

Nov. 9, 1971

D. H. BECKSTROM

3,618,372

METHOD AND APPARATUS FOR TESTING THE PENETRATION
RESISTANCE OF REINFORCED SHEET MATERIAL

Filed March 9, 1970

4 Sheets-Sheet 1

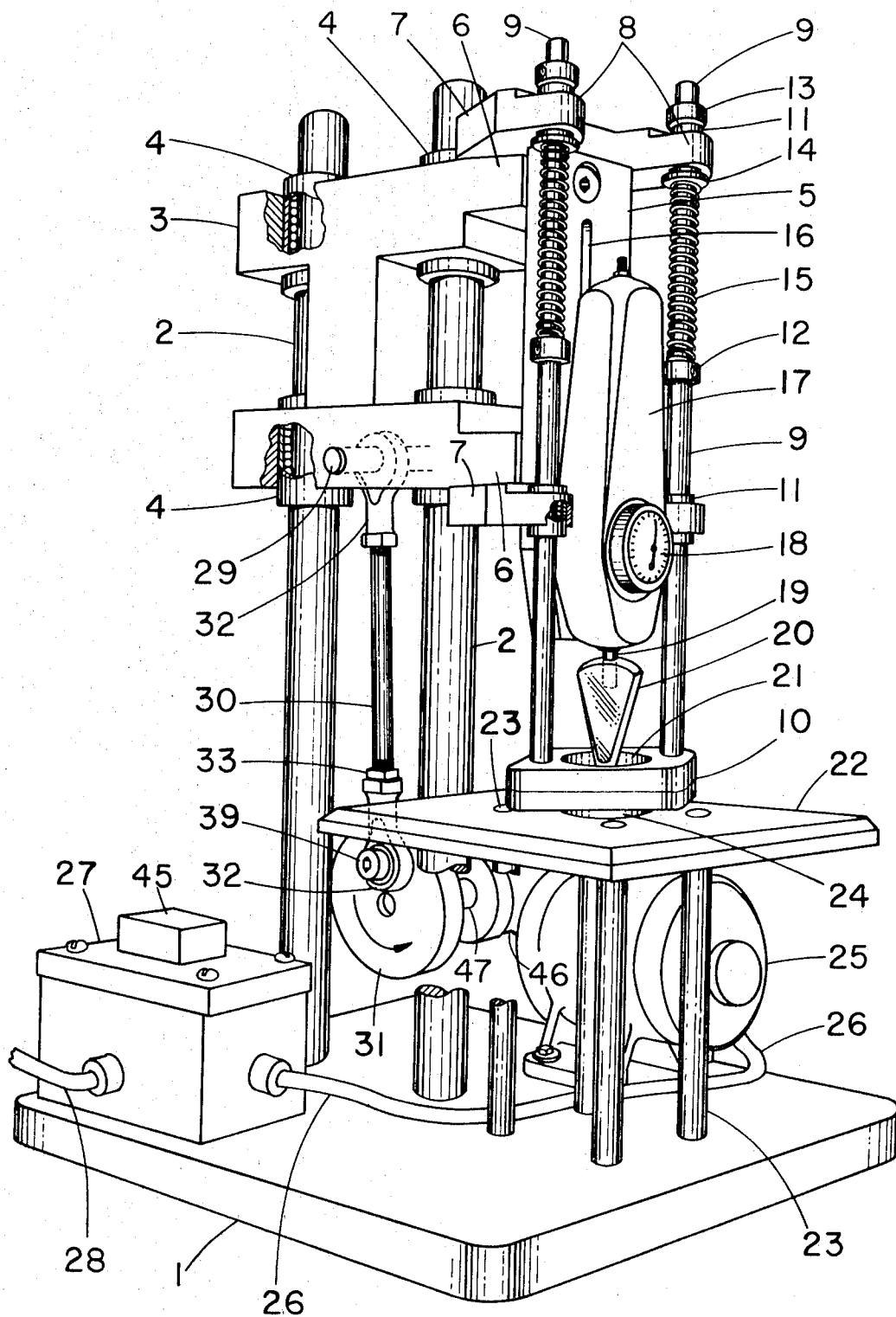


FIG. 1

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4 Sheets-Sheet 2

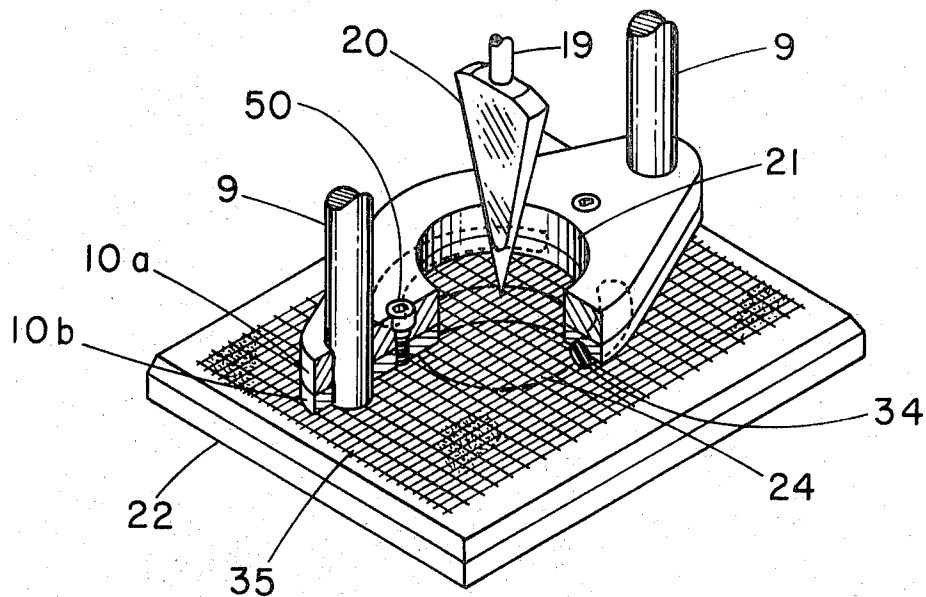


FIG. 2

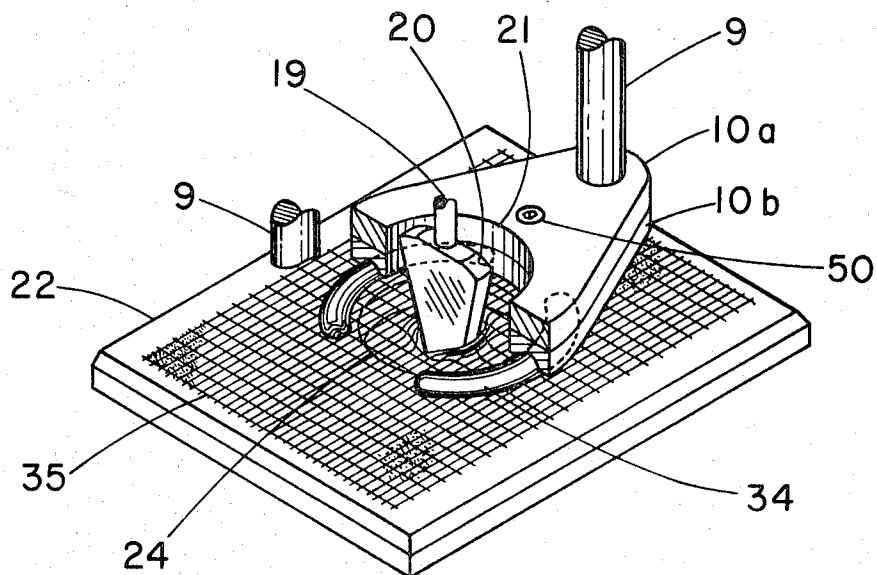


FIG. 3

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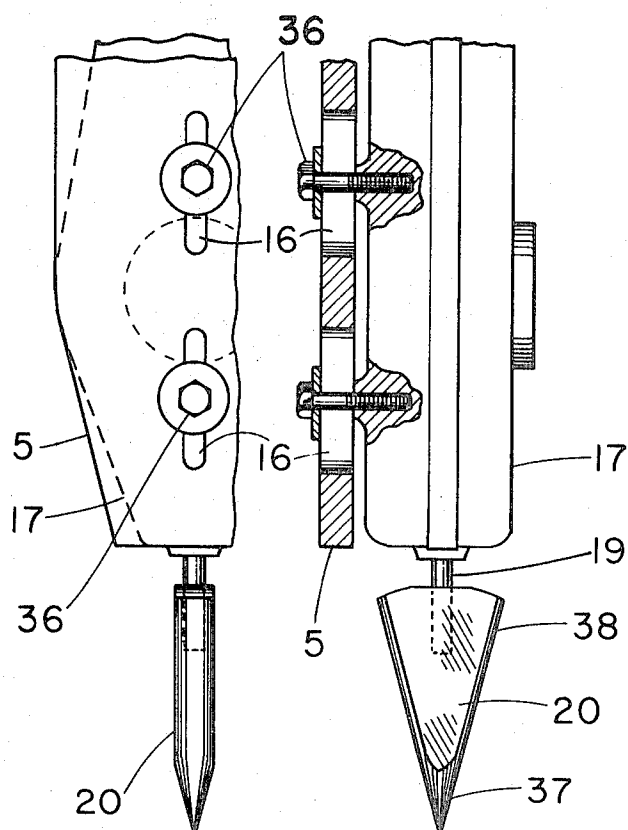


FIG. 4

FIG. 4a

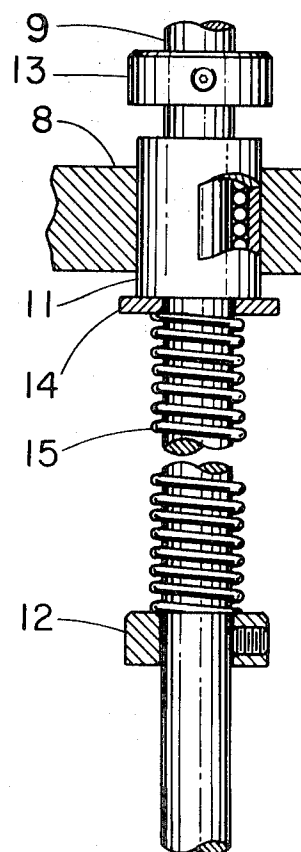


FIG. 5

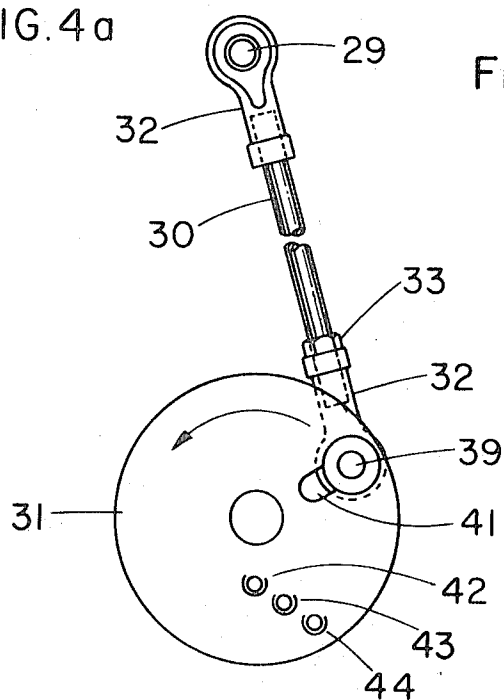


FIG. 6

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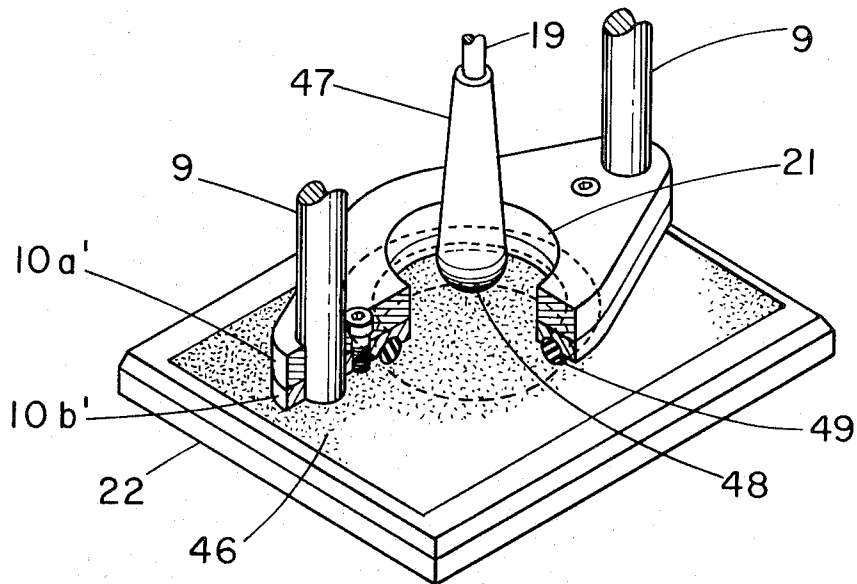


FIG. 7

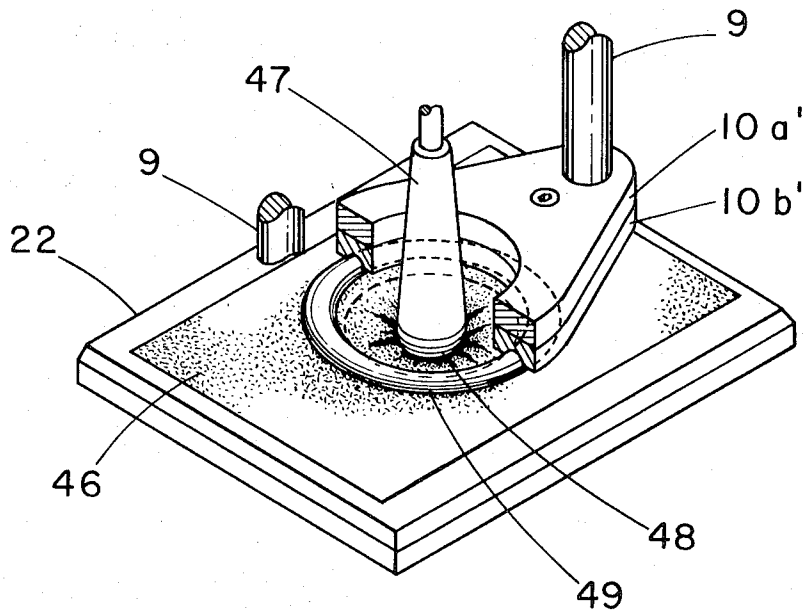


FIG. 8

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METHOD AND APPARATUS FOR TESTING THE PENETRATION RESISTANCE OF REINFORCED SHEET MATERIAL

Daniel H. Beckstrom, Neenah, Wis., assignor to Kimberly-Clark Corporation, Neenah, Wis.

Filed Mar. 9, 1970, Ser. No. 17,722

Int. Cl. G01n 33/34

U.S. Cl. 73-102

2 Claims

ABSTRACT OF THE DISCLOSURE

A method and device for measuring the penetration resistance of sheet materials, particularly reinforced sheet materials of the nature of woven or nonwoven fabrics and tissue papers. The method is characterized by holding the strength members of the sheet material which extend in one planar direction in a peripheral area bonding the zone through which a penetrating element is urged while permitting the strength members of the sheet material which extend in the other planar direction to be substantially free. The apparatus for the purpose includes a resilient gripping device which is, together with the penetrative probe, urged by a single means to the sheet material test sample.

The invention relates to a method and means for determining the resistance to rupture of sheet material, particularly sheets in the form of light weight webs of woven, non-woven fabrics and tissue papers.

It is a particular object of the invention to provide a simple compact device for testing sheet material for resistance to penetration including penetration by relatively pointed objects as well as penetration by relatively blunt objects involving, for example, a bursting effect.

It is another object of the invention to provide a novel method for reproducibly measuring the penetration resistance of light weight sheet materials, including particularly materials having a reinforcing media.

The invention will be more fully understood by reference to the following detailed description and accompanying drawings wherein:

FIG. 1 is a perspective view of one form of apparatus useful in the practice of the invention;

FIG. 2 is a somewhat enlarged fragmentary view partially in section particularly illustrating the cooperative relationship of the clamping device and penetrative probe of FIG. 1;

FIG. 3 is a view like that of FIG. 2 but illustrating the clamp device and probe of the test apparatus in operative position;

FIGS. 4 and 4A are respectively side elevation and front elevational views of the probe of FIG. 1;

FIG. 5 is a fragmentary elevational view partially in section of a portion of the structure of FIG. 1 with the illustrated spring in partially compressed condition;

FIG. 6 is a view in side elevation illustrating an eccentric drive mechanism useful in the apparatus of FIG. 1;

FIG. 7 and 8 are views like that of FIGS. 2 and 3 but with modified probes.

Referring now to the drawings more in detail, the numeral 1 (FIG. 1) designates a base having upwardly thereon a pair of vertically extending parallel disposed fixedly positioned guides 2. The guides 2 mount a carriage

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3, guide bearings 4 in the form of linear ball bushings being provided for the purpose of slidingly mounting the carriage 3 for vertical movement on the guides 2. The guide bearings 4 are four in number, a pair of upper and lower guide bearings being provided on each of the two upstanding guides 2. The carriage 3 includes a vertically extending front plate 5, upper and lower support blocks 6, and upper and lower horseshoe shaped cross-beams 7. The upper and lower cross-beams 7 each have arm members 8 through which pass vertically extending rods 9. The rods 9 at their lower end mount a clamping shoe 10 suitably formed with upper and lower plates 10a and 10b respectively (FIG. 2). Additionally, a quartet of linear ball bushings indicated at 11 and similar to but smaller than the bearings 4 are retained by and project above and below the arms 8 and slidingly support the vertically extending shafts 9. The shafts 9 also carry lower fixed spring abutments 12 and upper washers 14 between which springs 15 are retained. A washer 14 abuts spring 15 on the upper side of each of the springs, and each washer is itself engageable by a lower end of a ball bushing 11 in movement of carriage 3 downwardly. A collar 13 fixed on each shaft 9 is provided to abut the upper side of a ball bushing to inhibit downward movement of the shaft and clamp relative to the projection. The axial position of the collars 13 on shafts 9 govern the vertical height of the clamp shoe on the carriage; raising the axial position of the collars provides (FIG. 1) for a smaller maximum spacing between the clamp shoe 10 and platform 22 in the up position of the clamp shoe. As will be apparent from the description thus far, a movement of the carriage 3 downwardly causes the shafts 9 and clamp 10 to move down also; engagement of clamp 10 with platform 22 causes the ball bushing on the arms 8 of the cross-beams 7 to urge the washers 14 downwardly and to compress spring 15.

The front plate 5 of the carriage 3 has a pair of vertically extending slots 16 (FIGS. 4 and 4A) and a spring scale 17 having a gauge 18 is adjustably retained on the plate 5 in the slots by a nut and bolt combination indicated at 36 (FIGS. 4 and 4A). The gauge 18 has a depending shaft 19 which carries a penetrative probe 20, suitably of rigid plastic, to be referred to hereinafter more in detail. The probe 20 is adapted to extend through an opening 21 in the clamp device or shoe 10. Platform 22 which receives the clamp shoe 10 in abutment in downward movement of carriage 3 is itself retained on a plurality of upstanding support rods 23 and is provided with a large central aperture 24. In the operation of the apparatus, the penetrative probe 20 moves through the opening 21 of the clamp shoe and into the opening 24 of the platform 22 in the penetration of an object supported on the platform 22. Thus, movement of the probe is unimpeded except for the material to be tested.

An electric motor 25 is connected through electrical conduit 26 to a switch box 27 which is itself connected to a source of electric power (not shown) through connector 28.

The carriage 3 is provided with a horizontally extending shaft 29 which is connected to an eccentric drive mechanism for reciprocable vertical movement of carriage 3 upon actuation of motor 25. The eccentric drive mechanism includes a connecting rod 30 rotatably mounted with respect to shaft 29 and with respect also

to lower horizontally extending shaft 39 by yokes 32. A nut 33 (FIG. 6) threaded on the connecting rod provides for suitable connecting rod adjustment by limiting the effective length of rod 30. Additionally, an adjustment slot 41 (FIG. 6) provides for adjustable positioning of shaft 39. Further, the eccentricity may be changed by using either of the adjustment holes 42, 43, 44.

For the operation of the device there is provided a switch box 45 which may be so provided with controls as to permit either continuous operation of motor 25 or such as to provide for intermittent, that is, jogging action of the motor and the eccentric. Such switches are not shown in detail as they form no part of the present invention and such equipment is well known to the art.

The clamp shoe 10 (FIGS. 1 to 3) is provided on its lower side with resilient deformable gripping means 34. In FIGS. 2 and 3, the gripping means is formed in two separate sections, each extending in one lineal direction in the plane of the platform 22 and sample 35. Thus, the clamp shoe 10 retains threads of the sample 35 which extend transversely to the gripping means 34. Threads which lie under the penetrative probe 20 and extend in the same planar direction as the gripping means are not subject to significant restraint. Consequently, the passage of the probe through the test sample as illustrated in FIG. 3 will permit a measurement of the energy required to effect penetration by movement laterally of the longitudinal threads, for example.

The clamp shoe 10 is provided in two plates 10a and 10b so that the gripping means may be readily changed in contour. Thus, as shown in FIGS. 7 and 8, the resilient deformable gripping means, suitably of natural or synthetic rubber, may be endless in a circumferential sense as indicated at 49. The plates of the shoe 10 are conveniently retained together by cap screws as at 50.

For operation of the device as arranged in FIGS. 1 to 3 inclusive, the relationship of the probe to the gauge 18 is first adjusted. This adjustment may be made by fixing the position of the scale 17 in the slots 16 on the carriage so that the probe 20 may move only a limited vertical distance in the downward movement of the carriage. Conveniently, the gauge 18 may be adjusted independently in known manner to read, for example, zero at the full downward position in the absence of a test sample. By maintaining this pre-set condition, the results attained with individual test pieces will be related, and results have been found to be accurately reproducible. Following the adjustment with no sample on platform 22, the carriage by actuation of motor 25 is moved to an upward position (FIG. 1) so that a test sample as at 35 may be mounted across the opening 24. Such a sample is simply slid under clamping shoe 10 across the opening. As shown in FIG. 2, and as already indicated, such a sample is a scrim composed of longitudinally and laterally extending threads serving as strength members.

The motor 25 is then actuated through the switch at 45 and the eccentric mechanism causes the carriage 3 to be lowered and the clamp device or shoe 10 as well as the probe 20 to approach the platform 22. As the clamp 10 engages the platform 22 peripherally of the platform opening 24, the resilient deformable means 34 fixedly retains the transverse threads of the material undergoing test. However, as already noted, due to the shape of the resilient deformable members, the longitudinal threads are substantially unaffected. The penetrative probe 20 in the further downward movement of the carriage 3, as illustrated particularly in FIGS. 2 and 3, then engages the test material and passes through, the extent of resistance being indicated by the gauge 18.

Referring now again to the carriage 3 and the movement of the clamp shoe 10 and probe 20, when the clamp shoe 10 firmly contacts the base 22, the carriage 3 and, in particular, the arm members 8 slide downwardly on the rods 9 compressing the springs 15, the penetrative probe moving through the test piece. As the cam 31 continues

its movement following measurement and begins to raise the carriage 3, including thereby the clamp shoe 10 and probe 20, the energy of the springs 15 is gradually released as the carriage 3 moves upwardly. This release is such as to cause the ball bushings to abut collars 13, which raises the clamp 10 from platform 22 to simply prevent excessive upward movement. The device is then ready for another cycle and by re-positioning the test piece 35 by hand a plurality of test areas may be very quickly checked.

It is to be noted that the eccentric mechanism specifically described is a preferred embodiment but that many other devices might be employed in the actuation of the penetrative probe and the clamp means. Basically, such a device is required to move the clamp means and the penetrative probe into and out of a position on the platform 22 in which the clamp means retain the sheet material sample to be tested, and the probe penetrates the sheet material, means being provided for measurement of the energy to effect penetration.

The penetrative probe 20 employed in the arrangement of FIGS. 1 to 3 inclusive may be triangular but, more suitably, is a thin plate in the form of a conic section containing the cone axis of the cone from which it is derived. This provides the probe tip 37 and the lateral sides as at 38 in FIG. 4A rounded and assists penetration of sample material while inhibiting cutting.

Referring now to FIGS. 7 and 8, a further specific use of the test device is indicated. As illustrated, tissue 46 is positioned to be penetrated by a penetrative probe 47 having a semi-circular penetrative end 48. In this instance the tissue 46 is maintained in position on the platform by the deformable resilient ring 49 which is complete in a circumferential sense. In this instance the resilient deformable element 49 is retained by plate 10B' which is surmounted by plate 10A' similar to the plates 10A and 10B of FIG. 2.

The device described and the test methods outlined herein have proved thoroughly reliable in extensive tests; however, it is contemplated that the invention is not limited to the specific structures and methods shown but it is recognized that various modifications are possible and practical within the scope of the invention claimed.

I claim:

1. The method of determining the penetration resistance of a sheet material having longitudinally extending and laterally extending strength members in the plane of the sheet material, said method comprising urging a penetrative probe through the upper surface of sheet material in a limited zone of the material, holding the strength members which extend in one planar direction in a peripheral area bounding the zone while urging the probe through the sheet material and providing the strength members which extend in the other planar direction substantially free, and measuring the energy required to effect the penetration of the sheet material by the probe.

2. In apparatus for testing the penetration resistance of sheet material, a platform having an opening, clamp means arranged to border the opening of said platform and to retain on the platform a sheet material test sample extending over the said opening, said sheet material test sample having planar strength members, a penetrative probe, means for moving said clamp means and said penetrative probe into and out of a position on said platform in which the clamp means retains the sheet material sample to be tested and said probe projects to the platform opening to engage and penetrate through the surface of the sheet material sample extending over the said opening, and means for measuring the energy required to effect the penetration of a sample, said clamp means being so formed as to provide for retaining the strength members of the sample which extend in one planar di-

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rection against movement during penetration while permitting movement of planar strength members which extend in another lineal direction.

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RICHARD C. QUEISSER, Primary Examiner
M. SMOLLAR, Assistant Examiner
U.S. Cl. X.R.
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