# United States Patent

**Strydom**

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[54] **NON-DESTRUCTIVE HARDNESS, TESTING OF ARTICLES SUCH AS CIGARETTES**


[72] Inventor: **Mauritz Leon Strydom**, Stellenbosch, South Africa

[73] Assignee: **Tobacco Research and Development Institute Limited**



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May 16, 1969 South Africa.....69/3457

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[51] **Int. Cl.**.....**G01n 3/10**, G01b 13/08
[58] **Field of Search**.....73/78, 37.5, 37.8, 37.9, 94, 73/38



[56] **References Cited**

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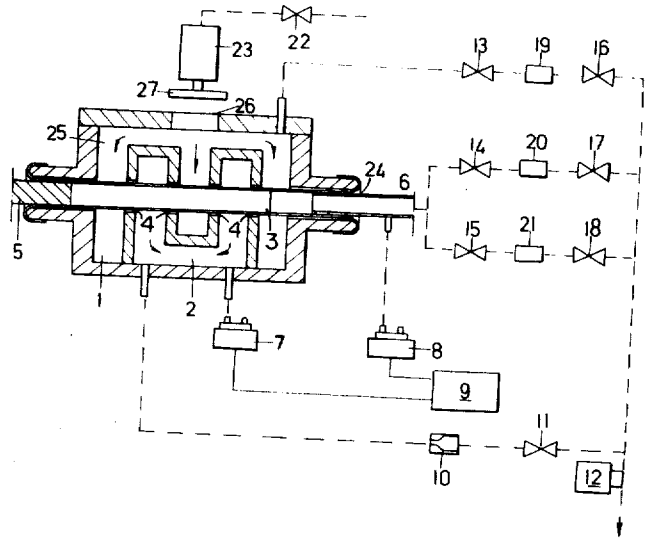
*Primary Examiner*—Richard C. Queisser
*Assistant Examiner*—Ellis J. Koch
*Attorney*—Waters, Roditi, Schwartz & Nissen

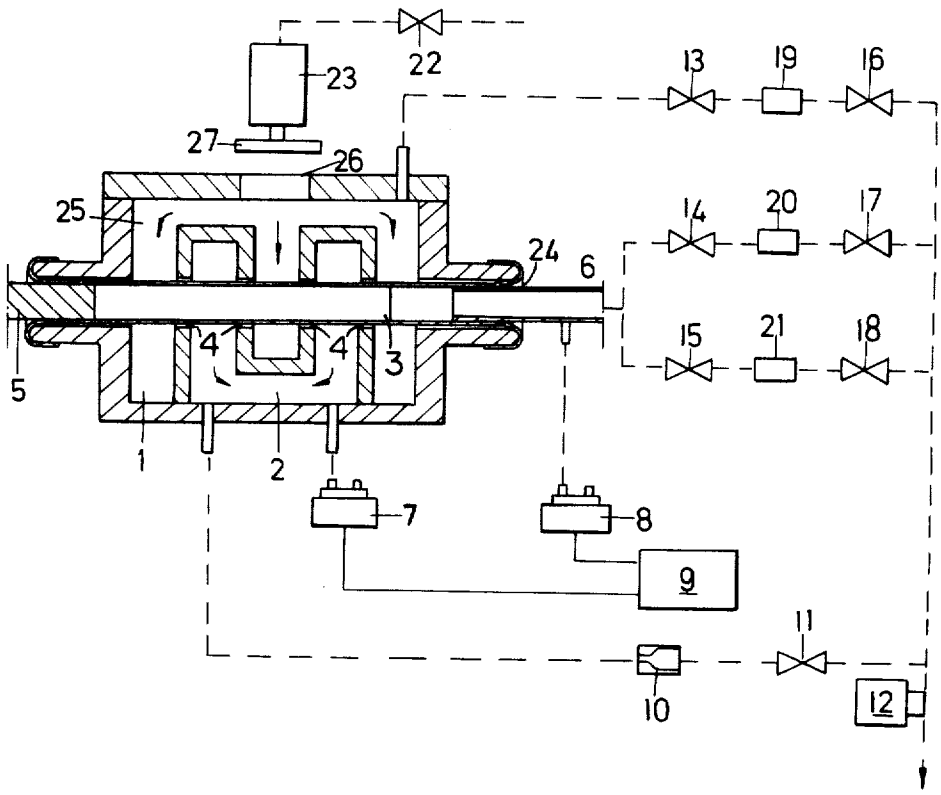


[57] **ABSTRACT**

A cigarette is tested for hardness by inserting it into a rubber sleeve which is surrounded by rings. Air is passed through the annuli formed between the cigarette and the rings. The pressure drop is measured firstly with the cigarette interior as is, secondly with the cigarette interior subjection to a first suction and thirdly with the interior subjected to a second suction. The pressure drops are measures of the diameters of the cigarette at the various interior loadings. From these diameters and the loadings the hardness of the cigarettes may be computed.


**6 Claims, 1 Drawing Figure**

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# NON-DESTRUCTIVE HARDNESS, TESTING OF ARTICLES SUCH AS CIGARETTES

This invention relates to the non-destructive hardness testing of articles such as cigarettes.

Conventional hardness testers measure the depth to which a plunger acting under a predetermined force dents the periphery of a cigarette. The depth of the dent is some inverse function of the true hardness expressed in gm/mm². Instruments which are able to give a reliable measure of the hardness of cigarettes by the conventional method are highly sophisticated and therefore expensive. A method of making and measuring dents caused by gas flow is described in U.S. Pat. No. 3,411,513.

In U.S. Pat. No. 3,115,772 it has been proposed to insert a cigarette into a sleeve, to apply pressure by liquid means to the sleeve and to measure the volume of gas expelled from the cigarette. The ratio of the volume before compression and the volume after compression is said to be a measure of the "firmness" of the cigarette. The term "firmness" as used in the U.S. specification and the term "hardness" used in this specification are interchangeable.

The applicant now proposes a method and apparatus which does not rely on liquid pressure or on the measurement of a small volume of gas expelled from a cigarette.

A method according to the invention comprises applying a first pressure to the outer covering and recording that pressure; establishing and recording the diameter of the article at the first pressure as a first diameter; pneumatically compressing the article at a second pressure higher than the first pressure and recording the second pressure;

establishing and recording the diameter of the article at the second pressure as a second diameter; and

deriving a measure of a property of the article from the diameters and pressures thus recorded.

The invention is further discussed with reference to the accompanying drawing which is a schematic representation of apparatus suitable for carrying out the method of the invention with the main component in section.

The heart of the unit consists of a series of rings **4** adapted to surround a cigarette **3**. Alternate sides of the rings **4** are connected to a chamber **2** and to a chamber **25** which is at atmospheric pressure through a port **26**. The cigarette is held in position by means of a thin rubber tube **24** which is stretched to such an extent that its inside diameter is smaller than that of the cigarette **3**.

A plug **5** seals the cigarette **3** from atmosphere and at the other side a tube **6** connects the inside of the cigarette **3** to a suction system.

The chamber **2** is connected to a vacuum pump **12** through a critical flow orifice **10** and a shut-off valve **11**. The vacuum pump **12** provides suction of at least 0.6 Kp/cm².

A transducer **7** measures pressure in the chamber **2** which is a function of the diameter of the cigarette **3**. A transducer **8** measures the suction applied to the cigarette. Transducers **7** and **8** can be sampled by a scanner/digital voltmeter **9**.

As a result of the inclusion of the critical flow orifice **10** in the circuit the rate of flow from the chamber **2** remains constant within wide limits regardless of the diameter of the tube **24** as long as there is clearance between the tube **24** and the rings **4**.

It is well known to measure the diameter of an article by measuring the pressure drop in a gas flowing through an annulus formed aroung the article. In the present case each of the rings **4** forms such an annulus. Since there are several rings **4** (four in the illustrated embodiment) the pressure reading in the chamber **2** is a measure of the diameter of the tube **24** as averaged over those several diameters that are surrounded by the rings **4**.

Shut-off valves **14** and **15** connect the cigarette interior to suction chambers **20** and **21**. Suction in chambers **20** and **21** is maintained at approximately −0.1 and −0.4 Kp/cm² respectively by means of control valves **17** and **18**.



The port **26** may be closed by means of a valve **27** actuated by a pneumatic cylinder **23** fed with compressed air through valve **22**. Opening of the valve **22** caused the valve **27** to close the port **26**. Closing of the valve **22** allows the port **26** to open

A shut-off valve **13** controls the admission of suction to the chamber **25**. The valve **13** leads to a suction chamber **19** the pressure of which is controlled by a valve **16**. The pressure in the chamber **19** is so regulated that with the port **26** closed the tube **24** is caused to stretch to a sufficient extent to allow for the insertion of a cigarette.

The test sequence is as follows:

Assume all shut-off valves closed. Open the valve **22**. The cylinder **23** is activated by compressed air and the port **26** is closed. Open the valve **13**. The rubber tube **24** is expanded. Insert a cigarette, the plug **5** and the tube **6**. Close **13** and **22** so that the port **26** is again uncovered. If the valve **11** is opened, the unloaded diameter DU can be obtained from the reading of the transducer **7** on the voltmeter **9**. Opening the valve **14** will cause a pressure load of 0.1 Kp/cm² on the cigarette. The transducer **7** reads D1 and the transducer **8** reads P1. Likewise D2 and P2 are obtainable by closing the valve **14** and opening the valve **15**.

Closing the valves **15** and **11** and opening the valves **22** and **13** will again open the tube **24**, preparatory to replacing the cigarette with the next to be tested.

Note that D1 and D2 are taken at pressure above a PO which is equal to the pressure exerted by the tobacco on the paper wall.

After correcting D1 and D2 by subtracting the thickness of the tube **24**, hardness "H" may be computed by utilising the formula:

$$H = (P2-P1)\,DU\,/\,(D1-D2)\ \text{gm/mm}^2$$

where

DU is the unloaded diameter
P1 is the pressure of first loading
P2 is the pressure of second loading
D1 is the diameter under loading of P1
D2 is the diameter under loading of P2

The pressure initially exerted by the tobacco on the paper wall may be computed as

$$P0 = P1 - \frac{(P2-P1)(DU-D1)}{(D1-D2)}$$

The hardness figure computed from measurements taken in the manner described above according to the above formula conforms very closely to figures determined by more conventional ways. In addition the figure of pressure exerted by the tobacco is very useful for comparison purposes during the control of cigarette manufacture.

Note that the tube **24** is not essential for a measure of hardness to be obtained. However, if the tube **24** be not used, the porosity of the cigarette paper will affect the measurements and these will have to be adjusted accordingly. In view of the absence of these adjustments when a tube is used, it is preferred to use the apparatus with the tube **24**.

I claim:

1. Apparatus for testing a cylindrical article such as a cigarette comprising a filling material and an outer covering, comprising:

means for supporting the article;

means for fluid-tightly sealing off one end of the article;

means for applying suction to the outer end of the article;

a chamber surrounding the article and at least one ring within the chamber dividing the chamber into two compartments, the ring surrounding the article with an annular gap between it and the article;

means for causing gas to flow through the annular gap from one side of the ring to the other side of the ring;

means for measuring the pressure difference between both sides of the ring; and

means for measuring the suction applied to the other end of the article.

2. The apparatus claimed in claim 1 including a gas-impervious sheath for circumferentially enclosing the article the gap being between the ring and the sheath.

3. The apparatus claimed in claim 2 in which the sheath is held in the chamber and including means to close the chamber and means to apply suction to the chamber to allow the sheath to expand to accept an article.

4. The apparatus claimed in claim 1 in which there are a plurality of rings arranged so that in the case of each ring, gas flow is from a first space to a second enclosed space, the first space being open to atmosphere and including means for subjecting the second space to suction.

5. The apparatus claimed in claim 4 in which the second space is connected to the means for subjecting it to suction through a critical flow orifice.

6. Apparatus for testing a cylindrical article such as a cigarette comprising a filling material and an outer covering, comprising:

a chamber having two end walls connected by side walls;

an opening in the side walls;

a shut off valve for controlling the opening;

registering bores in the end walls;



a cylindrical flexible gas-impervious sheath mounted between the bores and defining a tube between the end walls;

rings surrounding the tube and each spaced from the tube by an annular gap;

means for so connecting the rings that they divide the chamber into a first space into which the opening in the side walls leads and a second space communicating with the first space through the annular gaps;

means for plugging one end of the tube;

means for applying suction to the other end of the tube;

means for applying suction to the first space in the chamber;

means for applying suction to the second space in the chamber;

a critical flow orifice connected between the latter suction means and the second space;

means for measuring the pressure in the second space; and

means for measuring the suction applied to the other end of the tube.

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