March 2, 1954 R. B. FARIS, JR., ET AL 2,670,624

APPARATUS FOR MEASUREMENT OF LOW RATE DEFORMABILITY

Filed April 4, 1950

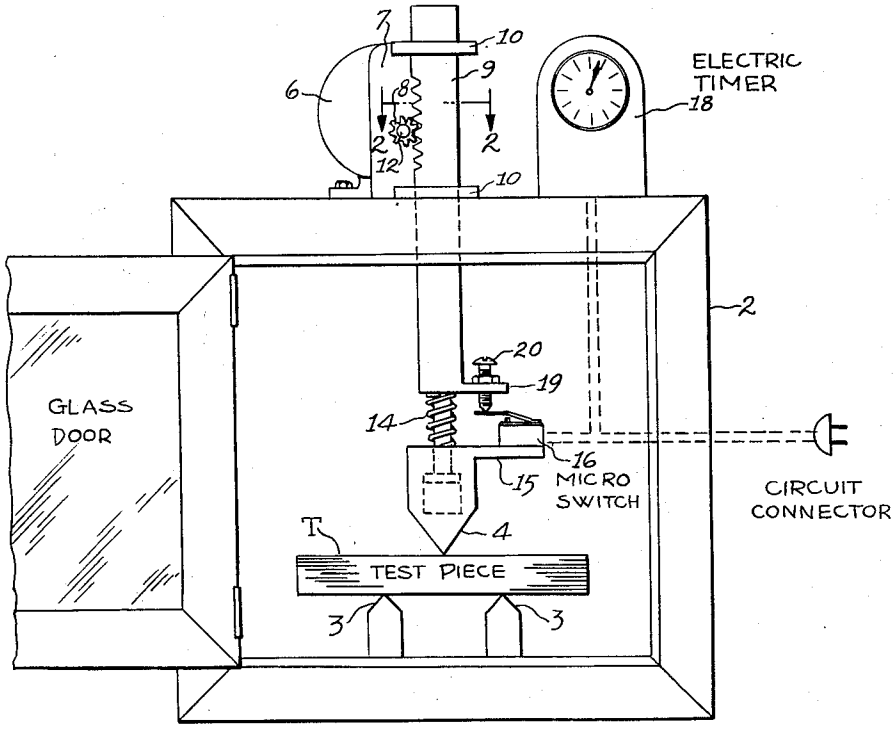


Fig. 1

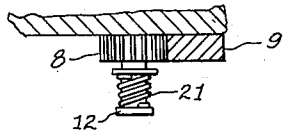


Fig. 2

INVENTORS

ROBERT B. FARIS JR., HARLEY F. HARDMAN, MELVIN M. F INK

BY

Oberlin & Limbach

ATTORNEYS

Patented Mar. 2, 1954 2,670,624

UNITED STATES PATENT OFFICE

2,670,624

APPARATUS FOR MEASUREMENT OF LOW RATE DEFORMABILITY

Robert B. Faris, Jr., Solon, Harley F. Hardman, Wickliffe, and Melvin M. Fink, Parma, Ohio, assignors to The Standard Oil Company, Cleveland, Ohio, a corporation of Ohio

Application April 4, 1950, Serial No. 153,832

4 Claims. (Cl. 73—15.6)

1

The performance of some materials which are on the order of semi-plastic or pseudo-plastic substances, that is, materials having some elasticity and slow flow or creep, cannot be determined by customary methods of tensile strength or shear-breakage testing. Their peculiar properties rather involve factors requiring a very considerable time element, as opposed to the rapid type of testing in tensile strength determinations. Also, there is a temperature factor which enters in the case of certain materials. One illustrative instance is the comparative measurement of asphalts as applicable to a determination of their characteristics for service life in pavements and the like. For instance, asphalt in exposure in pavement-usage is subjected to stresses more particularly brought about by thermal expansion and contraction as caused by ambient temperature changes, freezing and thawing, etc. And, bituminous pavements are particularly characterized by their ability to undergo deformation, i. e. bend without breaking, in transmitting traffic loads to the foundation and natural sub-grade. In one sense, thus, bituminous paving may be regarded as an abrasion-resistant weather-impervious protective coating withstanding the initial force of stresses which include certain long-time factors affecting deformability. Isolated properties of penetration, softening point, etc., as commonly determined for bituminous materials, are not sufficiently informative as to the overall behavior which may be expected of a given material in actual service life. Such fundamental variables as viscosity, elasticity, and yield point enter, but extensive investigation has shown that these fundamental variables may move counter to each other with changes in temperature, etc., such that these individual characteristics are of little value in judging relative behavior of different materials. Deformation, however, embodies the essential factors to such an extent that measurement of deformability becomes more convenient and practical as a basis of comparison. The present invention accordingly provides means by which deformability, at low constant deformation rate, of asphalt, and materials generally which exhibit slow flow characteristics, may be relatively evaluated in a practical manner. Other objects and advantages will appear from the following description.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth

2

in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 is a side elevational view of apparatus in accordance with the invention; and

Fig. 2 is a fragmentary sectional view taken on a plane substantially indicated by line 2, Fig. 1.

In the case of asphalts or bituminous materials, it is now found that the serviceability or operating life of the materials can best be determined in terms of maximum deformation or amount of bending at breaking. And, such testing is to be applied in terms of pressure at a constant but low rate of advance against the test piece. Test pieces or samples are to be made up to standardized dimensions, and their deformability is then determined under standardized conditions for comparison. The size of test pieces varies with the kind of material to be tested, but for illustration in the case of asphalts may advantageously be as follows: The asphalt or bituminous material in amount of 10 per cent by weight, is thoroughly mixed at 250° F. with 15 per cent by weight of limestone dust (200 mesh) and 75 per cent by weight of sand (40–80 mesh). The mixed material is then molded into test pieces of a fixed volume, in order to obtain a test piece density of about 2. This requires pressure of 10,000–15,000 pounds per square inch. A generally desirable dimension for the test piece is a form ½ by ½ by 5 inches. The test piece is cooled in the mold, and removed, and finally is tested at a standardized temperature. As there is a rather considerable time element in the testing, the temperature is to be accurately controlled, and standardized. In the case of bituminous materials for paving applications, we have found that a testing temperature of 0° F. is advantageous. The testing apparatus accordingly is enclosed in a temperature-control housing. This may be of general character as known, and for instance we desirably employ a temperature-control chamber or housing equipped with thermostat and a controlled refrigerant source, such conveniently as a circulating blower system and a Dry Ice compartment in circuit with the chamber. And, within the chamber 2, Fig. 1, spaced supports or knife edges 3 serve to support the piece to be tested T. An opposed knife edge member 4 is arranged intermediate to knife edges 3 to apply pressure against the supported test piece, and this member is driven forward at a constant speed, which however is of low rate. The rate

of travel of the deforming knife edge may be set as appropriate for any kind of material to be tested. In the case of paving asphalts, we have found that a forward feed rate of 0.07 inch per hour is particularly advantageous as affording a generally satisfactory comparable basis of testing, to afford direct comparison as to service performance that may be expected from the material when put into pavement usage. The driving of the pressure member 4 may be provided by suitable constant-drive means. In the form illustrated, a low constant speed motor 6 suitably attached to the housing, has reduction gearing 7, which through a pinion 8 drives a rack bar 9 in constant slow progression. The rack bar may be mounted to travel in guides 10 on the reduction gear box or otherwise suitably supported. And with particular convenience, the pinion 8 may be of re-set or disengageable type as commercially available. For instance, as in Fig. 2, the spring-held pinion splined on the shaft 12 may be manually slid out of engagement with the rack after completion of the test, and the rack may be raised back to its upper position and the pinion then be slid back into mesh. A peculiarity of the connection between the pressure member 4 and the driving rack 9 is that it embodies a lost-motion connection, and the purpose is to provide a time-element control. For instance, the rack member 9 may telescopingly engage into the pressure member 4, and a coil spring 14 may be interposed, whereby the rack 9 is driven down by a small amount, compressing the spring, before it engages against the pressure member 4 and applies its pressure thereto. The pressure member 4 by a bracket 15 carries switch 16 having contacts normally separated, and being in an electric circuit with a time-indicator 18. The rack bar 9 by a bracket 19 carries an adjustable tripper for the switch. This may be an adjustable screw 20 which can be set such that it pushes the switch arm to make contact as the rack bar starts the pressure on the member 4. The time-indicator may be of the electric clock type available commercially, and as seen, it functions to indicate the time of the starting of applying of pressure to the test piece, and then when the test piece breaks and no longer opposes resistance, the spring 14 separates the pressure member 4 sufficiently from the drive and rack bar 9 to allow the switch to break contact and stop the timer clock, whereupon the total time of the application of the deforming pressure is known. And, since the rate of movement of the rack bar is a known constant, such time measurement provides a precision micrometer space-traverse measure. Thus for example, if the rack bar drive rate has been set for 0.1 in. per 60 minutes, each minute becomes a space measure of 0.1/60; and so on in accordance with whatever rack drive rate has been adopted. And in general thus the time measure at constant rate gives a direct determination of the space traverse or the movement or the rack bar.

If the test piece be molded to twice the length necessary for the spacing between the support knife edges 3, it permits the placing of the test piece first such that the intermediate pressure knife edge 4 strikes it midway. The first test then breaks the sample into two equal halves, and each half may then be successively run through a similar test, and thus three readings on the same piece may be had, for extreme accuracy.

As illustrative of the test procedure:

An asphalt from Mid-Continent crude, pentration 63 at 77° F., in amount of 10 per cent by weight, was mixed at 250° F. with 15 per cent by weight of limestone ground to 200 mesh, and 75 parts by weight of sand of 40–80 mesh, and the well mixed material was molded at 20,000 pounds per square inch in a ½ inch by ½ inch by 5 inch mold, and after cooling was removed and placed on the support knife edges in the temperature-control chamber. After allowing the test piece to come to the temperature of the chamber, 0° F., the motor was started, and as the rack bar was forced down, compressing the lost-motion spring, the tripper operated the timer switch and the time indicator was started. With a constant speed of advance of 0.07 inch per hour, the upper knife edge was driven forward against the test piece. After about 25 minutes, through the glass front of the housing, a small crack was seen in the lower edge of the test piece. With further lapse of time, this crack extended, and finally the sample tore apart, and the lost-motion spring caused the switch to open and stop the timer. The total time was found to be 40.45 minutes, and so at the rack drive rate per minute as set for this test the distance travelled in the deformation in that time equalled 0.043 inch. Hence, the maximum deformability shown by this sample equals distance travelled divided by test piece thickness or 0.043/0.5 or 8.6 per cent. This percentage result can be compared directly with results similarly obtained on other asphalts, and as fore-noted, the deformability correlates to the practical performance which may be expected of a particular asphalt in actual pavement service.

Similarly, for any other material where it is desired to test the deformability by a constant advance rate of pressure knife edge, the ratio of distance travelled and test piece thickness may be determined with a drive rate suitable on a basis of temperature, size, etc., as appropriate for the kind of material to be tested.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In testing apparatus, a temperature control housing, spaced edges therein to support a piece to be tested, a movable opposed edge member intermediate said edges, and an electric switch carried by said member, the combination of a rack bar having an end telescoping with said opposed edge member for limited movement relative thereto, an adjustable tripper carried by said rack bar for actuating said electric switch, a spring between said rack bar and said edge member normally maintaining the tripper out of operative contact with the switch, a timing clock controlled by said switch, and means for driving said rack bar at a constant low rate of speed, said means including an axially movable pinion for meshing and unmeshing with said rack bar, and a drive motor and reducing gearing connected to said pinion.

2. In testing apparatus, a temperature control housing, spaced edges therein to support a piece to be tested, a movable opposed edge member intermediate said edges, an electric switch carried by said member, a rack bar having lost-motion connection to said opposed edge member, an adjustable tripper carried by said rack bar for actuating said switch, a spring normally main-

taining the tripper out of operating contact with the switch, a timer in circuit with said switch, and means for driving said rack bar at a constant low rate of speed.

3. In testing apparatus, a temperature control housing, spaced edges therein to support a piece to be tested, a movable opposed edge member intermediate said edges, means for determining the beginning and the end of movement thereof against the piece being tested, including an electric switch carried by said member, and a driving bar having lost-motion connection with said opposed edge member, together with an adjustable tripper carried by said bar for actuating said switch, and a spring normally maintaining the tripper out of operating contact with the switch, and means for driving said bar and opposed edge member at a constant low rate of speed.

4. In testing apparatus, a temperature control housing, spaced edges therein to support a piece to be tested, a movable opposed edge member intermediate said edges, means for determining the beginning and the end of movement thereof against the piece being tested, including a driving bar with lost-motion connection to said movable opposed edge member, and an electric switch at the lost-motion connection, means for driving said bar and opposed edge member at a constant low rate of speed, and means controlled by closing and opening of the switch by the bar movement relative to said opposed edge member for measuring the time of travel.

ROBERT B. FARIS, JR.
HARLEY F. HARDMAN.
MELVIN M. FINK.

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