Nov. 27, 1962 R. A. CRANE ET AL 3,065,632

FLEXURE FATIGUE TESTER

Filed Aug. 24, 1959 2 Sheets-Sheet 1

Fig. 1.

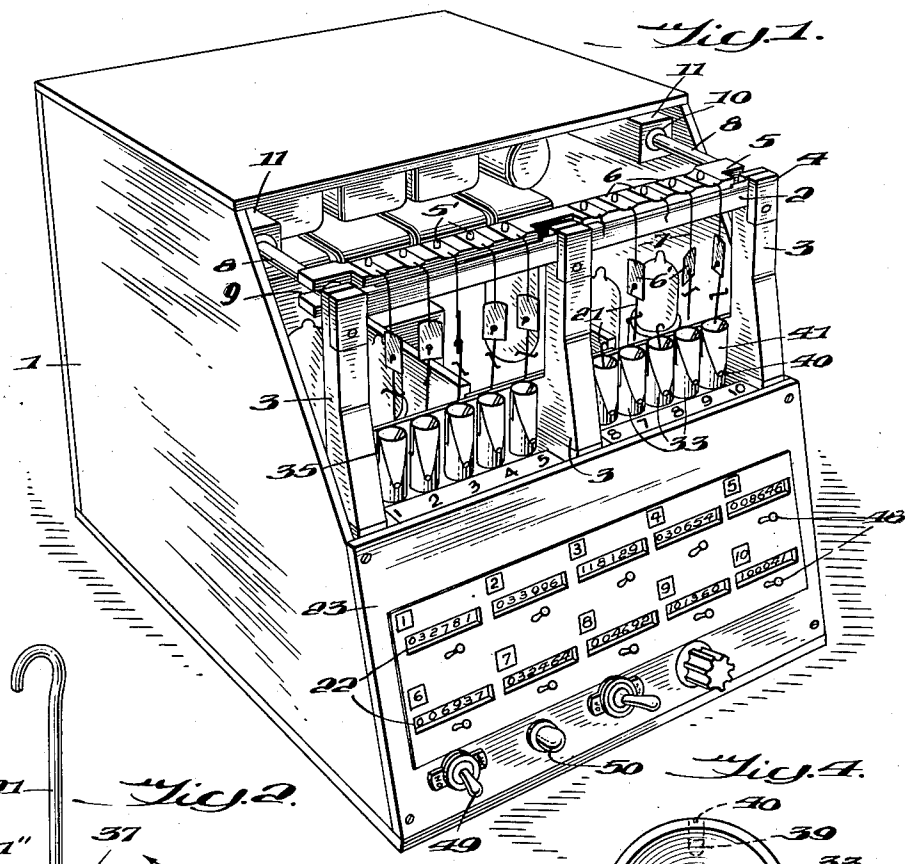


Fig. 2.

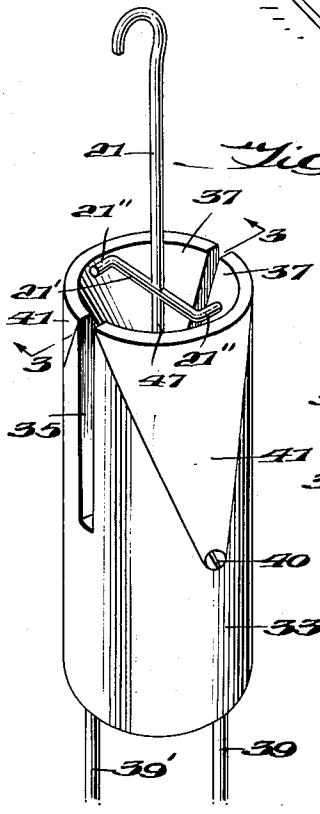


Fig. 3.

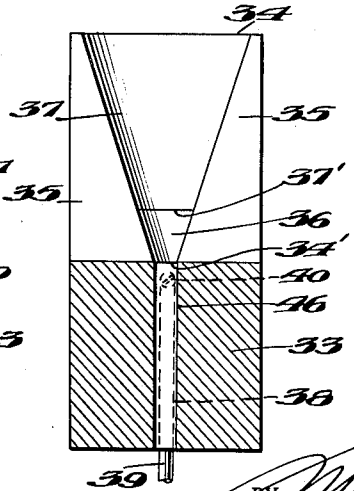


Fig. 4.

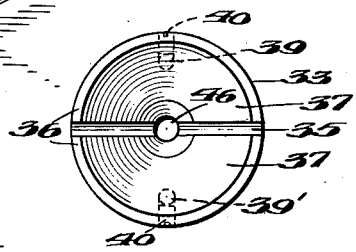
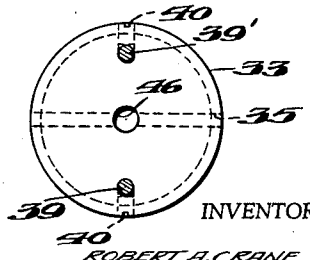


Fig. 5.



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Nov. 27, 1962 R. A. CRANE ET AL 3,065,632

FLEXURE FATIGUE TESTER

Filed Aug. 24, 1959 2 Sheets-Sheet 2

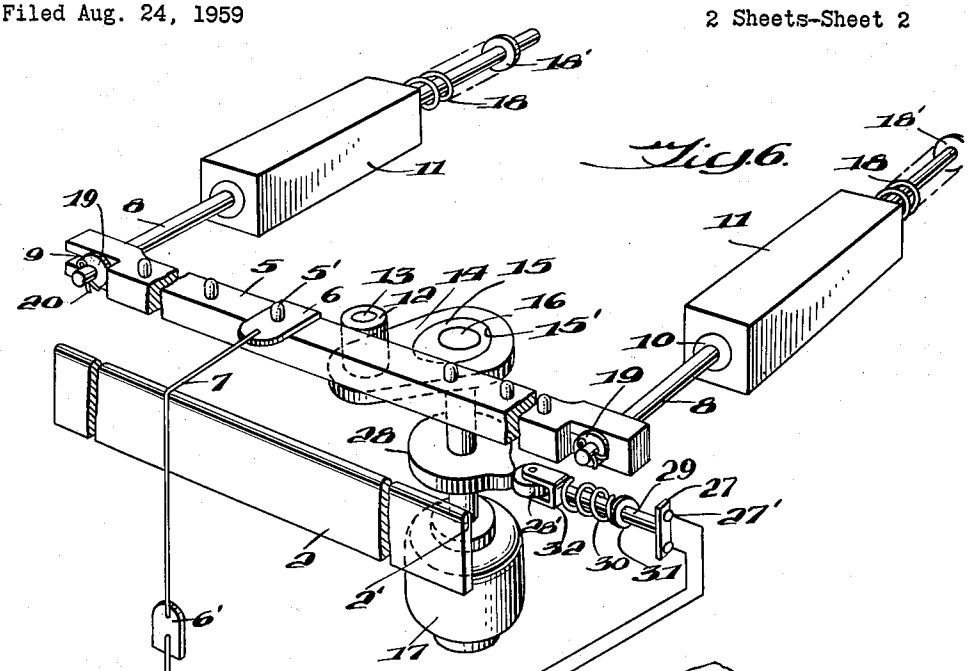


Fig. 6.

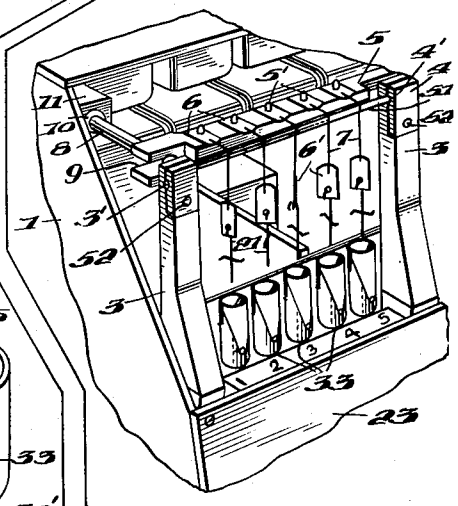
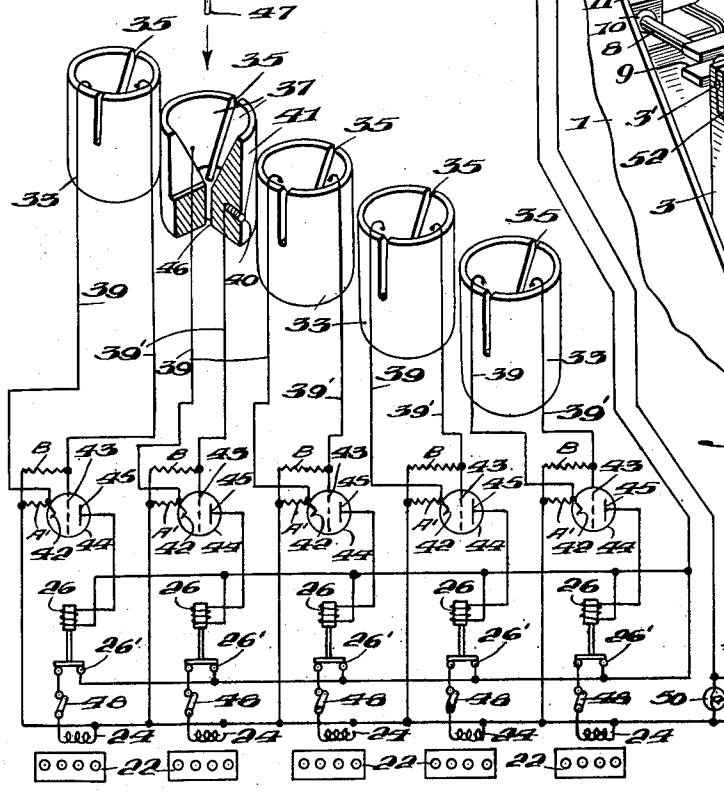


Fig. 7.



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FLEXURE FATIGUE TESTER

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Filed Aug. 24, 1959, Ser. No. 835,794
10 Claims. (Cl. 73—91)

This invention relates to flexure fatigue testers and is particularly directed to an improved apparatus for testing the resistance to flexure of single filament specimens.

Various factors affect the wear of filaments and the useful life of fabrics made of fibers. Among these factors is the effect of tension, compression, and bending or flexing forces on the filaments of which the fabric is made, as well as abrasion of the fibers as by friction, surface cutting, and fiber plucking. Friction and surface cutting produce direct damage to the filament at local points of contact with abrasive elements, while fiber plucking and other processes which produce fiber strains may cause immediate or dynamic fatigue rupture of filaments in tension, compression, or bending.

Since most fabrics, when in use, undergo considerable folding, creasing, and similar relative bending or twisting of the filaments, it is of considerable importance to be able to determine the resistance of various fibers to bending or flexure stress. In order to be able to compare test results, it is desirable that the actual stress on the filament have some definite value. It must be borne in mind that flexure of a filament places substantially one-half of the cross-sectional area undergoing flexure in compression, while the other half of the cross-sectional area is in tension. The degree of compression and tension at the point of flexure is affected both by the angle of the bend at this point and by the stress or tension on the fiber which extends in both directions from the point of flexure. The first of these factors also is affected by the sharpness or the radius of curvature at the point of the bend. This latter is readily understandable, as it directly affects the compression and tension in the parts of the filament undergoing flexure. It is desirable, therefore, that the angle at which the filament is flexed, and the radius of curvature of the flexing edge, and the tension in the filament extending away from the point of flexure, all be definitely determined and recorded, or at least maintained constant, in connection with tests of the resistance of filaments to flexure, so that results of such tests may be of value for comparative purposes.

In certain instances, it may be found that the speed at which the flexure is produced will have an effect upon the resistance of filaments to rupture under flexure, but this generally can be attributed to heat which is developed by the flexure and which is not fully dissipated during the test. Such a retention of heat in effect changes the ambient, and, therefore, changes the conditions under which the test is performed. In some instances, it may be desirable also to record ambient temperature and humidity, so that a comparison of the results will indicate whether the qualities of the filament undergoing a flexure test are affected by ambient conditions and provide a standard for comparison of flexure tests of different filament materials.

In order to provide a flexure fatigue tester for measuring results which may provide comparisons to gauge the qualities of different filaments and filament materials, it is desirable that the instrument be capable of flexing a fine filament in a reproducible manner over an accurately formed flexing edge of definite radius, recording or registering a large number of test cycles for measuring the number of flexures of a specimen filament prior to rupture thereof, and definitely determining the point at which it breaks. In carrying out the present invention, the instrument incorporates features which provide all of the

above requirements and, in particular, provides for flexing or bending a filament by rubbing it back and forth over a substantially rounded flexing edge at an angle of about 90° at the point of flexure. Since single fibers usually are not capable of supporting a very great weight in tension, it is necessary that small weights be utilized to hold the fibers stretched taut over the flexing edge. While various weights may be used for this purpose, it has been found that small weights, usually less than one gram, provide the needed tension in a filament to maintain it stretched continuously and uniformly over the flexing edge without imposing undue tensile forces thereon.

When a filament undergoing test ruptures, it generally does so by a breaking at one point, so that the weight depending freely from the end of the filament falls away from the flexing edge. In the present invention advantage is taken of this action by providing a switch which is actuated by the weight as it falls with the broken filament to stop a counter which is responsive to the number of reciprocations of the mechanism which pulls the filament back and forth over the flexing edge. Since the tensioning weights on the filaments are small, a very important part of this invention is the provision of a sensitive low contact pressure switch which is adapted to close an electric circuit when engaged by the tensioning weight so as to stop the operation of the counter.

In the illustrated embodiment of this invention, this sensitive low contact pressure switch comprises a cup member with a split female conical surface having sides which are electrically insulated from each other and partially coated with an electrically conducting paint. This cup switch is placed directly under the tensioning weight on the filament, so that when the filament breaks the weight falls into the cup and closes an electrical circuit between the split conical conductive surfaces thereof. This switch is disclosed and claimed in copending application Serial No. 835,793, filed August 24, 1959, of Robert A. Crane and assigned to the same assignee as the present application.

A practical embodiment of this invention can readily be made to include a number of sensitive low contact pressure switches and mounting means for supporting a corresponding number of specimen filaments. A separate counter is provided for each split cup and filament mounting, and all are adapted to be operated simultaneously in response to the reciprocations of the filament mounting member.

Each counter is adapted to be stopped in response to an electrical signal which is established when its respective filament breaks, and the tension weight thereon closes the electric circuit through the low contact pressure switch. With such a tester, a single filament may be tested or a number of individual filaments may be tested simultaneously up to the number which can be accommodated by the mounting member corresponding to the number of low contact pressure switches in the instrument.

An object of this invention is to provide an improved flexure fatigue tester.

Another object of this invention is to provide a flexure fatigue tester for simultaneously testing a plurality of individual filaments and recording the number of flexures of each individual filament without stopping the instrument when each filament breaks.

A further object of this invention is to provide an improved flexure fatigue tester capable of testing a plurality of individual filaments under flexure and automatically counting the number of flexures of each individual filament undergoing test.

Still another object of this invention is to provide an improved flexure fatigue tester in which individual filaments may be stretched over a flexing edge by a relatively very small tensile force produced by a very light weight and to

utilize the light weight to actuate a sensitive low contact pressure switch for indicating the rupture of its respective attached filament.

Further objects and advantages of this invention will become apparent from the following description referring to the accompanying drawings, and the features of novelty which characterize this invention will be pointed out with particularity in the claims appended to and forming a part of this specification.

In the drawings:

FIG. 1 is a perspective view of a flexure fatigue tester incorporating an embodiment of the present invention;

FIG. 2 is a perspective view of a low contact pressure switch of the type shown in the instrument illustrated in FIG. 1;

FIG. 3 is an elevational view, in half-section, taken along a plane indicated at 3—3 in FIG. 2, showing details of the low pressure switch;

FIG. 4 is a top plan view of the low contact pressure switch shown in FIGS. 2 and 3;

FIG. 5 is a bottom plan view of the low contact pressure switch shown in FIGS. 2, 3, and 4;

FIG. 6 is a schematic diagram of the major operating parts and circuit components of the flexure fatigue tester shown in FIG. 1, certain parts being shown in partial section or broken away to illustrate details better; and

FIG. 7 is a fragmentary perspective view of an instrument, similar to that shown in FIGS. 1 and 6, in which the rounded flexing edge is formed by a wire or a rod.

Referring to the drawings, an improved flexure fatigue tester is illustrated which is adapted to test simultaneously a number of individual filaments. This invention is equally applicable to filament flexure fatigue testers for testing a single filament or for testing a relatively large number of filaments simultaneously. Where a single filament only is to be tested, the instrument need only be provided with a simple counter which can record or register the number of cycles to which a filament is subjected in flexing it over a suitable flexing edge. In most instances, and particularly for production quality control, it will be found desirable to construct the instrument so that it can simultaneously test a plurality of filaments and simultaneously individually record or register the flexing cycles to which each individual filament is subjected.

In the flexure tester illustrated in FIG. 1, ten filaments are adapted to be tested simultaneously. The instrument may conveniently be assembled in a housing **1** in which all of the principal operating and measuring elements are mounted. In this embodiment, a relatively narrow thin flexing bar member **2** is rigidly mounted on three supporting posts **3** and secured to the upper ends of these posts by clamping plates **4**, with the flat sides of the flexing bar member **2** extending upwardly so that they are substantially vertical when the instrument is placed on a level supporting surface. The flexing bar member **2** is provided with a curved flexing edge **2'** accurately formed to a uniform curvature and size, preferably rounded to a diameter between .001 and .005 inch, or about .5 to 5 filament diameters. Other sizes of flexing edges may be used where relatively large filaments are to be tested, however, in order to obtain practical tests of single filaments formed of fibers generally used in textile manufacture, these relatively small diameters were found to give test results which bear a significant degree of correlation with the rate of their destruction in fabrics during actual use.

A plurality of filaments is adapted to be tested simultaneously by being drawn back and forth across the flexing bar member **2** by a suitable mounting member. In this embodiment, the mounting member comprises a filament mounting bar **5** provided with a plurality of longitudinally spaced upwardly extending pegs **5'**, which are adapted to be engaged by filament holding tabs **6**, secured in any suitable manner, as by adhesive, to the ends of filaments **7**. The mounting bar **5** is adapted to be supported by a pair of drawbars **8**, an end of each of which is mounted in one end of the filament mounting bar **5**. In such a construction, it is highly desirable that slight misalignment between the drawbars should not bind or otherwise adversely affect the smooth operation of the instrument.

The mounting of the drawbars **8** in the filament mounting bar **5** can conveniently be utilized to assure an easy self-adjustment of the drawbars that compensates for any parallel misalignment in the drawbars and also assures proper positioning of filaments undergoing test. This can be done by mounting an end of one drawbar **8** in a longitudinally extending slot **9** which bifurcates one end of the mounting bar **5** and mounting a corresponding end of the other drawbar **8** in a closely fitting hole in the other end of the bar **5**. This fixes the transverse position of the filament mounting bar **5**, and thus the position of the test filaments. These drawbars **8** are slidably supported by any suitable bearings, such as journal bearings **10** in bearing blocks **11**, mounted on the sides of the housing **1** adjacent to the upper ends of these sides. This arrangement of the bearing supports for the drawbars **8** maintains the drawbars substantially in parallelism and further minimizes the possibility of binding of the drawbars on the filament mounting bar **5**.

Filaments **7** are adapted to be drawn back and forth across the flexing edge **2'** of the flexure bar **2** by reciprocation of the filament mounting bar **5**. Preferably this reciprocation of the mounting bar should be performed at a regular operating cycle speed with a minimum of abrupt changes in speed. This can be conveniently obtained by operating the mounting bar **5** sinusoidally, so that it gradually approaches standstill at both ends of its travel and gradually accelerates from such standstill positions during each part of its operating cycle. Such sinusoidal reciprocation of the mounting bar **5** can readily be obtained by an eccentric actuating mechanism which rotates at a substantially constant speed.

In the illustrated embodiment, this eccentric actuating mechanism comprises a roller drive member **12** rotatably mounted on a drive pin **13** mounted on a crankarm **14**. This crankarm **14** is driven by an eccentric **15**, which is adapted to revolve within an eccentric race **15'** in the crankarm **14**, and the eccentric **15** is drivingly mounted on a suitable drive shaft **16**, which is adapted to be driven by any suitable prime mover, such as an electric motor **17**. Operation of the motor **17** rotates the drive shaft **16** and the eccentric **15** within the race **15'**, so as to cause the crankarm **14** to oscillate back and forth and to move the roller drive member **12** toward and away from the flexing bar **2**. The filament mounting bar **5** is adapted to be held in engagement with the roller drive member **12** by the drawbars **8** which are resiliently biased away from the mounting bar **5** by compression springs **18** suitably seated against the rear end of the bearing blocks **11** and spring seat washer **18'** mounted on the outer ends of the bars **8**. The force of these springs is transmitted to the ends of the filament mounting bar **5** through washers **19**, which are loosely mounted on the ends of the bars **8** on the sides thereof away from the bearing blocks **11** and are secured to the ends of the drawbars **8** by any suitable means, as cotterpins **20**. In this manner, the drawbars **8** resiliently bias the filament mounting bar **5** into firm driving engagement with the roller drive member **12**, so that the mounting bar **5** will reciprocate sinusoidally with the oscillatory movement of the roller member **12**, and transmit this sinusoidal reciprocating motion to filaments **7** mounted on the bar.

In order to maintain the filaments **7** continuously stretched taut over the flexing edge **2'** of the flexing bar **2**, the free ends of the filaments **7** are secured in any suitable manner, as by adhesive, to holding tabs **6'** similar to the holding tabs **6**, and suitable light weights **21** of electrically conductive material and predetermined size are attached to the holding tabs **6'**. The weights **21** may be of any suitable form and, as has been previously

stated, preferably are less than one gram, so as to subject the specimen filament to a minimum tensile stress while maintaining it taut in both directions from the flexing edge 2'.

With such an arrangement the filament will be drawn back and forth across the flexing edge 2' until the bending or flexure fatigue of the filament will cause it to break. By arranging the flexing edge 2' of the flexing bar member 2 in substantially the same horizontal plane as the upper supporting surface of the mounting bar 5, the filaments 7 are stretched across the flexing edge 2' at substantially a right angle. Since all of the filaments tested in a given instrument of this type will be bent at substantially the same angle over the flexing edge of the flexing bar member and for any given tests the curvature of the flexing edge 2' will be maintained constant, the use of weights 21 of a known and uniform size provides for readily gauging the flexing qualities of a filament in accordance with the number of flexing cycles to which a filament is subjected prior to breaking.

In accordance with the present invention, the number of flexing cycles to which each individual filament is subjected is adapted to be counted without requiring that the apparatus be stopped until all of the filaments undergoing tests have been broken. This can readily be done by counting the number of times that the mounting bar 5 is reciprocated from the time that the apparatus is put into operation until each respective fiber breaks. In order to count the reciprocations of the mounting bar 5 a plurality of counters 22, preferably of the electromagnetic type, corresponding to the number of filament mounting pegs 5' on the mounting bar, is provided. These counters conveniently are mounted on a front panel 23 of the instrument housing to provide for easy reading thereof. For further convenience, these counters 22 may be numbered, as indicated in FIG. 1, by numbers which correspond to the fiber mounting pegs on the mounting bar.

These counters may be of any conventional type, and each is adapted to be operated by a solenoid coil 24 suitably connected to a source of electrical power supply 25 through the contacts 26' of a relay 26, and contacts 27' of a mechanically operated circuit breaker 27. The circuit breaker 27 may be of any suitable type for periodic operation in response to operation of the mounting bar 5 so as to open and close the electrical circuit through its contact 27' in accordance with each cycle of operation of the mounting bar. The illustrated embodiment of this circuit breaker 27 shows a cam 28 mounted on the motor drive shaft 16 and drivingly rotatable therewith, so as to operate a follower 28' mounted on a circuit breaker operating rod 29. A compression spring 30 is arranged between a stationary spring seat 31 and a follower mounting bracket 32 on the end of the operating rod 29 so as resiliently to bias the follower 28' into engagement with the cam 28. In this manner, every cycle of reciprocation of the mounting bar 5 produces a corresponding operation of the circuit breaker 27 to close an electrical circuit through the contacts 27' so as to energize the solenoid coils 24 through their respective relay contacts 26' and thus to record or register another cycle of operation.

In order individually to count the number of cycles of flexing of any individual filament undergoing test, it is necessary that its respective counter 22 be deenergized when the filament breaks. In accordance with the present invention, advantage is taken of the fact that when the filament 7 breaks its stretching weight 21 will fall away from the flexing bar member 2, and this weight can be utilized to operate a switch which will deenergize its respective counter solenoid coil 24. Since the stretching weights 21 are purposely made relatively light it is necessary that switches operable by such weights as they fall be of a very low contact pressure type. Such a switch can conveniently take the form of a pair of electrically conductive elements which are insulated from each other and are adapted to be connected electrically by a weight which falls upon the conductive elements when its respective filament is broken.

In the illustrated embodiment of this invention the pair of electrically conductive elements of the low contact pressure switch may conveniently be formed as elements on an integral cup member 33 of suitable insulating material, such as a plastic. As is more clearly shown in FIGS. 2, 3, and 6 the cup member 33 preferably comprises an inner concave surface in the form of an inverted frustum of a cone with the base 34 thereof adapted to face upwardly for the reception of a weight 21 when the respectively connected filament 7 breaks. One of these cup switches is arranged substantially in longitudinal alignment with its respective mounting peg 5' and is adapted to be directly under one of the weights 21 attached to a specimen filament secured to its respective peg. This arrangement is more clearly shown in FIG. 1. Each cup member 33 is divided substantially diametrically thereof by a split 35 so as to separate the inwardly tapered female conical surface of the inverted frustum of a cone forming the cup into two substantially equal sections 36. The split 35 preferably extends longitudinally of the cup member 33 substantially to the apex or small end 34' of the frustum of the cone forming the inner cup surface. The two electrically conductive elements of the low pressure switch are formed on the two split portions 36 of the cup member 33 by simply coating the inner surface of each of these two portions of the cup with any suitable electrical conductive material, such as a silver paint. This forms a thin layer 37 of electrically conductive material which preferably extends into the inverted conical surface a distance short of the apex of the cone, as indicated by the lower end 37' of the coating.

In order to provide a convenient means for electrically connecting each of the electrically conductive elements formed by the layers 37, a pair of longitudinally extending passages 38 is drilled or otherwise suitably formed in the base of the cup member 33, preferably in a plane at substantially right angles to the plane of the slot 35. These passages 38 extend into the cup any suitable distance and are adapted to receive electrical conductors 39 and 39' which are fastened in position in the cup member 33 by set screws 40 which extend into the cup member from the outside thereof and press against the ends of the conductors 39 and 39'. These set screws 40 form convenient terminals for the conductors 39 and 39' to which the electrically conductive elements 37 can be connected. Such connections between the electrically conductive elements 37 and the set screws 40 can conveniently be made by simply extending the electrically conductive paint coating over the outer edge of the cup member 33 and a portion of the outside of the two split halves of the cup member 33, as indicated at 41, to a position where this electrically conductive coating covers the heads of the set screws 40. Preferably the outside coating 41 narrows down from the full width of the semicircular end of the cup member 33 to substantially the size of the set screw 40, and care is taken to assure that the paint does not cover the sides of the slot 35. In this manner, the two electrically conductive elements formed by the inner layer 37 and the outer coating or connection 41 are electrically insulated from each other by the slot 35 and by the insulating material of which the cup member 33 is made.

The conductors 39 and 39' are respectively connected to the filament 42 and grid 43 of an amplifier 44 having a plate 45 forming part of an amplifying circuit for energizing the coil of the relay 26 connected to each of the counter solenoid coils 24. With this arrangement, the cam 28 on the driveshaft 16 energizes the solenoid coil 24 of counter 22 through the contacts 27' of the circuit breaker 27 and the relay contacts 26' of the relay 26 for each cyclic reciprocation of the filament mounting bar 5. Thus, all of the counters 22 simultaneously

record or register each cycle of reciprocation of the mounting bar 5 each time they are connected to the source of electrical power supply 25. On breakage of any of the filaments 7, its respective weight 21 will fall and be deposited within the inverted cone forming the upper portion of the cup member 33. This should disconnect the respective counter from the energizing circuit through the circuit breaker contacts 27'.

In order to assure that each weight will properly close its switch circuit, each weight 21 preferably is formed of a suitable width, which may comprise a transversely extending crossbar portion 21' having angularly extending ends 21'', to enable it to span the space between the two electrically conducted elements formed by the layers 37 within the cup so as to electrically connect these two elements. In order to assure against the accidental arrangement of the weight 21 within a cup member 33 in a manner in which the weight would not span the space between the two electrically conducted layers 37, the weight member 21 preferably is formed with a longitudinally extending guide rod portion 47 and the cup member 33 is formed with a longitudinally extending passage 46 which extends from the lower end of the member 33 to the apex or small end 34' of the frustum of a cone forming the cup surfaces of the switch. With this construction, when a weight 21 falls within a cup member 33, the guide rod portion 47 will fall into the passage 46 and will guide the weight 21 downwardly into the cup member until the crossbar portion 21' thereof contacts the two electrically conductive layers 37. The angularly extending ends 21'' of the crossbar portion 21' should be longer than the width of the slot 35, so as to prevent the crossbar portion 21' from becoming lodged in the slot 35 and thereby failing electrically to connect the two electrically conductive element layers 37.

In this manner when a specimen filament breaks, its respective weight 21 will fall into a split cup switch member 33 and the crossbar portion 21' thereof will be guided into electrical contact with the split female conical surface layers 37 thereby electrically connecting these surfaces and completing an electrical circuit from the source of electrical power 25 through the amplifying circuit. This supplies a biasing signal to the grid 43 of the amplifier 44 which closes an electrical circuit through the amplifier 44 and energizes the coil of the relay 26. Such energization of the coil of the relay 26 operates this relay to open the electrical circuit through the relay contacts 26' so as to deenergize the counter solenoid coil 24 which stops the operation of the respective counter 22. Obviously, the counter control circuit could be connected so that the relay 26 would normally be energized, and when a filament broke, so that a weight 21 fell into a cup switch 33, the respective grid 43 would bias its tube 44 so as to open-circuit the coil of the relay 26. A simple rearrangement of the relay contacts to provide for opening the circuit through the relay contacts when its coil is deenergized in this alternative control circuit will give the same counter operation as in the illustrated circuit. In this manner, each counter 22 will record or register only the cycles of operation of the mounting bar 5 during which its respective weight 21 is held suspended out of contact with the electrically conductive element layers 37 by its respective filament 7. After a filament 7 has broken and its weight 21 has fallen into its switch cup member 33, its counter 22 will remain inoperative as long as the weight 21 remains in the cup member 33. It thus becomes unnecessary to disconnect manually the various counters of the instrument, as they will remain deenergized until the weights 21 are manually removed from the cup members.

For convenience, it may be desirable to disconnect a counter from the electrical circuit to assure that it will not be reconnected by the removal of its weight member. A suitable manually operable switch 48 may be electrically connected in the circuit of each counter solenoid coil 24 for electrically connecting and disconnecting this coil in circuit with its respective relay contacts 26'. If desired, a master switch 49 also may be provided for electrically connecting and disconnecting the entire electrical system of the instrument from the source of electrical power supply 25, and an indicator light 50 may be connected across the instrument side of the terminals of the switch 49 to indicate when the instrument is connected to the source of electrical power supply. In this manner, a single filament or a plurality of filaments may readily be tested for their resistance to flexure, and comparable results will be obtained. Also by using weights of different sizes and by changing the curvature of the flexing edge, different aspects of the flexure characteristics can be checked.

Under certain circumstances, it may be found desirable to vary the curvature of the flexing edge of the flexure fatigue tester in order to determine the effects on filaments of more or less acute bending or flexure. This may be done by substituting a flexing bar 2 having a flexing edge 2' rounded on a different diameter. FIG. 7 illustrates a modification of the flexing edge member in which the flexing edge is formed by the curved or rounded surface of a relatively small cylindrical element 51, such as a wire or rod. This small cylindrical element 51 may conveniently be clamped in suitable grooves 4' and 3' formed respectively in the ends of the clamping plates 4 and supporting posts 3. The clamping plates 4 are suitably secured to the post 3, as by screws 52, to assure holding the small cylindrical element 51 taut and rigid throughout its length between the posts 3. The remainder of the flexure tester illustrated in this figure may conveniently comprise the same basic and operating elements and circuits as that illustrated and described with reference to FIGS. 1 through 6. This type of flexing edge element 51 has the advantage of being more readily replaceable and of assuring a uniformity to the size of the flexing edge for various tests, as a simple wire of given diameter may be stretched between the supporting posts 3, and, by recording the size of wire used, the size of the flexing edge can be assuredly reproduced, even if the original flexing edge element should be lost.

While a particular embodiment of this invention has been illustrated and described, modifications of the instrument and various of its mechanical and electrical components may occur to those skilled in the art. It is to be understood, therefore, that this invention is not to be limited to the particular details disclosed, and it is intended in the appended claims to cover all modifications within the spirit and scope of this invention.

We claim:

1. A filament flexure fatigue tester comprising a flexing member having a curved surface forming a flexing edge, means rigidly mounting said flexing member for maintaining a fixed flexing edge, means including a reciprocable filament mounting member and a drive for reciprocating a filament mounted on said mounting member back and forth over said flexing edge, means for counting the reciprocations of a filament over said flexing edge, a weight of predetermined size adapted to be attached to a specimen filament which is secured to said mounting member and which extends over said flexing edge, and means for stopping said counting means on breakage of the specimen filament secured to said mounting member.

2. A filament flexure fatigue tester comprising a flexing bar member having a curved surface forming a flexing edge, means rigidly mounting said flexing member for maintaining a fixed flexing edge, means including a filament mounting bar having a plurality of longitudinally spaced upwardly extending pegs for mounting filament holding tabs thereon, means including a pair of drawbars arranged with one end of each operatively engaging a separate end of said mounting bar for supporting said mounting bar, bearing means for slidably supporting said drawbars substantially in parallelism, means for resiliently

biasing each of said drawbars in a direction away from said mounting bar and thereby resiliently drawing said drawbar ends into operative engagement with said mounting bar, means operatively engaging said mounting bar and cooperating with said drawbars for reciprocating said mounting bar towards and away from said flexing edge, a plurality of electrical means for counting the reciprocations of said mounting bar, a plurality of weights each of predetermined size adapted to be attached to a specimen filament which is secured to one of said mounting pegs and which extends over said flexing edge, and means comprising an electrical control circuit connected to each electrical counting means for deenergizing each respective counting means on breakage of the specimen filament secured to its respective mounting peg.

3. A filament flexure fatigue tester comprising a flexing bar member having a curved surface forming a flexing edge, means rigidly mounting said flexing member for maintaining a fixed flexing edge, means including a mounting member for concurrently mounting a plurality of filaments thereon and a drive therefor sinusoidally reciprocating said mounting member for reciprocating a filament mounted thereon back and forth over said flexing edge, a plurality of electrical means for counting the reciprocations of said mounting member each arranged for association with one of said filament mountings, a separate electrically conductive weight of predetermined size adapted to be attached to each specimen filament which is secured to said mounting member and which extends over said flexing edge, means comprising an electrical control circuit connected to all of said electrical counting means for deenergizing each respective counting means on breakage of the specimen filament secured to said mounting member on the mounting respectively associated with said counting means, said electrical control circuit including a separate circuit breaker connected to each of said counting means for controlling the energization thereof. and means including a separate low contact pressure switch for energizing each respective circuit breaker responsive to breakage of the specimen filament associated therewith whereby said circuit breaker is actuated to open circuit position and said counting means is deenergized, said low contact pressure switch comprising a pair of electrically conductive elements insulated from each other and adapted to be electrically connected by said weight on breakage of said specimen filament and thereby to energize said circuit breaker.

4. A filament flexure fatigue tester comprising a flexing bar member having a curved surface forming flexing edge formed to a uniform curvature and size, means including a filament mounting member and a drive sinusoidally reciprocating said mounting member for reciprocating a filament mounted thereon back and forth over said flexing edge, electrical means for counting the reciprocations of said mounting member, an electrically conductive weight of predetermined size adapted to be attached to a specimen filament which is secured to said mounting member and which extends over said flexing edge, means comprising an electrical control circuit connected to said electrical counting means for deenergizing said counting means on breakage of the specimen filament secured to said mounting member, said electrical control circuit including a circuit breaker connected to said counting means for controlling the energization thereof, a signal amplifying circuit for energizing said circuit breaker to open circuit position whereby said counting means is deenergized, means including a low contact pressure switch for supplying a biasing signal to said signal amplifying circuit responsive to breakage of said specimen filament, said low contact pressure switch comprising a pair of electrically conductive elements insulated from each other and adapted to be electrically connected by said weight on breakage of said specimen filament and to said amplifying circuit for supplying said biasing signal thereto.

5. A filament flexure fatigue tester comprising a flexing member, means including a filament mounting bar for mounting a plurality of filament holding tabs thereon, said mounting bar having a slot bifurcating an end thereof, means including a pair of drawbars arranged with one end of one of said drawbars loosely extending through said mounting bar slot for supporting said mounting bar and having means on the end of said one drawbar for operatively engaging the respective adjacent end of said mounting bar and the corresponding end of the other of said drawbars having a closely-fitted connection to the other end of said mounting bar, bearing means for slidably supporting said drawbars substantially in parallelism, means for resiliently biasing each of said drawbars in a direction away from said mounting bar, means operatively engaging said mounting bar and cooperating with said drawbars for reciprocating said mounting bar towards and away from said flexing bar member, a plurality of means for counting the reciprocations of said mounting bar each comprising an electric counter, and means for energizing each electric counter in accordance with each reciprocation of said mounting bar, a plurality of electrically conductive weights each adapted to be attached to a specimen filament which is secured to said mounting bar and which extends over said flexing bar, means comprising an electrical control circuit connected to each electric counter for deenergizing each respective counter on breakage of its respective specimen filament secured to said mounting bar, each of said electrical control circuits including a circuit breaker connected to its respective counter for controlling the energization thereof, means including a low contact pressure switch for supplying a biasing signal for energizing said circuit breaker to actuate it to open-circuit position responsive to breakage of its said respective specimen filament whereby said counter is deenergized, said low contact pressure switch comprising a cup member of electrically insulating material having a female conical surface therein with the base thereof facing upwardly under one of said weights attached to a specimen filament secured to said mounting bar, said cup member having a slot therethrough extending diametrically across said female conical surface splitting the same into two parts, an electrically conductive surface on both parts of said split female conical surface insulatedly separated from each other, and means electrically connecting said conductive surfaces on said split parts to said circuit breaker for supplying said biasing signal thereto responsive to an electrical connection of said conductive split female conical surfaces by said conductive weight.

6. A filament flexure fatigue tester comprising a flexing member, means including a filament mounting bar having a plurality of longitudinally spaced upwardly extending pegs for mounting filament holding tabs thereon, said mounting bar having a slot substantially perpendicular to said pegs and bifurcating an end thereof, means including a pair of drawbars arranged with one end of one of said drawbars extending through said mounting bar slot for supporting said mounting bar and having means on the end of said one drawbar for operatively engaging the respective adjacent end of said mounting bar and the corresponding end of the other of said drawbars having a closely fitted connection to the other end of said mounting bar, bearing means for slidably supporting said drawbars substantially in parallelism, means for resiliently biasing each of said drawbars in a direction away from said mounting bar, means operatively engaging said mounting bar and cooperating with said drawbars for reciprocating said mounting bar towards and away from said flexing bar member, a plurality of means corresponding to said plurality of filament mounting pegs for counting the reciprocations of said mounting bar each comprising an electric counter and means for periodically energizing each electric counter in accordance with each reciprocating operation of said mounting bar, a plurality of electrically conductive weights each adapted to be attached to a specimen filament which is secured

to one of said mounting pegs and which extends over said flexing bar, means comprising an electrical control circuit connected to each electric counter for deenergizing each respective counter on breakage of its respective specimen filament secured to its respective mounting peg, each of said electrical control circuits including a circuit breaker connected to said counter for controlling the energization thereof, means including a low contact pressure switch for supplying a biasing signal for energizing said circuit breaker responsive to breakage of its said respective specimen filament whereby said circuit breaker is actuated to open-circuit position and said counter is deenergized, said low contact pressure switch comprising a cup member of electrically insulating material having a female conical surface therein with the base thereof facing upwardly under one of said weights attached to a specimen filament secured to said peg, said cup member having a slot therethrough extending diametrically across said female conical surface splitting the same into two parts, an electrically conductive surface on both parts of said split female conical surface insulatedly separated from each other, and means electrically connecting said conductive surfaces on said split parts to said circuit breaker for supplying said biasing signal thereto responsive to an electrical connection of said conductive split female conical surfaces by said conductive weight.

7. A filament flexure fatigue tester comprising a flexing bar member having a curved surface forming a flexing edge, means including a filament mounting bar having a plurality of longitudinally spaced upwardly extending pegs for mounting filament holding tabs thereon, said mounting bar having a slot therein, means including a drawbar arranged with one end loosely extending through said mounting bar slot and having means on the end thereof for operatively engaging said mounting bar, bearing means for slidably supporting said drawbar, means for resiliently biasing said drawbar in a direction away from said mounting bar, means operatively engaging said mounting bar and cooperating with said drawbar for reciprocating said mounting bar towards and away from said flexing edge, a plurality of means corresponding to said plurality of filament mounting pegs for counting the reciprocations of said mounting bar each comprising an electric counter and means for periodically energizing each electric counter in accordance with each reciprocation of said mounting bar, a plurality of electrically conductive weights each of a predetermined size adapted to be attached to a specimen filament secured to one of said mounting pegs and extending over said flexing edge, means comprising an electrical control circuit connected to each electric counter for deenergizing each respective counter on breakage of the specimen filament secured to its respective mounting peg, each of said electrical control circuits including a circuit breaker connected to said counter for controlling the energization thereof, means including a low contact pressure switch for supplying a biasing signal for energizing said circuit breaker for actuation thereof to open circuit position responsive to breakage of its said respective specimen filament whereby said counter is deenergized, said low contact pressure switch comprising a cup member of electrically insulating material having a female conical surface therein with the base thereof facing upwardly substantially in longitudinal alignment with its respective mounting peg and adapted to be directly under one of said weights attached to a specimen filament secured to said peg, said cup member having a slot therethrough extending diametrically across said female conical surface splitting the same into two parts, an electrically conductive surface on both parts of said split female conical surface insulatedly separated from each other, and means electrically connecting said conductive surfaces on said split parts to said circuit breaker for supplying said biasing signal thereto responsive to an electrical connection of said conductive split female conical surfaces by said conductive weight.

8. A filament flexure fatigue tester comprising a flexing member comprising a small substantially round cylindrical element forming a curved flexing edge with a diameter of between .5 and 5 filament diameters, means rigidly mounting said small cylindrical element member for maintaining a fixed flexing edge, means including a filament mounting bar having a plurality of upwardly extending pegs spaced longitudinally thereof for mounting filament holding tabs thereon, means including a pair of drawbars arranged with one end of each operatively engaging a separate end of said mounting bar for supporting said mounting bar, bearing means for slidably supporting said drawbars substantially in parallelism, means including a compression spring for resiliently biasing each of said drawbars in a direction away from said mounting bar and biasing said end means thereon into firm engagement with said mounting bar, means including an eccentric roller drive member operatively engaging said mounting bar and cooperating with said drawbars for sinusoidally reciprocating said mounting bar towards and away from said flexing edge, a plurality of means corresponding to said plurality of filament mounting pegs for counting the reciprocations of said mounting bar each comprising an electric counter and a cam operated relay for periodically energizing each electric counter in accordance with each reciprocation of said mounting bar, a plurality of electrically conductive weights each of a predetermined size adapted to be attached to a specimen filament secured to one of said mounting pegs and extending over said flexing edge, means comprising an electrical control circuit connected to each electric counter for deenergizing each respective counter on breakage of the specimen filament secured to its respective mounting peg, each of said electrical control circuits including a circuit breaker connected to said counter for controlling the energization thereof, a signal amplifying circuit for energizing said circuit breaker to open circuit position whereby said counter is deenergized, means including a low contact pressure switch for supplying a biasing signal to said amplifying circuit responsive to breakage of its said respective specimen filament, said low contact pressure switch comprising a pair of electrically conductive elements insulated from each other and adaptable to be electrically connected by said weight on breakage of the respective specimen filament and being connected in said amplifying circuit for supplying said biasing signal thereto.

9. A filament flexure fatigue tester comprising a flexing bar member having a curved surface forming a flexing edge with a diameter of between .5 and 5 filament diameters accurately formed to a uniformly rounded curvature and size, means including a filament mounting bar having a plurality of upwardly extending pegs spaced longitudinally thereof for mounting filament holding tabs thereon, means including a pair of drawbars arranged with one end of each operatively engaging a separate end of said mounting bar for supporting said mounting bar, bearing means for slidably supporting said drawbars substantially in parallelism, means including a compression spring for resiliently biasing each of said drawbars in a direction away from said mounting bar and biasing said end means thereon into firm engagement with said mounting bar, means including an eccentric roller drive member operatively engaging said mounting bar and cooperating with said drawbars for sinusoidally reciprocating said mounting bar towards and away from said flexing edge against the resilient pressure of said springs, a plurality of means corresponding in number to said plurality of filament mounting pegs for counting the reciprocations of said mounting bar each comprising an electric counter and a cam operated relay for periodically energizing each electric counter in accordance with each reciprocation of said mounting bar, means including a plurality of electrically

conductive weights each of a predetermined size adapted to be attached to a specimen filament secured to one of said mounting pegs and extending over said flexing edge, means comprising an electrical control circuit connected to each electric counter for deenergizing each respective counter on breakage of the specimen filament secured to its respective mounting peg, each of said electrical control circuits including a circuit breaker connected to said counter for controlling the energization thereof, a signal amplifying circuit for energizing said circuit breaker to open circuit position whereby said counter is deenergized, means including a low contact pressure switch for supplying a biasing signal to said signal amplifying circuit responsive to breakage of its said respective specimen filament, said low contact pressure switch comprising a cup member of electrically insulating material having a female conical surface therein with the base thereof facing upwardly under one of said weights attached to a specimen filament, said cup member having a slot therethrough extending diametrically across said female conical surface splitting the same into two parts, an electrically conductive surface comprising a thin coating of conductive paint on both parts of said split female conical surface extending from short of the apex thereof to assure complete insulation between said split parts and over said outer base and outer side of said cup to points separated by said slot, and means electrically connecting said conductive surfaces on said split parts to said signal amplifying circuit for supplying said biasing signal thereto responsive to an electrical connection of said conductive split female conical surfaces by said conductive weight.

10. A filament flexure fatigue tester including a flexing member comprising a wire forming a curved flexing edge with a diameter of between .5 and 5 filament diameters, means rigidly mounting said flexing wire member for maintaining a fixed flexing edge, means including a filament mounting member and a drive sinusoidally reciprocating said mounting member for reciprocating a filament mounted thereon back and forth over said flexing edge, electrical means for counting the reciprocations of said mounting member, an electrically conductive weight of predetermined size adapted to be attached to a specimen filament secured to said mounting member and extending over said flexing edge, means comprising an electrical control circuit connected to said electrical counting means for deenergizing said counting means on breakage of the specimen filament secured to said mounting member, said electrical control circuit including a circuit breaker connected to said counting means for controlling the energization thereof, a signal amplifying circuit for energizing said circuit breaker to open-circuit position whereby said counting means is deenergized, means including a low contact pressure switch for supplying a biasing signal to said signal amplifying circuit responsive to breakage of its said specimen filament, said low contact pressure switch comprising a cup member of electrically insulating material having a female conical surface therein with the base thereof facing upwardly under said weight attached to a specimen filament, said cup member having a slot therethrough extending diametrically across said female conical surface splitting the same into two parts, an electrically conductive surface on both parts of said split female conical surface extending from short of the apex thereof to assure complete insulation between said split parts and over said outer base and outer side of said cup to points separated by said slot, and means electrically connecting said conductive surfaces on said split parts to said amplifying circuit for supplying said biasing signal thereto responsive to an electrical connection of said conductive split female conical surfaces by said conductive weight on breakage of said specimen filament.

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