United States Patent

Schmid et al.

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[45] **July 25, 1972**

[54] BOOK SHEET TESTING APPARATUS

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[52] **U.S. Cl.** **73/93**, 73/100

[51] **Int. Cl.** **G01n 3/32**

[58] **Field of Search** 73/100, 95, 96, 93

[56] **References Cited**

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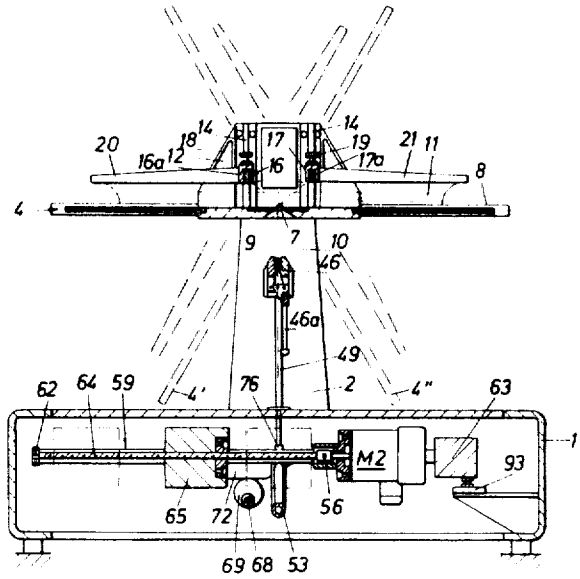
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[57] **ABSTRACT**

Apparatus for testing the strength of connections between the rear edges of sheets and the backs of books comprises an oscillatable table which supports a book in open position and has a slot through which the selected sheet extends downwardly to be engaged by a gripper. Dynamic testing takes place in response to oscillation of the table, and static testing takes place in response to exertion upon the selected sheet of a variable tensional stress which is transmitted by way of the gripper. Both testing operations are terminated in automatic response to extraction of the selected sheet from the back of the book.

17 Claims, 5 Drawing Figures



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4 Sheets-Sheet 1

Fig.1

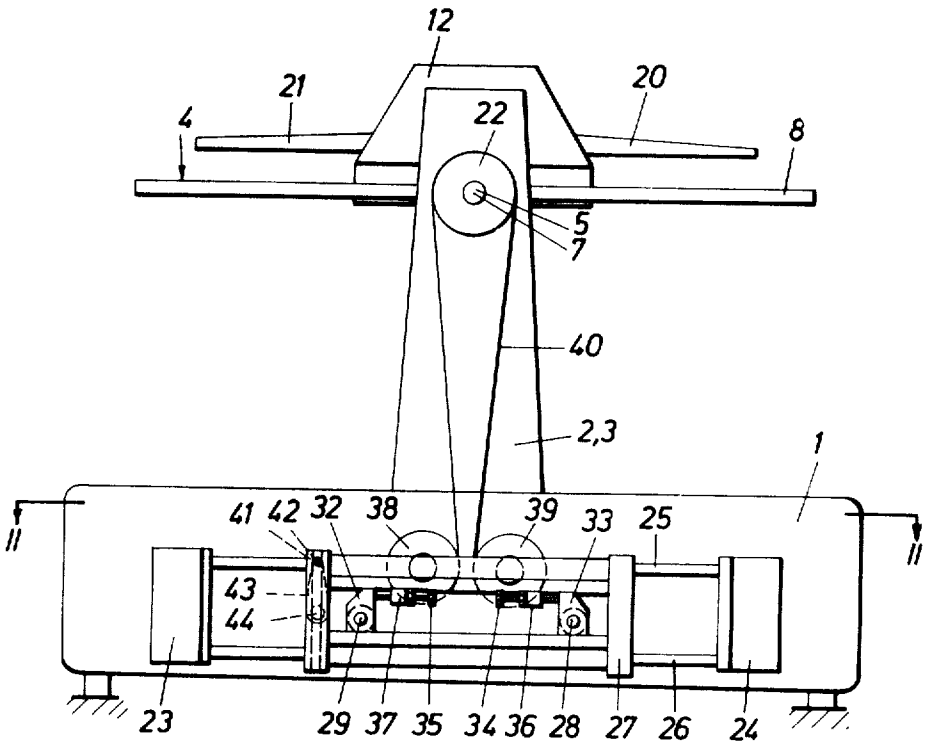
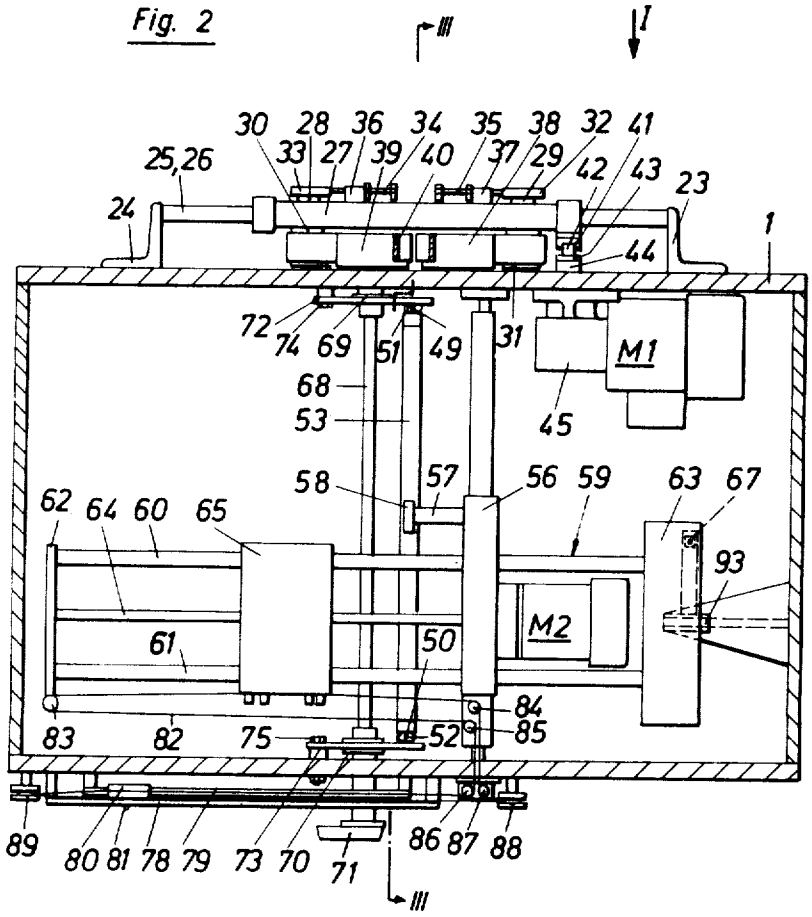


Fig. 2


III
I
30
28
36
34
35
38
32
41
33
27
39
40
37
29
42
43
25,26
23
24
1
44
72
74
69
51
49
31
M1
68
53
45
58
57
56
59
63
67
62
64
60
65
93
M2
61
50
84
83
82
75
52
85
89
80
81
78
79
73
70
71
86
87
88
III

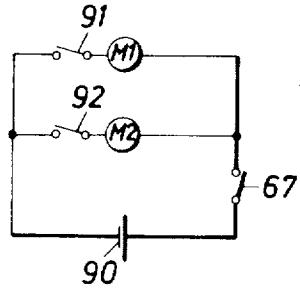

91
M1
92
M2
67
90

Fig. 5

Fig. 3

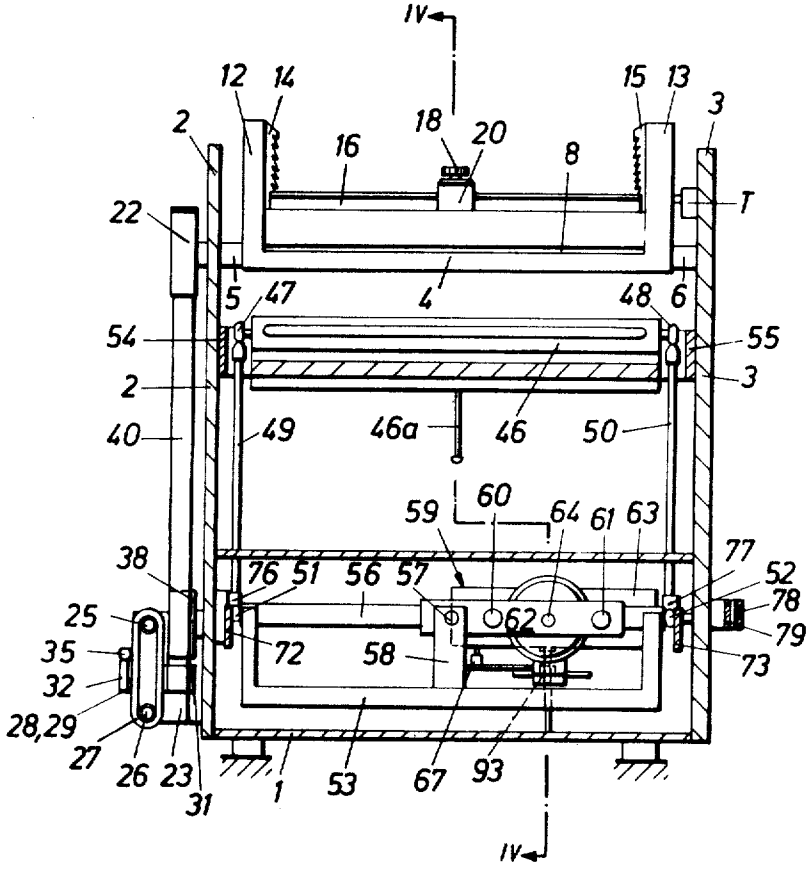
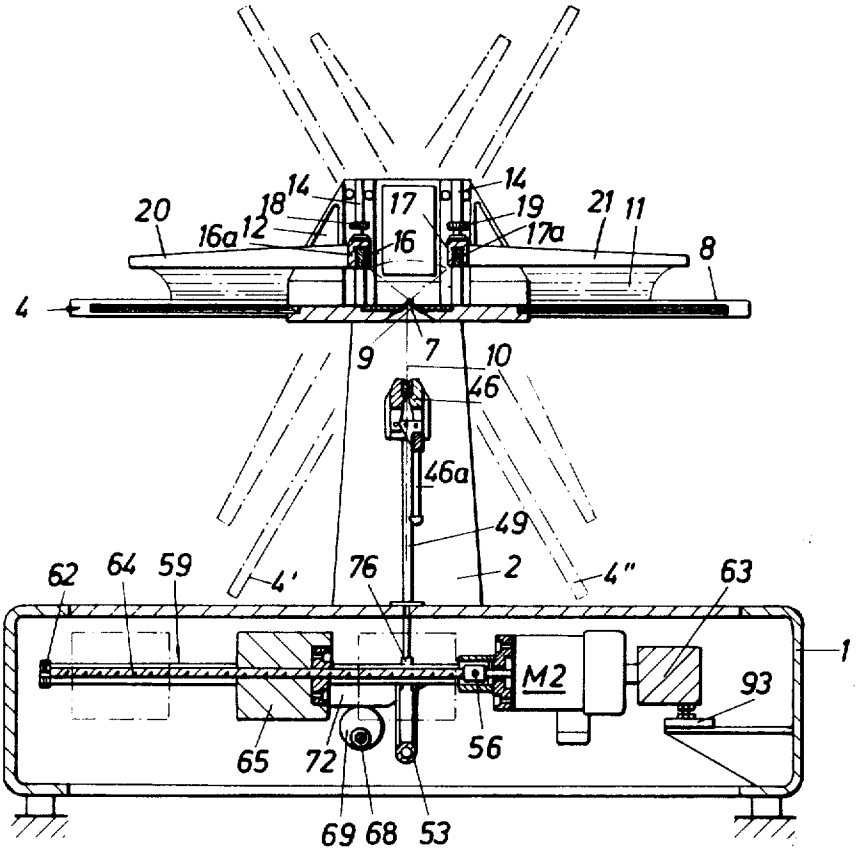

IV
12
14
15
13
3
2
18
20
16
8
T
22
5
47
4
48
6
54
55
2
3
40
49
46a
46
50
59
60
64
61
63
38
76
51
56
57
77
52
78
25
62
79
35
72
58
73
32
28,29
27
26
23
31
1
53
67
93
IV

Fig. 4


20
18
14
12
16a
17
16
19
17a
21
11
8
4
9
7
10
46
46a
49
62
64
59
4'
76
2
4"
63
1
M2
93
65
72
56
69
68
53

BOOK SHEET TESTING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for testing the connections between the rear edges of sheets and the backs of books, magazines or the like. More particularly, the invention relates to improvements in apparatus for determining the magnitude of the resistance which must be overcome in order to extract a sheet from a book, magazine, brochure or the like wherein the rear edges of sheets are adhesively bonded or otherwise secured to the back of the book.

At the present time, the strength of connections between the rear edges of sheets and the backs of books is tested in accordance with either one of two methods which respectively involve static and dynamic stressing. The method of subjecting a selected sheet to static stresses involves opening the book, clamping it to a support, engaging the selected sheet by means of a gripper or tongs, and applying to the gripper a force which produces on the selected sheet a pull in a direction away from the back of the book. The magnitude of that force which results in extraction of the rear edge of the selected sheet from the back of the book is indicative of the static resistance of the sheet to extraction of its rear edge.

Dynamic testing involves engaging the selected sheet with a gripper, exerting on the gripper a pull of constant magnitude, and employing an arm of the like to swing the selected sheet back and forth until the rear edge of the sheet is extracted from the back. The number of oscillations is indicative of the dynamic resistance which the sheet was capable to offer to extraction of its rear edge.

A drawback of conventional methods is that such dynamic and static testing operations must be carried out by resorting to two entirely different apparatus. This contributes to the cost of testing. Moreover, two discrete apparatus occupy a substantial amount of space which is at a premium in bookbinding shops and like establishments.

SUMMARY OF THE INVENTION

An object of the invention is to provide a relatively simple and compact apparatus which allows for dynamic and/or static testing of sheets in books, brochures, magazines or the like.

Another object of the invention is to provide an apparatus which can be readily converted from static testing to dynamic testing or vice versa, and which allows for continuous and accurate determination of static and/or dynamic stresses to which one or more selected sheets of a book are subjected in the course of a testing operation.

A further object of the invention is to provide an apparatus wherein certain components which are used for static testing can perform useful functions in the course of dynamic testing, or vice versa.

An additional object of the invention is to provide an apparatus which can test sheets in books of different sizes, shapes and/or thicknesses and which can be automatically arrested in response to completion of a testing operation.

The invention is embodied in an apparatus for testing the strength of connections between the rear edges of sheets and the backs of books, magazines, brochures or the like (hereinafter called books). The apparatus comprises a first testing unit which can be operated to subject the connection between at least one selected sheet and the back of a book to dynamic stresses (for example, by oscillating the selected sheet or sheets with reference to the remainder of the book or vice versa about an axis which coincides with the rear edge of the selected sheet while the sheet is simultaneously subjected to a tensional stress acting thereon at right angles to its rear edge and tending to cause extraction of such rear edge from the back of the book), and a second testing unit which can subject the connection between at least one selected sheet and the back of a book to static stresses (for example, by varying the aforementioned tensional stress by way of a balance arm which acts on the gripper and tends to move the gripper away from the rear edge of the selected sheet with a controllable force).

The number of oscillations and the magnitude of the tensional stress can be recorded to enable the operator to determine the maximum resistance of the selected sheet or sheets to dynamic and static stresses.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved testing apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic side elevational view of a testing apparatus which embodies one form of the invention, substantially as seen in the direction of the arrow I in FIG. 2;

FIG. 2 is a horizontal sectional view as seen in the direction of arrows from the line II—II of FIG. 1;

FIG. 3 is a vertical sectional view as seen in the direction of arrows from the line III—III of FIG. 2;

FIG. 4 is a vertical sectional view as seen in the direction of arrows from the line IV—IV of FIG. 3; and

FIG. 5 is a circuit diagram of the prime movers in the apparatus of FIGS. 1–4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing in detail, the testing apparatus comprises a fixedly mounted hollow housing or base 1 provided with two upwardly extending arms or holders 2, 3 which are mirror symmetrical with reference to a vertical plane which halves the housing and is normal to the plane of FIG. 3. The holders, 2, 3 respectively support the trunnions 5, 6 of a table-like support 4 (hereinafter called table) oscillatable about a horizontal axis 7. The top surface 8 of the table 4 serves to support an opened book 11 (FIG. 4) in such a way that it serves as a rest for the exposed surfaces of two sheets, namely, of those sheets which flank the sheet or sheets selected for testing in accordance with the present invention.

The table 4 is provided with an elongated slot 9 which is parallel to the axis 7 and which serves for introduction of the selected sheet. Such sheet is then located in a plane 10 which includes the axis 7. The width of the slot 9 is selected in such a way that it permits convenient introduction of at least one sheet. The axis 7 is located slightly above the plane of the supporting surface 8, preferably at such a distance from this plane as corresponds to the distance between the bound rear edge of the selected sheet and the surface 8. The book 11 whose sheet or sheets are to be tested is opened up, the sheet which is selected for testing is introduced into the slot 9, and the exposed sides of sheets which flank such selected sheet are placed onto the surface 8 of the table 4. The book 11 is centered on the table 4 in such a way that the entire sheet to be tested is located in the plane 10. The rear edge of the selected sheet then coincides, at least substantially, with the sommon axis 7 of the trunnions 5 and 6. Such centering of the book 11 is facilitated by the fact that the portions of the surface 8 at both sides of the slot 9 are curved upwardly as best shown in FIG. 4. This insures that the exposed sides of the sheets which flank the selected sheet lie on the surface 8 all the way (or nearly all the way) to the back where the rear edges of the sheets are bound to each other, for example, by means of an adhesive.

The means for clamping the book 11 to the table 4 in the just described position comprises two upstanding walls 12, 13 which are secured to or form integral parts of the table 4 and are adjacent to the trunnions 5, 6. The inner sides of the walls 12, 13 are provided with pairs of toothed racks 14, 15 best shown in FIG. 3. As illustrated in FIG. 4, the racks 14 on the wall 12 are disposed at the opposite sides of the plane 10. The clamping means further comprises two pressing members 16, 17 in the form of rails whose ends carry elastically mounted pawls which can be engaged by the teeth of one of the racks

14 and by the teeth of the corresponding rack 15. When an open book 11 is placed onto the surface 8 of the table 4, the rails 16, 17 are pushed downwardly whereby their pawls ride over the downwardly inclined flanks of teeth on the corresponding racks 14, 15 until the rails abut against or are closely adjacent to the front and rear covers of the book. The undersides of the rails 16, 17 are provided with longitudinally extending grooves (shown in FIG. 4) which accommodate inserts 16*a*, 17*a* serving to bear directly against the covers of the book 11. The operator then rotates screws 18, 19 which mesh with the rails 16, 17 and respectively bear against the inserts 16*a*, 17*a* whereby the inserts move downwardly and fixedly secure the book 11 to the table 4. The rails 16, 17 are respectively provided with outwardly extending arms 20, 21 which also abut against the outer sides of the respective covers to further prevent uncontrolled movement of the book 11 with reference to the table 4. Proper manipulation of the screws 18 and 19 insures that the inserts 16*a*, 17*a* subject the corresponding covers of the book 11 to identical or nearly identical stresses all the way from the upper to the lower edges of the covers.

The first testing unit which subjects the selected sheet or sheets to dynamic stresses comprises means for oscillating or rocking the table 4 and the major part (remainder) of the book 11 with reference to the selected sheet or sheets, i.e., with reference to each sheet which extends downwardly through and beyond the slot 9 in the table 4. For example, the first testing unit can be designed to rock the table 4 back and forth between the phantom-line end positions 4' and 4'' shown in FIG. 4. This testing unit comprises a pulley 22 which is secured to the trunnion 5 and is outwardly adjacent to the holder 2. An elongated flexible element 40, e.g., a steel band or belt, is trained over the pulley 22 and its end portions are respectively trained over two additional pulleys or idler pulleys 38, 39 rotatably mounted in a carriage 27 reciprocable along horizontal tie rods 25, 26 which are secured to brackets 23, 24 affixed to the outer side of the housing 1 as best shown in FIG. 1. The carriage 27 supports two turnable adjusting shafts 28, 29 whose axes are parallel to the axes of the pulleys 22, 38, 39 and which respectively carry clamps 30, 31 engaging the adjacent extremities of the belt 40. The outer end portions of the adjusting shafts 28, 29 respectively carry levers 33, 32 which abut against the tips of adjustable screws or bolts 35, 34 mounted in nuts 37, 36 fixed to the carriage 27. The screws 35, 34 are rotatable with reference to the nuts 37, 36 to thereby change the angular positions of shafts 28, 29 and clamps 30, 31. By rotating the screws 34, 35, the operator can select the tension of the belt 40.

The drive means for moving the carriage 27 back and forth along the tie rods 25, 26 and for thereby oscillating the table 4 and the part of the book 11 with reference to the selected sheet (which extends through the slot 9) comprises a motor M1 (FIGS. 2 and 5) which is mounted in the housing 1 and drives a variable-speed transmission 45. The output shaft 44 of the transmission 45 is fixedly secured to a crank arm 43 having at its opposite end a roller follower 42 which extends into the vertical groove of a motion receiving guide 41 affixed to the carriage 27. When the motor M1 is on and rotates the output shaft 44 of the transmission 45, the follower 42 on the crank arm 43 orbits about the axis of the shaft 44 and causes the guide 41 to move the carriage 27 back and forth between two predetermined end positions. A counter T (FIG. 3) of any known design is provided to record the number of oscillations of the table 4, such number being indicative of the resistance of the rear edge of the selected sheet to dynamic stresses which arise when the table 4 is rocked by the pulley 22 and belt 40. The just described first testing unit which subjects one or more selected sheets to dynamic stresses can be operated independently of the second testing unit, for example, when the person in charge merely wishes to determine the maximum number of oscillations which the rear edge of a selected sheet can stand prior to being extracted from the back of the book 11 on the table 4.

The second testing unit comprises a device for stressing a gripper or tongs 46 having two jaws which extend in parallelism with the axis 7 at a level below the table 4 and can engage or release the adjacent sides of the selected sheet in response to pivoting of a handle 46*a* which actuates a conventional toggle mechanism (not shown). The longitudinal ends of the gripper 46 are adjacent to the holders 2, 3 and are coupled to upper end portions of two upright links 49, 50 by means of ball and socket joints 47, 48 or analogous universal joints. The joints 47, 48 are guided in vertical grooves provided therefor in ways 54, 55 respectively secured to the inner sides of the holders 2, 3 (see FIG. 3). The lower end portions of the links 49, 50 are articulately coupled to the adjacent ends of an inverted U-shaped horizontal yoke 53 by means of ball and socket joints 51, 52. The parts 46, 49, 50, 53 together constitute a parallelogram motion mechanism which is movable up and down in the plane 10 to subject the selected sheet to a static stress in response to downward movement of the yoke 53. The device for urging the yoke 53 downwardly with a controlled force comprises a horizontal shaft 56 which is journalled in the housing 1 and is provided with a rigid radially extending arm 57. The free end of the arm 57 is provided with an antifriction bearing (not shown) for the free end of a second arm 58 which is rigid with the horizontal portion of the yoke 53. The shaft 56 constitutes the fulcrum for a balance arm 59 including two spaced parallel cylindrical rods 60, 61 which are fixed to the shaft 56. The left-hand ends of the rods 60, 61 are fixedly secured to a crosshead 62 (see particularly FIG. 2) and their right-hand ends are fixedly secured to a counterweight 63. A second weight or mass 65 is slidably guided by the rods 60, 61 for reciprocating movement along that portion of the balance arm 59 which extends between the crosshead 62 and shaft 56 to thereby tend to change the inclination of the balance arm 59, the position of the yoke 53, and hence the tensional stress on the selected sheet of the book 11. Changes in inclination of the balance arm 59 affect downward movement of the yoke 53 and gripper 46 by way of the arms 57 and 58.

The shaft 56 or the right-hand portion of the balance arm 59 carries an electric motor M2 whose externally threaded output shaft 64 constitutes a fee screw which is parallel with the rods 60, 61 and meshes with a spindle nut (not shown) of the movable weight 65. Thus, when the motor M2 is on, the output shaft 64 moves the weight 65 toward the crosshead 62 to thereby increase the tensional stress upon the selected sheet of the book 11.

As shown in FIG. 5, the motors M1 and M2 are connected in parallel with each other and in series with an energy source 90 as well as with a normally closed master switch 67 which is controlled by the counterweight 63, i.e., by the balance arm 59. The master switch 67 is opened to thus arrest the motors M1 and M2 when the balance arm 59 pivots in a counterclockwise direction, as viewed in FIG. 4.

The means for moving and holding the balance arm 59 in a neutral position, for example, when the second testing unit is to remain idle, comprises a horizontal shaft 68 which is mounted in the housing 1 and is parallel with the shaft 56. The shaft 68 is rigidly connected with two disk-shaped eccentrics 69, 70 which are respectively adjacent to the lower ends of the holders 2 and 3. A portion of the shaft 68 extends from the housing 1 and is provided with a handle 71 which can be turned by hand. The eccentrics 69, 70 can pivot two levers 72, 73 which are mounted in the housing 1 on pivot pins 74, 75 and can be moved into engagement with the undersides of annular abutments 76, 77 on the links 49, 50. When the lever 71 is turned in a direction to pivot the levers 72, 73 upwardly (by way of the eccentrics 69, 70), the levers 72, 73 respectively bear against the abutments 76, 77 to hold the gripper 46 in an upper end position and to simultaneously maintain the balance arm 59 in neutral position in which the counterweight 63 abuts against a fixed stop 93 in the housing 1. When the lever 71 is turned in the opposite direction, the levers 72, 73 can move away from the abutments 76, 77.

The second testing unit further comprises a device for indicating the magnitude of the tensional stress on the selected sheet of the book **11**. The indicating device includes an elongated scale **78** which can be calibrated in kilograms or pounds and is attached to or provided on the outer side of the housing **1**. The scale **78** is mounted in front of a horizontal guide **79** for a slide **80** which is provided with a pointer **81** arranged to travel along the scale **78**. The slide **80** is connected with the median portion of a cord or string **82** whose ends are secured to the movable weight **65**. the cord **82** is trained over sheaves **83, 84, 85, 86, 87, 88, 89** in a manner as shown in FIG. **2** so that it moves the pointer **81** along the scale **78** in response to movement of the weight **65** along the rods **60, 61** of the balance arm **59**.

Referring again to FIG. **5**, when the switch **91** is opened by the operator, the first testing unit is inactive. Opening of the switch **92** inactivates the second testing unit. When the second testing unit is idle, the selected sheet is preferably subjected to a tensional stress of fixed magnitude; for example, such tensional stress can be applied by moving the balance arm **59** to neutral position.

When the rear edge of the selected sheet is extracted from the back of the book **11**, the balance arm **59** tilts in a direction to move the weight **65** to a lower level whereby the counterweight **63** permits opening of the master switch **67** and thus stops the motors M1 and M2. The number of oscillations of the table **4** is read on the counter T and the tensional stress is determined by reading the position of the pointer **81** with reference to the scale **78**.

If the switch **91** is open and the switch **92** is closed, the motor M2 drives the weight **65** to increase the tensional stress on the selected sheet. When the selected sheet tears or is extracted from the back of the book **11**, the weight **65** descends and the counterweight immediately opens the master switch **67**. Such movement of the weight **65** about the axis of the shaft **56** does not cause any changes in the position of the pointer **81** so that the latter indicates that tensional stress which resulted in tearing or extraction of the sheet. Analogously, when the selected sheet tears or is extracted in response to oscillation of the table **4** while the switch **92** is open, the number of oscillations as indicated by the counter T represents the magnitude of that dynamic stress which caused the sheet to tear or to be extracted from the back of the book **11**.

It will be seen that the first testing unit comprises rocking means (**22, 27, 40**, M1) for oscillating the remainder of a book **11** on the table **4** with reference to the selected sheet (which extends through the slot **9**) and the gripper **46** which subjects the selected sheet to a tensional stress acting at right angles to the rear edge of the selected sheet. The second testing unit comprises means (**56, 59**, M2, **65**) for varying the magnitude of tensional stress by way of the parallel motion mechanism including the gripper **46**. Thus, the latter forms part of both testing units.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims

1. Apparatus for testing the strength of connections between the rear edges of sheets and the backs of books, comprising a support for the sheets flanking at least one selected sheet in open position of a book; means for clamping the book to said support; first testing means for subjecting the connection between the selected sheet and the back of the book on said support to dynamic stresses, comprising rocking means for effecting repeated oscillatory movements between the selected sheet and the remainder of the book about an axis which coincides, at least substantially, with the rear edge of the selected sheet while the selected sheet is simultaneously subjected to tensional stresses acting thereon substantially at right angles to said axis, said rocking means comprising motor means operative to oscillate said support and the remainder of the book with reference to the selected sheet, and gripper means operative to engage and to subject the selected sheet to said tensional stresses; and second testing means for subjecting the connection between the selected sheet and the back of the book to static stresses, comprising second motor means operative to vary the tensional stress upon the selected sheet by way of said gripper means, means for rendering said motor means inoperative in response to extraction of the rear edge of the selected sheet from the back of the book on said support, means for indicating the magnitude of tensional stresses upon the selected sheet, and means for indicating the number of oscillations.

2. Apparatus for testing the strength of connections between the rear edges of sheets and the backs of books, comprising a support for a book; clamping means for securing the book to said support; first testing means for subjecting the connection between at least one selected sheet and the back of the book on said support to dynamic stresses, comprising gripper means for applying to the selected sheet tensional stresses acting in a direction away from the rear edge of such selected sheet and rocking means for oscillating said support and the book thereon with reference to the thus gripped selected sheet, said rocking means including a pulley secured to said support and turnable about an axis which coincides, at least substantially, with the rear edge of the selected sheet, a flexible element trained over said pulley, and motor means operative to move said flexible element back and forth to thus oscillate said support by way of said pulley; and second testing means for subjecting the connection between at least one selected sheet and the back of the book to static stresses by way of said gripper means.

3. Apparatus as defined in claim **2**, wherein said first testing means further comprises a reciprocable carriage and said flexible element has end portions connected to said carriage, said motor means being arranged to reciprocate said carriage.

4. Apparatus as defined in claim **3**, wherein said flexible element is a metallic band and further comprising a crank drive interposed between said motor means and said carriage.

5. Apparatus for testing the strength of connections between the rear edges of sheets and the backs of books, comprising a support for the sheets flanking at least one selected sheet in the open position of a book; means for clamping the book to said support; first testing means for subjecting the connection between the selected sheet and the back of the book on said support to dynamic stresses, comprising rocking means for effecting repeated oscillatory movements between the selected sheet and the remainder of the book on said support about an axis which coincides, at least substantially, with the rear edge of the selected sheet and gripper means operative to engage and subject the selected sheet to tensional stresses; and second testing means for subjecting the connection between said selected sheet and the back of the book on said support to static stresses, comprising means for varying the tensional stress upon the selected sheet by way of said gripper means while the connection between the selected sheet and the back of the book on said support is subjected to dynamic stresses.

6. Apparatus as defined in claim **5**, wherein said rocking means comprises means for oscillating said support and the remainder of the book with reference to the selected sheet.

7. Apparatus as defined in claim **5**, wherein said support has a surface against which the sheets flanking the selected sheet abut and wherein said axis is parallel to said surface.

8. Apparatus as defined in claim **5**, wherein, said support has a surface against which the sheets flanking the selected sheet abut and provided with a slot through which the selected sheet extends, the width of said slot being a multiple of the thickness of a sheet and said slot being at least substantially

parallel to the rear edge of the selected sheet in clamped position of the book on said support.

9. Apparatus as defined in claim 5, wherein said gripper means is arranged to maintain the selected sheet in a substantially vertical plane.

10. Apparatus as defined in claim 9, wherein said gripper means is disposed below said support.

11. Apparatus as defined in claim 9, wherein said gripper means forms part of a parallel motion which further includes substantially vertical links connected with said gripper means, and further comprising guide means defining a substantially vertical path for said links.

12. Apparatus as defined in claim 11, wherein said stress varying means of said second testing means comprises a balance arm tiltable about a predetermined axis and operatively connected with said parallel motion to urge said gripper means downwardly with a variable force and to thus subject the selected sheet to tensional stresses acting substantially at right angles to the rear edge of such sheet.

13. Apparatus as defined in claim 12, wherein said balance arm includes a first portion at one side of said predetermined axis and a second portion at the other side of said predetermined axis, said first portion being operatively connected with said parallel motion and said second testing means further comprising a weight movable lengthwise of said first portion.

14. Apparatus as defined in claim 13, wherein said second testing means further comprises motor means mounted on said second portion of said balance arm and arranged to move said weight lengthwise of said first portion.

15. Apparatus as defined in claim 14, wherein said motor means comprises an externally threaded output shaft and said weight includes an internally threaded portion meshing with said output shaft to effect movement of said weight lengthwise of the first portion of said balance arm in response to rotation of said output shaft.

16. Apparatus as defined in claim 5, wherein each of said testing means comprises an electric motor and further comprising normally closed switch means in circuit with said motors and means for opening said switch means in response to extraction of the rear edge of the selected sheet from the back of the book.

17. Apparatus as defined in claim 16, wherein said stress varying means of said second testing means comprises a balance arm tiltable about a predetermined axis and means for applying to the selected sheet tensional stresses whose magnitude varies in response to tilting of said balance arm, said means for opening said switch means including a counterweight on said balance arm.

* * * * *