June 7, 1955 J. D. CONTI 2,709,915

FLEX TESTING DEVICE

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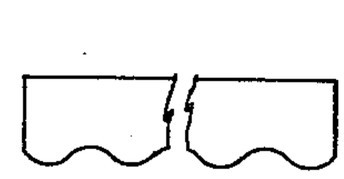

Fig. 4

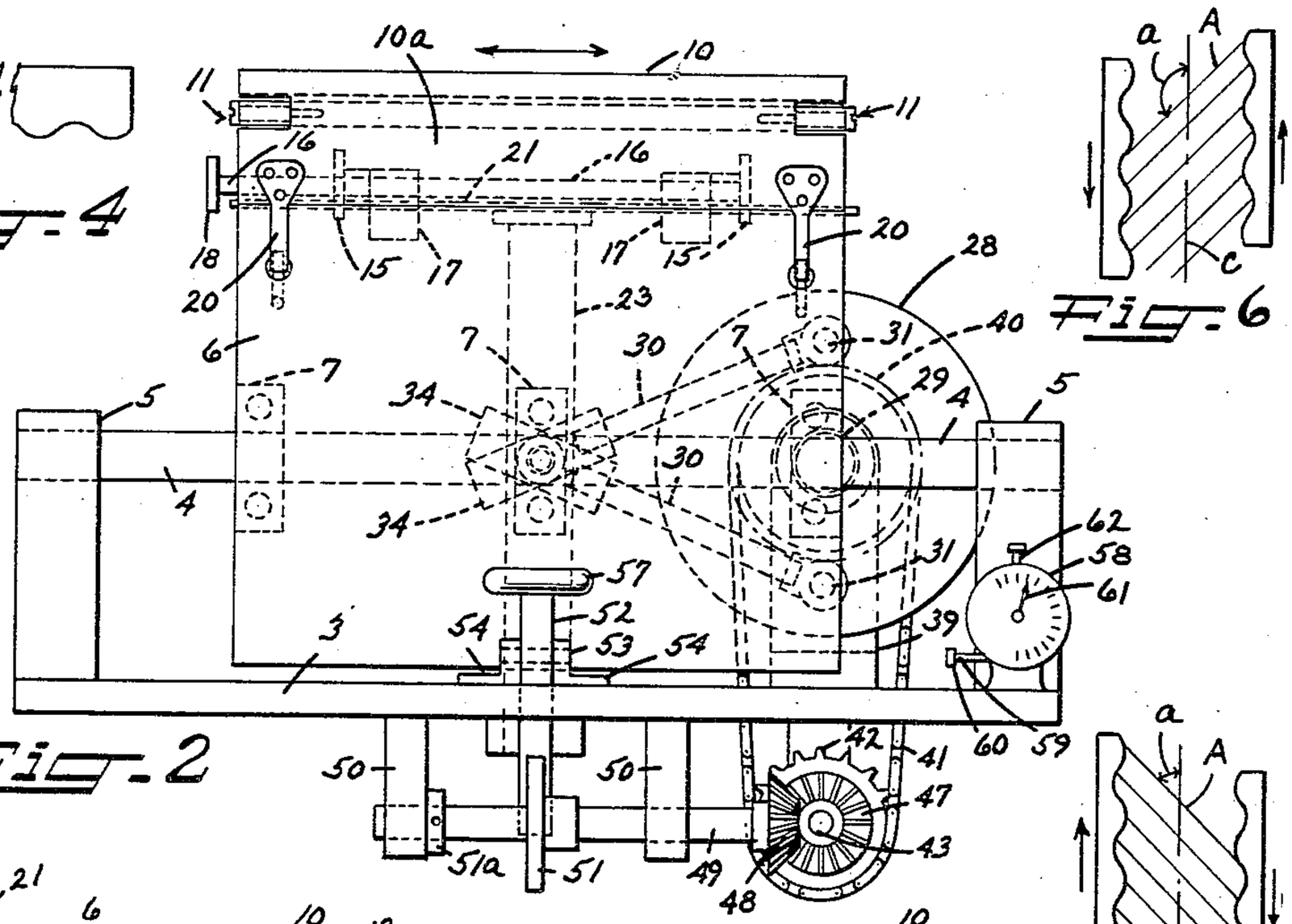

Fig. 2

Fig. 6

Fig. 5

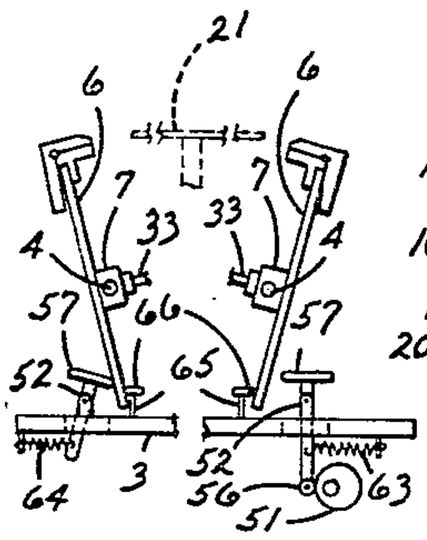

Fig. 2a

Fig. 1

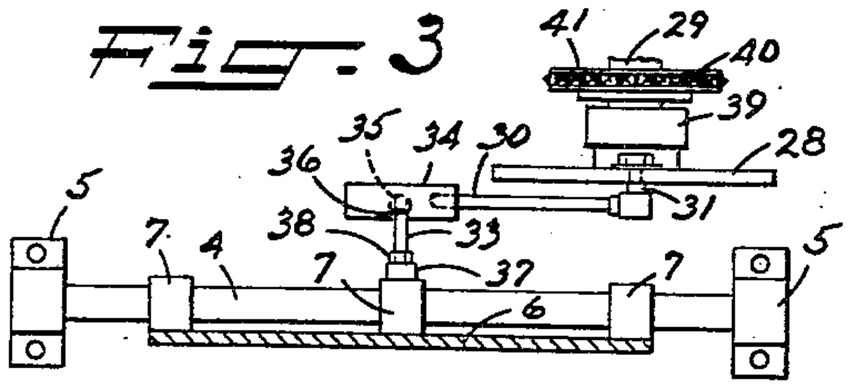

Fig. 3

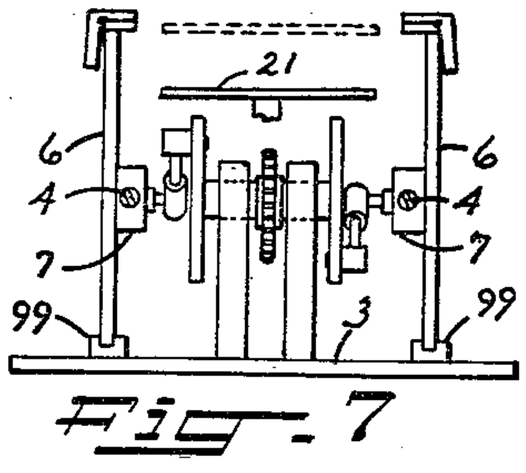

Fig. 7

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FLEX TESTING DEVICE

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This invention relates to a device for testing sheets or webs of materials, such as pellicles of plastic material of which cellophane is representative, woven or knitted fabrics, or other sheets including non-woven fibrous felt-like or paper-like sheets in which the fibers are adhered by autogenous bonds or by any suitable cementing or adhesive material.

The device of the present invention grips opposite edges of the sheet and then shifts the gripped edges in opposite directions but along parallel lines extending generally parallel to the plane occupied by the sheet in the initial position in which it is supported between the jaws of the gripping device. This action flexes the sheet generally along diagonal lines extending from one edge to the other and by reversing the motion of the two jaws, the direction of the diagonals is shifted from an angle of inclination to one side of a center line of the sheet between the jaws to an angle of inclination on the other side. The sheet is flexed into a series of waves, the crests and depressions of which extend between the gripped edges along lines extending diagonally with respect to the center line of the sheet between the jaws and the angle of inclination of these lines of the crests and depressions with respect to the center line of the sheet between the jaws is continuously shifted from a maximum to one side of the center line to a maximum on the other side of the center line. A modified embodiment places the sheet under tension in a direction along lines parallel to the crests and depressions.

The testing device serves to indicate the resistance of the sheet to various actions. In the first place, it determines the durability of the sheet under repeated flexure which is constantly shifting through all directions. Secondly, it may determine, particularly in the case of fibrous sheets such as woven or non-woven fabrics, their susceptibility to wrinkling under tensions which shift through various angles with respect to any given line from the plane of the sheet.

It is an object of the invention to provide a simple, compact machine or device for automatically testing sheet materials of all types for durability under flexure. Ancillary objects of the invention are to provide a device or machine of this type which is simple, compact and portable. Further objects of the invention will be apparent from the drawing and the description thereof hereinafter.

In the drawing, which is illustrative of the invention,

Figure 1 is a side elevation of one embodiment of the invention,

Figure 2 is an end elevation of the device shown in Figure 1,

Figure 2*a* is a somewhat diagrammatic end elevation of a modification,

Figure 3 is a view taken on line III—III of Figure 2 showing the mechanism for shifting one of the jaw supports,

Figure 4 is a plan view showing the contour of the jaws,

Figures 5 and 6 are diagrammatic views showing the flexing action in opposite extreme relative positions of the jaws of the testing device, and

Figure 7 is a side elevation of a modification.

In general, the device of the present invention comprises a pair of generally parallelly disposed jaws and means for supporting the jaws for translation in a direction generally parallel to their length. In another embodiment, the means for supporting the jaws for translation also supports them oscillatably about axes generally parallel to their lengths. The invention in all cases comprises means for shifting the jaws in translatory movement in opposite directions, and in some cases it comprises means for shifting the jaws in translatory movement in opposite directions while simultaneously oscillating them about the axes referred to so that in all cases a sheet material having its opposite edges secured by the jaws is caused to flex into a plurality of ripples or waves, the crests of which extend generally in the direction of the lines A in Figure 5 while the jaws are shifted from their intermediate positions directly opposite each other in the direction of the arrows shown. The angle of inclination *a* of the crests from the center line *c* continually decreases from a value close to 90° when the wrinkles or waves are first formed during the shifting of the jaws from their intermediate positions where they are directly opposed in face to face relationship to a minimum value depending upon the extent of shift of the jaws from their intermediate positions and the distance between the jaws. The machines of the invention can be designed to provide any minimum angle *a* but generally, the attainment of a minimum angle of about 30° is adequate for the testing of most types of sheet materials whether of the non-fibrous film type, such as cellophane or cellulose acetate or other plastic pellicles, or of the fibrous type, such as fabrics of woven or non-woven type. The lines A of flexure shift from the minimum angle of inclination *a* (attained when the jaws are in their extreme positions of displacement after moving in the direction of the arrows in Figure 5) back through a 90° angle to the center line *c* to a maximum value of *a* when the jaws are shifted to their extreme positions in the direction of the arrows shown in Figure 6. In effect, the waves formed during the travel of the jaws in the direction of the arrows shown in Figure 5 vary their angular relationship or disposition continuously from a value near 90° to the minimum value of *a* and then, when the jaws while proceeding in the opposite directions pass through their intermediate positions, a new set of waves or wrinkles are formed extending with their crests along the lines A in Figure 6, the direction varying from near 90° to the maximum value of *a* when the jaws have reached their extreme positions. This action, of course, is repeated as long as desired for the carrying out of the test, such as until the sheet shows signs of rupture or some other undesirable change such as loss of transparency in the case of non-fibrous pellicles.

The embodiment shown in Figures 1 to 4 comprises a platform 3 which may be supported by any suitable means such as by the provision of legs therebeneath or by suitable clamping or other securement to a bracket or stationary support. A pair of guide members 4, such as shafts or rods having round cross section are supported in end brackets 5 secured to the top of the platform 3. The shafts 4 are fixed in the brackets 5 by keys, set screws or the like. Upon each guide 4 there is supported a supporting member in the form of plate 6. The connection may be made by attaching to the inwardly-facing surfaces of the plates 6, slide blocks 7 having bores through which the guide rods 4 extend and in which the rods fit in relatively slidable and rotatable relationship.

Means is provided for gripping opposite edges of a sheet material. Thus the plates **6** carry at their adjacent or opposed edges, shown at the top, gripping means or gripping devices, such as fixed jaw members **8**. These fixed jaws are rigidly secured to the plates **6** such as by the angle brackets **9**. Movable jaw members **10** are pivotally mounted with respect to the fixed jaws **8** such as by the hinges **11**. Each of the fixed and movable jaw members **8** and **10** may be provided with gripping plates **12** set in their opposed faces where the sheet material is to be received for gripping. Alternatively, the opposed faces of the jaws may grip the sheet material directly and if desired they may be roughened for the purpose of increasing the security of grip. The gripping means comprising jaws **8** and **10** that are carried by each of the plates **6** are urged toward each other by a spring **13** which may be secured directly to the plate **6** or, as shown, to a projecting lug or hook **14** extending inwardly from the plates **6**.

Means is provided for closing the jaws and causing them to tightly grip the sheet introduced therein. This means comprises a pair of cams or eccentrics **15** fixedly secured on a shaft or rod **16** which is rotatably mounted in a pair of spaced bearings **17** secured on the inside of each plate **6**. A hand knob **18** may be provided for turning the eccentrics for closing or releasing the jaws. The cams or eccentrics **15** bear against the downwardly extending arm **10***a* of the movable jaw **10**. When the rise of the cams or eccentrics **15** is brought against the arm **10***a*, the jaws **10** are urged tightly into gripping relationship. By turning the cams or eccentrics out of this position, the jaws are released. Means may be provided for opening the gripping means when the cams or eccentrics **15** release the jaws **10**. This means may comprise springs **19**. These springs **19** are secured to the lower ends of projecting elements **20** secured to the arms **10***a* of the jaws **10** and they may be secured to the plates **6** or to the hooks **14**, the latter securement being shown, for urging the jaws **10** in a direction about their pivots **11** such that the jaws **10** are opened away from the fixed jaws **8**.

Means is provided for temporarily supporting a sheet material in the plane extending between the jaws of the opposed gripping means. For this purpose, a plate or table **21** is secured to the top of a preferably square-sectioned or splined rod **22** to prevent rotation, which rod extends through a pedestal **23** fixed on the platform **3**. The rod **22** extends through the platform **3** and may be provided with a handle or knob **24** by which it may be lifted from the low solid-line position shown to the upper dotted-line position. To hold the plate in its upper position, the rod **22** is provided with a groove **25** and a boss **26** beneath the platform **3** is provided with a spring-urged ball detent **27** adapted to engage the notch **25** resiliently and releasably.

Means is provided for shifting the plates **6** axially of the guide rods **4**. This means comprises the following elements, the system for each plate being similar except for their out-of-phase relationship. A crank disc **28** is fixedly secured to a shaft **29** which is the common support and driving means for the discs **28** of each plate-shifting means. A crank rod **30** is pivotally secured to the disc **28** such as by the pin **31** extending through the slot **32** in the disc **28**. The other end of the crank rod **30** is connected to an arm or link **33** by means of a socketed yoke **34**, the socket of which is adapted to receive the enlarged spherical end **35** of the link **33**. The socket in yoke **34** has a lateral opening **36** for the link **33** to extend through and the opening is of sufficient extent to allow a swivel or universal motion relatively between the arm **33** and the socket member **34**. The other end of the link **33** is connected to the central one of the several slide blocks **7** secured to plate **6**. This connection may involve the screwing of the end of the link **33** into a boss **37** integral with the slide member **7** and the locking of the link in the boss **37** by means of the lock nut **38**.

The shaft **29** extends through the spaced pedestal bearings **39** and carries between the bearings a sprocket **40** which is fixedly secured on the shaft **29** and is driven by a chain **41**. The chain **41** is driven in turn by a sprocket **42** carried on shaft **43** supported beneath the platform in bearings in the brackets **44**. Shaft **43** in turn is driven by a sprocket **45** which is driven by a chain **46** from a suitable source of power, such as an electric motor or the like (not shown).

In this first embodiment, means is provided for oscillating or rocking the plates **6** about the guide rods **4**. For this purpose, the shaft **43** carries at its ends, bevel gears **47** which mesh with bevel gears **48** keyed to shafts **49**. The shafts **49** are supported in bearings in the lower ends of the bracket **50** secured beneath the platform **3**. Each of the shafts **49** carries fixedly mounted thereon an eccentric or cam **51** and a thrust collar **51***a*, the latter bearing against one of the brackets **50**. Levers **52**, pivotally mounted on pins **53** each extending between a pair of brackets **54** on table **3**, extend downwardly through slots **55** in table **3** and are provided with follower rollers **56** at their lower ends adapted to engage the cams or eccentrics **51**. At their upper ends, the levers **52** carry rotors such as rollers or wheels **57**, preferably rubber-tired, adapted to bear against the surface of plate **6** at points spaced from the axis of rods **4** in a direction away from the side thereof on which the spring **13** is disposed.

Measuring or counting means is provided for determining the extent of operation of the device. This device may count the revolutions of one of the shafts such as shaft **43** or shaft **29** or even shaft **49**. Alternatively, it may count the reciprocations of the plates **6** or the oscillations thereof. As shown, the counter **58** is mounted on the platform **3** adjacent one end of the stroke of one of plates **6**. The counter **58** is provided with a reciprocating plunger **59** having a transverse bear **60** disposed in the way of plate **6** so that at the end of each stroke of plate **6** to the right as viewed in Figure 1, the plunger **59** is actuated, thereby imparting an impulse to the stroke-counting mechanism in the counter **58**, the effect of which is registered or indicated by the hand **61** operating over the calibrated dial face of the counter. The counter **58** may be provided with a reset button or plunger **62** by which it may be reset to zero at any time desired. It is to be understood that any suitable counting means may be employed and if desired, a recorder may be supplied instead of a simple indicator **61**.

The jaws **12** may have a straight line edge along their opposed surfaces or the edges may be curved, for example, the edge of each of the jaws may have the form of a sine wave as shown in Figures 4 to 6. If desired, the sheet material need not be gripped continuously throughout the length of their edges but the gripping surfaces of the jaws may be interrupted at intervals along their length so that the edges of the sheet are gripped at spaced points, preferably at regularly spaced points or areas along the length of the jaws.

The sheet to be tested is laid upon the table **21** after the latter has been elevated to the dotted line position shown in Figure 2. The device is moved either manually or by operation of the motor until the plates **6** are brought to their intermediate positions where the full length of the gripping means on one plate is directly opposed to the full length of the gripping means on the other plate. After the edges have been inserted over the fixed lowered jaws **8**, the knobs **18** are turned so that the eccentrics **15** are rotated to cause the movable jaws **10** to grip the edges of the sheet against the lower fixed jaws **8**. Then the table **21** is lowered by manually pulling knob **24** down. This leaves the sheet fully stretched between the jaws in their intermediate posi-

tions ready to be flexed. The counting device **58** is set to zero and the device is started in operation. It should be noted that in the intermediate position of the plates **6**, the crank pin **31** in the mechanism for shifting one plate **6** is 180° out of phase with respect to the position of the crank pin **31** associated with the shifting mechanism for the other plate **6** so that the plates immediately shift from their intermediate position in opposite directions, such as in the direction of the arrows shown in Figure 5, until they reach an extreme of displacement.

As the gripping means shift in opposite directions from their intermediate positions, the eccentrics **51** rotate in such manner that the followers **56** are caused to move away from the shafts **49** thereby allowing the plates **6** to oscillate under the urging of the spring **13** in such fashion that the gripping means on each plate approaches toward the center line between the plates. This is necessary in order to allow the oppositely gripped points along the edge of the sheet to shift in opposite directions while maintaining the sheet between the points taut but without excessively tensioning or stretching the material between the gripped points. Of course, for certain materials, it may be desirable to effect a certain degree of stretching during this flexing action and the selection or design of the cams or eccentrics **51** in relation to the throw of the cranks **28** may be made specifically with this purpose in mind.

The machine may be stopped when the desired duration of the tests is completed and as stated hereinabove, this may be at the beginning of rupture or undesirable change in character of the sheet. Numerous samples of the same sheet material may be tested to provide an average of results. Some materials have different properties in different directions and these samples may be tested after mounting each in a different orientation with respect to the jaws. For example, a sheet of cellophane or other plastic pellicle may be mounted with the machine direction of the sheet parallel to the direction of the jaws and succeeding samples may be tested after mounting with the machine direction at right angles to the jaws or at various angles of inclination thereto. Similarly, nonwoven fabrics may have the fibers oriented in one direction along the sheet and the sheet may be mounted in the testing machine with the direction of fiber orientation parallel to, perpendicular to, or at any angle of inclination to the jaws. Similarly, woven and knitted fabrics may be mounted with the warp or wales respectively parallel to, perpendicular to or at any desired angle of inclination to, the jaws.

In the modification shown in Figure 2*a*, one of the eccentrics **51** and the spring **13** are omitted. The lever **52** associated with the remaining eccentric **51** is urged against the eccentric by a spring **63** one end of which is secured to the lever and the other end of which is secured to a lug under platform **3**. The other lever **52** is urged with its rotor **57** against the plate **6** by a spring **64** one end of which is secured to the lever and the other end to a lug under platform **3**. Detent posts **65** are fixed in the platform **3** and may have rollers **66** at their upper ends to limit the swinging of plates **6** when the device is not in use. The device shown in Figure 2*a* is otherwise the same as that of Figures 1 to 3.

When mounting a sheet for testing in the device of Figure 2*a*, the sheet is rested upon plate **21** in its upper position, and one side edge is secured in the gripping means on one of the plates **6**. Then the sheet is pulled taut until the plates **6** are both approximately vertical when they are in their intermediate positions along rods **4**. Then the opposite edge of the sheet is gripped in the jaws of the other plate **6**. The device may then be driven as in the other embodiment for testing the sheet. In this case the spring **64** cooperates resiliently with eccentric or cam **51** instead of relying upon opposed eccentrics or cams to maintain the sheet taut during flexing while allowing the necessary variations in the distance between jaws.

In another embodiment shown diagrammatically in Figure 7 the plates **6** may have simple translatory movement as in the above-described modification but the oscillatory motion is omitted. Instead the plates **6** slide in fixed guide plates **99** having grooves in which the bottom edges of the plates **6** reciprocate. In this embodiment, spring **13** may be omitted and parts **47** to **57** inclusive of the previous embodiment are omitted or disconnected from the system for driving the plates in a translatory fashion. The modification of Figure 7 tests the flexure without tensioning the sheet being tested. This is accomplished by selecting a sample of sufficient width so that when secured in the jaws it bulges out of the flat plane between them at all times during operation of the machine. In this way the jaws never apply tension to the sheet.

It is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A device for testing a sheet of material comprising a pair of supporting members, gripping means supported on each of the members with the jaws of one opposed to the jaws of the other whereby the sheet to be tested may extend therebetween, means mounting said members for reciprocating movement in substantially parallel relationship, means for reciprocating one of said members and its gripping means for one edge of the sheet generally longitudinally of one edge of said sheet, and means for reciprocating the other of said members and its gripping means for holding the other edge of the sheet in a direction opposite to that of the first gripping means.

2. A machine as defined in claim 1 comprising a movable table, means for moving said table into and out of a position in which said table extends between the gripping means for one edge of the sheet and the gripping means for the other edge of the sheet.

3. A device for testing a sheet of material comprising a pair of supporting members, gripping means supported on each of the members with the jaws of one opposed to the jaws of the other whereby the sheet to be tested may extend therebetween, means mounting said members for reciprocating movement in substantially parallel relationship, means for reciprocating one of said members and its gripping means for one edge of the sheet generally longitudinally of said one edge of the sheet, means for reciprocating the other of said members and its gripping means for holding the other edge of the sheet in a direction opposite to that of the first gripping means, means for oscillating each gripping means about parallel axes, and means for simultaneously actuating the oscillating and both said reciprocating means.

4. A device as defined in claim 3 comprising a reciprocable rod mounted between said axes and having a direction of reciprocation substantially perpendicular to the plane through said axes, a table supported by said rod, and means for reciprocating said table into and out of a position between the gripping means associated with each supporting member.

5. A device for testing a sheet of material comprising a pair of spaced supporting members, means mounting said members for pivoting on parallel spaced axes and for reciprocation in a direction substantially parallel to said axes, means for oscillating said members about said axes, means for simultaneously reciprocating said members in opposite directions axially of their respective axes of oscillation, and gripping means carried by said members and having the general direction of their length extending substantially parallel to said axes.

6. A device for testing a sheet of material comprising a pair of parallel guide rods, a supporting member slidably and rotatably mounted on each guide rod, a gripping device secured to each member and having its grip-

ping jaws facing the gripping jaws of the other device, means for axially reciprocating the members longitudinally of said rods, the reciprocating means for one of said members being 180° out of phase with respect to the reciprocating means for the other member, means for oscillating each member about its associated rod, and means for simultaneously actuating the oscilalting and reciprocating means.

7. An apparatus for testing a sheet of material comprising a pair of parallel guide rods, a plate mounted on each rod, devices mounted on each plate for gripping opposite lateral edges of the sheets, means for oscillating the plates each about the axis of its respective rod, and means for reciprocating each plate along the axis of its rod in a direction opposite to that of the other plate.

8. An apparatus as defined in claim 7 in which the reciprocating means comprises a pair of cranks, and connecting rods between the cranks and the plates.

9. An apparatus as defined in claim 7 in which the oscillating means comprises an eccentric, a follower system comprising a member for engaging the eccentric and transmitting motion from the eccentric to a respective plate, and spring means for urging the plate against the follower system.

10. An apparatus as defined in claim 9 comprising spring means for urging the plates to move the gripping means on one away from the gripping means on the other.

11. An apparatus as defined in claim 9 in which the reciprocating means comprises a pair of cranks, and connecting rods between the cranks and the plates.

12. An apparatus as defined in claim 11 comprising a supporting member between the plates, means for reciprocating the supporting member in a direction substantially perpendicular to a plane through the axes of the guide rods, a plate secured to the supporting member, and means whereby the supporting member may be reciprocated to move the plate into and away from a position in alignment with the jaws of the gripping means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,318,506	Lovell	May 4, 1953

FOREIGN PATENTS

700,171	France	Feb. 25, 1931