Jan. 18, 1955

R. DE S. COUCH ET AL

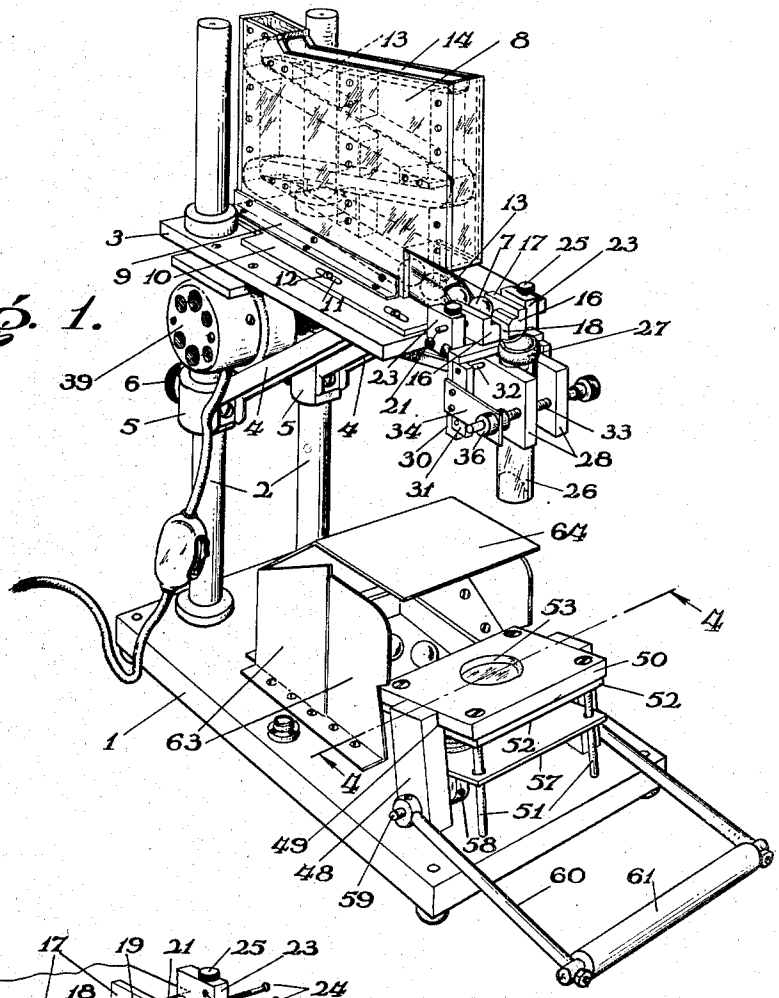
IMPACT FATIGUE TESTING OF PACKAGING MATERIALS AND CONTAINERS

2,699,672

Filed Oct. 27, 1950

2 Sheets-Sheet 1

Fig. 1.



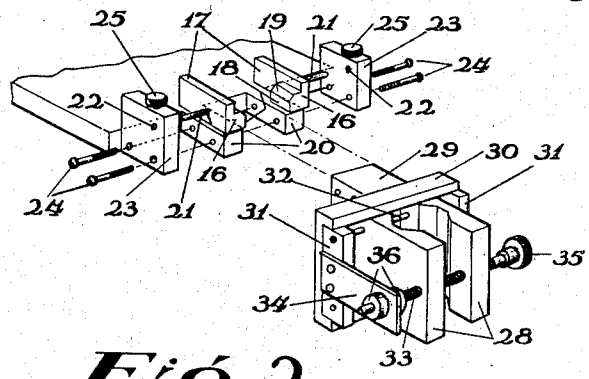


Fig. 2.

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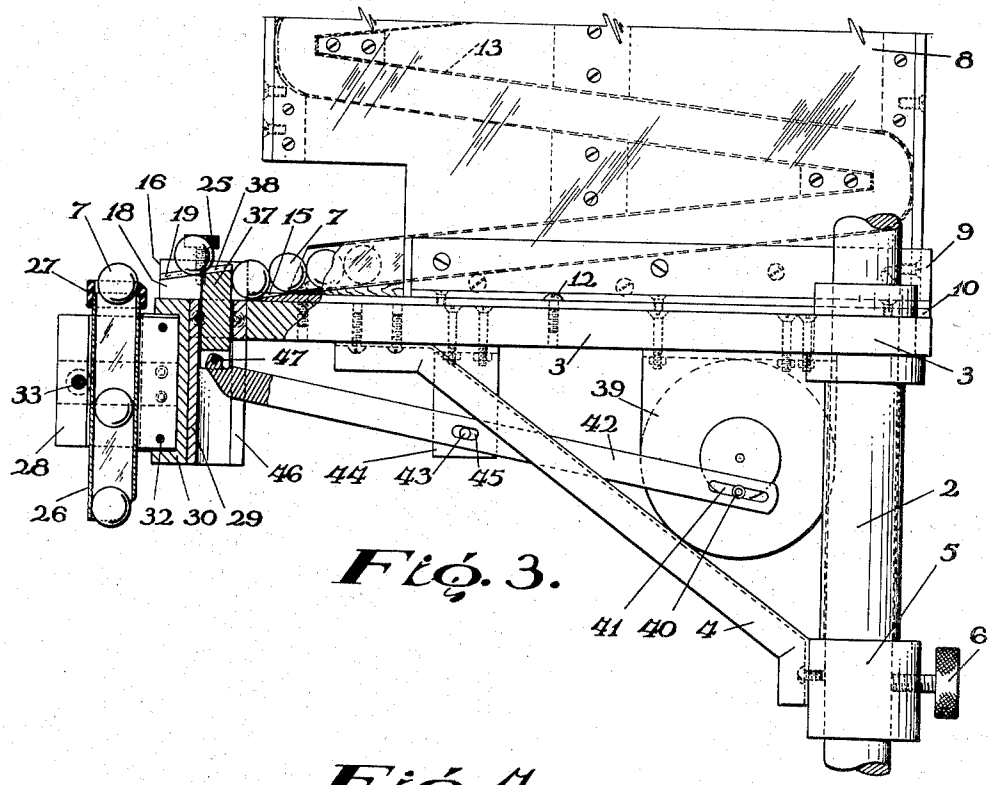
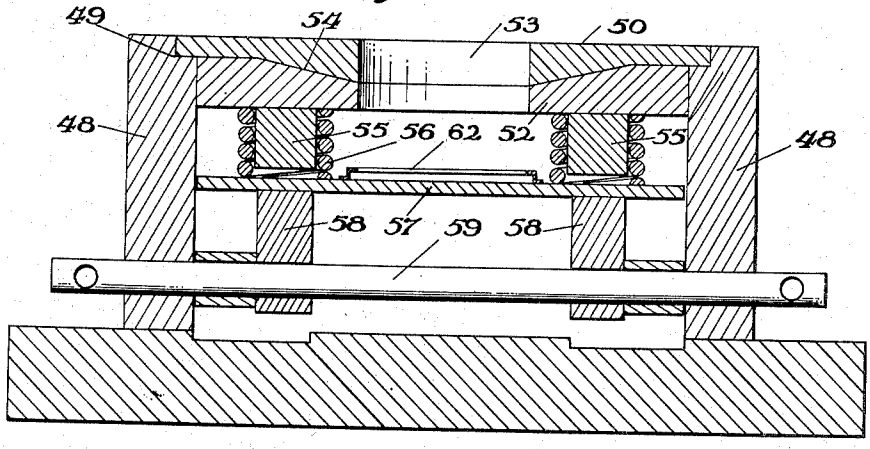


Fig. 3.

Fig. 4.



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IMPACT FATIGUE TESTING OF PACKAGING MATERIALS AND CONTAINERS

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5 Claims. (Cl. 73—12)

This invention relates to apparatus for testing the impact fatigue resistance of packaging materials which are subject to failure when exposed to repeated blows or stresses in commercial use. For example, the invention can be employed to determine the serviceability of paper used in the construction of bags and other flexible light containers under the conditions and stresses encountered by such containers after filling and during handling and shipment in actual field usage. For convenience, the invention will be described hereinafter with particular reference to such containers, but it will be understood that it is not restricted to this application as pointed out below.

Heretofore packaging materials such as kraft paper, glassine, and the like and/or bags or containers made from such materials have been subjected to various tests by both the paper manufacturer and the bag purchaser or user in an effort to determine whether such bags or containers will perform satisfactorily under conditions of actual use. For example, the paper manufacturer usually subjects the paper from which the bag is to be made to the well known Mullen, tear, tensile strength and folding endurance tests. Also the bags can be tested on a control basis for properties such as siftproofness, grease resistance, moisture resistance, etc. All of these tests are valuable to the paper manufacturer and to the purchaser and/or user of the bags. However, the results of such tests show very poor correlation with the actual performance of the bag in field usage, i. e., with the resistance which the filled bag offers to breakage during handling and shipping under conditions of actual use, and hence do not make it possible to predict accurately the actual performance of a bag in the field. This is a matter of vital interest to the bag purchaser and/or user because, if the bag fails to deliver its contents in good condition, there is not only a financial loss but also an intangible loss of consumer good will.

It appears that the aforesaid poor correlation is due in part to the fact that the tests mentioned above measure only one property of the bag material at a time, and in part to the fact that they do not take account of the effect on the bag of the repeated impacts to which it is subjected in actual use. In other words, during normal handling and shipment a filled bag may receive several types of physical stresses simultaneously or in quick succession; further the bag material is subjected to repeated impacts which cause fatigue and eventual rupture of the bag material under forces substantially less than its original strength. Heretofore the only method of predicting the performance of a bag in field usage with any substantial degree of accuracy was to subject it to a so-called drop test in which the bag was filled and then dropped repeatedly under conditions simulating actual usage. The results of such drop tests show a much better correlation with actual performance in the field, but the test itself is not simple enough for general use as a control test and further is not suitable for use by either the paper manufacturer or the bag manufacturer but only by the purchaser or user of the bag.

One of the objects of the present invention is to provide novel apparatus for the control testing of a material, which is used in the construction of bags, paper bags, and light containers, by the manufacturer of the material, the container manufacturer, or the container purchaser whereby it is possible to make a reliable prediction as to the performance of the filled container in actual field usage.

Another object is to provide an improved apparatus for testing such containers in which the container material is subjected to stresses closely simulating those encountered in actual usage.

A further object is to provide an improved apparatus for testing such containers in which the resistance of the container material to fatigue resulting from repeated stresses is taken into account.

Still another object is to provide a simple testing apparatus which automatically carries out the preceding objects.

Other objects will appear more fully hereinafter.

In practicing the present invention, a section of the container wall to be tested, for example a section of the paper used in making a bag, is supported peripherally in an approximately horizontal position and its unsupported central portion is then subjected to a series of repeated impacts, preferably by dropping a series of weights thereon in succession although a single weight can be dropped repeatedly if desired. The size of the weights and the height from which they are dropped are adjusted with respect to the initial strength of the container wall section so that each impact is substantially less than that required to cause rupture of the section in its original condition. The unsupported portion of the container wall section is thus subjected to repeated impacts which gradually weaken said portion due to fatigue of the material and eventually cause rupture of the weakened material. Inasmuch as these impacts are similar to those encountered in field usage and produce similar complex physical stresses in the material, the number of impacts that can be sustained by the wall section without rupture is a reasonably accurate and reliable indication of the actual performance of the container in field usage.

When small concentrated weights are used such as metal balls, the impact stresses will be concentrated in a relatively small area of the container wall section, and in many cases the conditions of actual usage are more closely simulated by distributing the impact stresses over a larger area. Moreover, some types of paper such as kraft paper vary substantially in strength from point to point, having small spots of relatively weak strength. A small weight striking such a weak spot may cause premature rupture of the material with resulting inaccurate and scattered test results. In such cases it is desirable to distribute the impact by transmitting it to the test section through buffer material over a larger area, as for example by placing a disk of rubber over the section being tested at the point where it receives the impact of the dropping weights.

In testing materials by repeated impacts as described above, the results obtained may be affected by the rate at which the impacts are delivered; that is, if the interval between impacts is too short, the test section may break under a smaller number of impacts than when the interval is greater. However, there is no critical minimum interval and it is only necessary to observe the precaution set forth below that the test should be adjusted so that a reasonable number of impacts are delivered before rupture takes place. In the case of ordinary paper bags, for example, the impacts can be delivered at the rate of one every two seconds. Longer intervals can be used if desired, but the time required to make the test will be correspondingly increased. In any event the intervals between successive impacts should be substantially equal; in other words, the weights should be dropped at regular timed intervals to insure comparable results.

In the practical use of the above method as a control test, the weights should of course be of the same size and should be dropped from the same height for any given type of bag in order to obtain directly comparable results. To minimize experimental error, moreover, the individual impacts should be adjusted so that at least a reasonable number of such impacts are required to produce rupture. On the other hand, if the impacts are too light, an unreasonably large number will be required to produce rupture and the test will be unduly prolonged. The limits

to be observed are not critical and may be varied to suit conditions; in testing ordinary paper bags, an average minimum of about fifteen impacts and an average maximum of about fifty impacts may be taken as reasonable limits. Using the same weights, a wide range of papers may be tested within these limits by adjusting the height of the drop. Papers as fragile as 25 lb. glassine and laminated glassine and as strong as 70 lb. kraft paper have been tested satisfactorily in this way.

It will also be understood that the test specimen may be maintained at any desired temperature and under any desired conditions of relative humidity in order to obtain the most accurate indication of the performance to be expected under the actual conditions of use.

When paper bags and like containers are tested by the foregoing method, or by the drop test, there may be a considerable variation in the results obtained with individual bags due to unavoidable variations in the bag material. Such variations are more apt to occur with paper of the kraft type than with glassine and like materials which are more uniform. The same variations of course appear in the actual performance of the bags in field usage. However, if the impact test and the drop test are run on a number of bags, say fifteen or twenty, the average results of both tests show a close correlation with each other and with the actual performance of the bags in the field.

It will be understood that the test can be performed by hand if desired, the weights being dropped individually and in succession from the proper height. However, it is preferable to employ suitable apparatus for holding the test specimen and for dropping the weights in succession thereon. Broadly speaking, such apparatus may take any of widely different forms, its principal elements comprising a container holding a plurality of weights at an adjustable elevation above the test specimen and preferably arranged to feed said weights in succession to a discharge point; automatically operable means for releasing the weights one by one from the container and allowing them to drop by gravity, which means may comprise any suitable dispensing or ejecting mechanism; and a suitable means for peripherally supporting the container wall section with its unsupported central portion in an approximately horizontal position beneath the point of release of the weights.

The accompanying drawings illustrate a preferred form of such apparatus, but it is to be expressly understood that said drawings are for purposes of illustration only and are not to be taken as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawings,

Fig. 1 is a perspective view of the apparatus;

Fig. 2 is an exploded perspective view illustrating certain details of the apparatus;

Fig. 3 is a side view, partly in section, of the upper part of the apparatus; and

Fig. 4 is a section on the line 4—4 of Fig. 1 and showing means for supporting the container wall section.

The device preferably comprises a portable unit having a suitable base 1 of any desired material, shape and size, and one or more upright standards mounted on and extending above the base 1, said standards being here shown as a pair of rods 2. The weight container and the weight releasing mechanism are supported on a plate 3 of any suitable material, size and shape, said plate being slidably mounted on the rods 2 so that its height above the base 1 can be adjusted as desired. In the form shown, the plate 3 is provided with openings at one end through which the rods 2 extend slidably, the plate extending forwardly from the rods and its forward end being supported by struts 4 terminating in collars 5 that are also slidable on the rods 2. This assembly can be located at the desired height in any suitable manner as by means of thumb nuts 6 threaded in the collars 5 and capable of being tightened against the rods 2.

In the form shown, the weights comprise metal balls 7, and the container holding these balls is suitably constructed to feed them in succession to a discharge point, preferably by a gravity feed. By way of example, the drawings illustrate a box-like structure 8 formed of suitable transparent plastic material and secured by means of angles 9 to a base 10 that is adjustably mounted on the plate 3 by means of slots 11 and screws 12. Enclosed in the box 8 is a feed tube 13 which also may be of transparent plastic material and is preferably of serpentine configuration in order to hold the required number of balls 7 without occupying undue space. The balls 7 are fed into the upper end of the tube 13, which may be disposed horizontally with its top wall cut away to provide an opening loading trough 14, and descend by gravity throughout the length of the tube to its open lower end. As shown, the tube terminates slightly short of the end of the base 10 which is beveled at 15 (Fig. 3) to form a continuation of the incline of the feed tube.

The balls 7 are restrained from escaping from the tube 13 by any suitable barrier located adjacent the lower end of the tube. In the form shown, a pair of blocks 16 are supported on the plate 3 and provided with wings 17 which project inwardly to the end of the base 10, the space between these wings forming a continuation of the ball passage through the feed tube. At their forward or outer ends, the blocks 16 are provided with inwardly extending lugs 18 which together form a barrier across the feed passage and retain the balls 7 therein. The lugs 18 are of less height than the sides of the blocks 16 and their inner corners are preferably beveled as indicated at 19 and also inclined to the horizontal (Fig. 3) to provide an inclined runway for the discharge of the balls 7 as they are lifted one by one above the barrier as hereinafter described. Preferably the blocks 16 are mounted on the supporting plate 3 for lateral movement to adjust the width of the discharge passage. For example, the forward end of the plate 3 is provided with spaced tongues 20 (Fig. 2) on which the blocks 16 rest, and each block is provided with a laterally extending pin 21 which projects through a hole 22 in a supporting block 23 that is secured to the tongue 20 in any suitable manner as by means of screws 24. The lateral position of the blocks 16 may thus be adjusted by sliding the pins 21 in the openings 22, and the blocks may be secured in their adjusted positions by tightening thumb nuts 25 threaded in the supporting blocks 24 and capable of being tightened in engagement with the pins 21.

In order to make sure that the dropping balls 7 strike the container wall section to be tested, a vertical guide tube 26 is preferably mounted in position to receive the balls leaving the blocks 16 and to cause them to drop vertically onto said test section. In the form shown, the upper end of the guide tube is surrounded by a collar 27 of sponge rubber or like material to cushion the impact of the balls therewith. The tube is held in the proper position by clamping it between a pair of plates or jaws 28 which can be mounted on the plate 3 in any suitable manner. As illustrated, a block 29 projects between the tongues 20 of the plate 3 and is held therein by means of the screws 24 which are long enough to extend through the supporting blocks 23 and the tongues 20. A plate 30 is secured to the block 29, said plate having upper and lower flanges and end blocks 31 extending between said flanges to provide a box-like structure in which the inner ends of the clamping jaws 28 are slidably mounted on pins 32 fixed in the end blocks 31. The jaws may be tightened or released in any suitable manner, as by means of a screw 33 rotatable at one end in a supporting arm 34 secured to one of the end blocks 31, the other end of the screw carrying a thumb nut 35. Endwise movement of the screw relative to the arm 34 is prevented by collars 36 secured to the screw on opposite sides of said arm. The screw is threaded in the outer ends of the two clamping jaws 28, one jaw having a right-hand thread and the other jaw having a left-hand thread.

In the case of a stationary barrier such as that formed by the blocks 16 and their lugs 18, the release of the balls 7 requires them to be lifted one by one above the barrier so that they roll down the inclined runway formed by the bevels 19 of the blocks 16. This elevation of the balls is suitably accomplished by means of a vertically reciprocating plunger 37 (Fig. 3) which slides in a bore in the block 29 just behind the barrier, the upper end of the plunger being provided with a V-shaped groove 38 which is aligned with the bevel 15 when the plunger is depressed and with the bevels 19 when the plunger is elevated to the position shown in Fig. 3. An electric motor 39 is mounted on the lower side of the plate 3 and drives an eccentric pin 40 operating in a slot 41 of an arm 42. The pin 40 causes rocking movement of the arm 42 by virtue of a suitable pivotal mounting intermediate the ends of the arm, here shown as comprising a pin 43 mounted on a bracket 44 secured to the plate 3, said pin extending into a slot 45 formed in the arm 42. The

other end of the arm 42 thus moves up and down in timed sequence, said end extending through a slot 46 in the block 29 and being pinned at 47 to the lower end of the plunger 37. The rocking movement of the arm thus elevates the plunger to lift one of the balls 7 sufficiently to permit it to clear the barrier formed by the lugs 16 and thus to be discharged to the guide tube 26 as illustrated in Fig. 3. The subsequent downward movement of the plunger permits the next ball 7 to move forwardly on top of the plunger and against the barrier 16 where it remains until the plunger is again elevated. Thus the balls 7 are dropped one by one at timed intervals through the tube 26, the length of the interval between impacts being governed by the speed of rotation of the motor 39.

The container wall section to be tested is supported in an approximately horizontal plane beneath the discharge tube 26 where it is struck by the dropping balls 7. For convenience, the section is preferably inclined somewhat with respect to the true horizontal so as to cause rebound of the balls therefrom to one side where they can be collected in any suitable receptacle. Preferably the mechanism employed for clamping the test section is also arranged to tension the section radially to such an extent that it is stretched out smoothly in a true plane but without exerting any substantial stress on the material of the section.

Figs. 1 and 4 show a suitable mechanism for accomplishing the above objectives. A pair of spaced blocks 48 are mounted on the base 1 in an inclined position as shown in Fig. 1, each of said blocks having a recess 49 extending along its inner upper corner to receive an upper clamping plate 50. The plate may be secured in the recesses 49 in any suitable manner as by means of corner bolts 51 extending through said upper plate 50 to the base 1 and threaded in the latter. A lower clamping plate 52 is movable vertically between the blocks 48, said plate 52 preferably sliding on the corner bolts 51 whereby its movement is properly guided. The plates 50 and 52 are centrally apertured as shown at 53 so that the central portion of the test section clamped between the plates is left unsupported to receive the impact of the balls 7 as they drop from the tube 26. Preferably the opposed clamping surfaces of the plates 50 and 52 are beveled as indicated at 54 so that when they are moved into clamping engagement, the test section is radially tensioned as described above.

Any suitable means can be employed for moving the lower plate 52 into clamping engagement with the upper plate 50. As shown, a pair of studs 55 project below the plate 52 and are surrounded by coil springs 56 which are interposed between the plate 52 and an actuating plate 57. The plate 57 slides on the corner bolts 51 and is moved upwardly to compress the springs 56 by means of eccentric arms 58 mounted on a common shaft 59 which is rotatably mounted in the blocks 48 and is actuated by means of arms 60 and a suitable handle 61. When the handle is depressed, therefore, the eccentrics 58 are rotated to elevate the plate 57 and compress the springs 56, the plate 52 being thus urged resiliently into clamping engagement with the plate 50.

The observation of the effect of the repeated impacts on the test section may be facilitated by a suitable mirror located beneath the unsupported central portion of the test section and conveniently mounted on the actuating plate 57 as shown at 62.

Due to the inclination of the test section with respect to the horizontal, the balls all rebound from the test section toward the same side, i. e., inwardly toward the standards 2. Hence they may be collected in a suitable receptacle or housing mounted on the base 1 inwardly of the clamping device. As shown, a suitable area of the base is enclosed by side walls 63 and a rear wall is bent outwardly over the side walls to form a hood 64. The balls are preferably collected in a suitable removable receptacle such as a drawer.

In making a test with the above apparatus, it is only necessary to clamp a section of the bag to be tested and to start the motor 39, upon which the balls are dropped in succession at timed intervals (preferably about two seconds) and the number of drops required to produce rupture is counted. Meanwhile the balls rebound from the test section and are collected in the receptacle 63, 64 for return to the loading trough 14 as needed.

The succession of steel balls dropping on the test section brings into play most of the strength characteristics encountered in the drop test and closely simulates the conditions existing in actual usage in the field. The first ball stretches the paper; as succeeding impacts are applied the paper continues to stretch and never regains its former dimension. Eventually the paper appears to be so weak that the final impact causes failure by a combination of bursting and tearing stresses. Examination of the characteristics brought into play in this test and in the drop test makes it evident that fatigue in the paper is of vital importance. With the exception of the folding endurance test, this factor is not measured by any of the common paper tests heretofore used, which accounts in large part for the poor correlation between such tests and actual field performance. In the method of the present invention, on the other hand, the fatigue factor is essentially involved and directly affects the results obtained.

It will be seen that the foregoing apparatus can be used to great advantage, not only by the purchaser and user of the container but also by the container manufacturer and by the manufacturer of the container material as well, because they are thus enabled to make a reliable prediction as to the serviceability of the container in the field. The test can be made on a control basis with various kinds of packaging and wrapping materials which are to be subjected to repeated blows or stresses so as to involve the factor of fatigue of the material. While the foregoing discussion has referred for convenience to ordinary paper bags of kraft paper or glassine, it will be understood that other types of bag material may be similarly treated such as paper laminated to foil, paper coated with polyethylene, Saran and like plastics, films of regenerated cellulose and flexible plastics, and the like. The invention is also useful in testing such materials when used as wrappers in such a manner that they are subjected to impacts. For instance, candy bars and many other articles are often placed on chipboard and then wrapped so that the article may be loose in the package. Furthermore, the impact fatigue resistance of relatively stiff and rigid packaging materials may be similarly tested, such as semi-rigid or substantially rigid paperboard or plastic sheets. It is to be understood that the expression "bags and like containers" is used generically in the appended claims to include all such packages and containers.

It will be understood by those skilled in the art that there are various ways in which repeated impacts can be applied to the paper test section. The use of metal balls falling freely by gravity is preferred because each ball delivers the same impact without being influenced by friction or variations in the force utilized, but it is within the broad aspects of the invention to employ any other desired type of impact generating and applying means as, for example, a power-driven hammer-type apparatus or a pendulum effect. Moreover, with respect to the preferred method using freely falling weights, the apparatus described above and illustrated in the drawings is by way of example only, as various changes can be made in the form, details of construction and arrangement of the parts, and other known types of weight feeding and dispensing mechanisms and sheet clamping devices can be substituted for those specifically described. Reference should therefore be had to the appended claims for a definition of the invention.

What is claimed is:

1. Apparatus for determining the impact fatigue resistance of bags and like containers comprising an elevated container holding a plurality of weights and comprising means for feeding said weights in succession to a discharge point, intermittently operating weight-dispensing means at said discharge point whereby said weights are dispensed one by one at timed intervals and drop by gravity from said elevated container, and means located below said container for supporting a section of the material to be tested at spaced points with the intermediate portion of said section extending across the path of said dropping weights, said supporting means comprising upper and lower centrally apertured clamping plates having clamping surfaces engaging the peripheral portion of said section and disposed at an angle to the plane of the intermediate central portion of said section whereby it is radially tensioned by the clamping engagement of said plates.

2. Apparatus as defined in claim 1, one of said clamp-

ing plates being fixed and the other clamping plate being resiliently movable toward said fixed plate.

3. Apparatus as defined in claim 1, said supporting means being disposed at an angle to the horizontal, said intermediate portion being thereby tilted to cause rebound of said weights to one side.

4. Apparatus as defined in claim 1 including a mirror mounted beneath said central portion for observation of the impact of said weights thereon.

5. Apparatus for determining the impact fatigue resistance of bags and like containers comprising means for clamping and supporting a section of the container material with an unsupported portion thereof extending between said supporting means, a container holding a plurality of weights and located above said section, said weight container comprising a feed passage through which said weights move in succession and a barrier across said passage for stopping said weights at a discharge position, weight-discharging means operable at timed intervals on the weights at said discharge position and comprising a vertically reciprocable element behind said barrier for lifting said weights one by one over said barrier and discharging them from said weight container, and a vertical guide tube mounted above said section with its upper end outside said barrier in position to receive the discharged weights which drop by gravity through said tube onto the unsupported portion of said section.

References Cited in the file of this patent

UNITED STATES PATENTS

974,867	Eddy	Nov. 8, 1910
1,604,141	Amsler	Oct. 26, 1926
1,709,638	Thwing	Apr. 16, 1929
2,192,622	Radtke	Mar. 5, 1940
2,264,412	Shindel	Dec. 2, 1941
2,281,324	Preston	Apr. 28, 1942
2,579,503	Lubin et al.	Dec. 25, 1951

FOREIGN PATENTS

248,888	Great Britain	Mar. 18, 1926
486,533	Great Britain	June 7, 1938