said frame structure, motive means for driving said disc, a plurality of circumferentially grooved sheaves mounted on a face of said disc for free rotation and adapted to have a wire rope test specimen reeved therearound, an arm fulcrumed to said frame structure beneath said disc, an attachment device carried by said arm adapted to fix the free ends of the test specimen, an adjustable weight carried by said arm beyond said attachment device for tensioning the test specimen, and means for positioning at least one of the said grooved sheaves sidewise from the point at which a free end of the specimen is fixed.

5. A method of testing endurance properties of flexible elements comprising looping a specimen of such an element around a plurality of grooved sheaves journaled on a rotary member, anchoring the ends of said specimen, maintaining a portion of the loop of said specimen at a predetermined fleet angle with respect to at least one of said sheaves, applying a load to at least one of the anchored ends of the specimen, and turning the rotary member so as to subject the specimen to repeated bending stresses in at least two different planes.

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