Sept. 7, 1965 W. B. FORDYCE 3,204,449

TESTING OF CIGARETTE FILTERS

Filed April 4, 1962 2 Sheets-Sheet 1

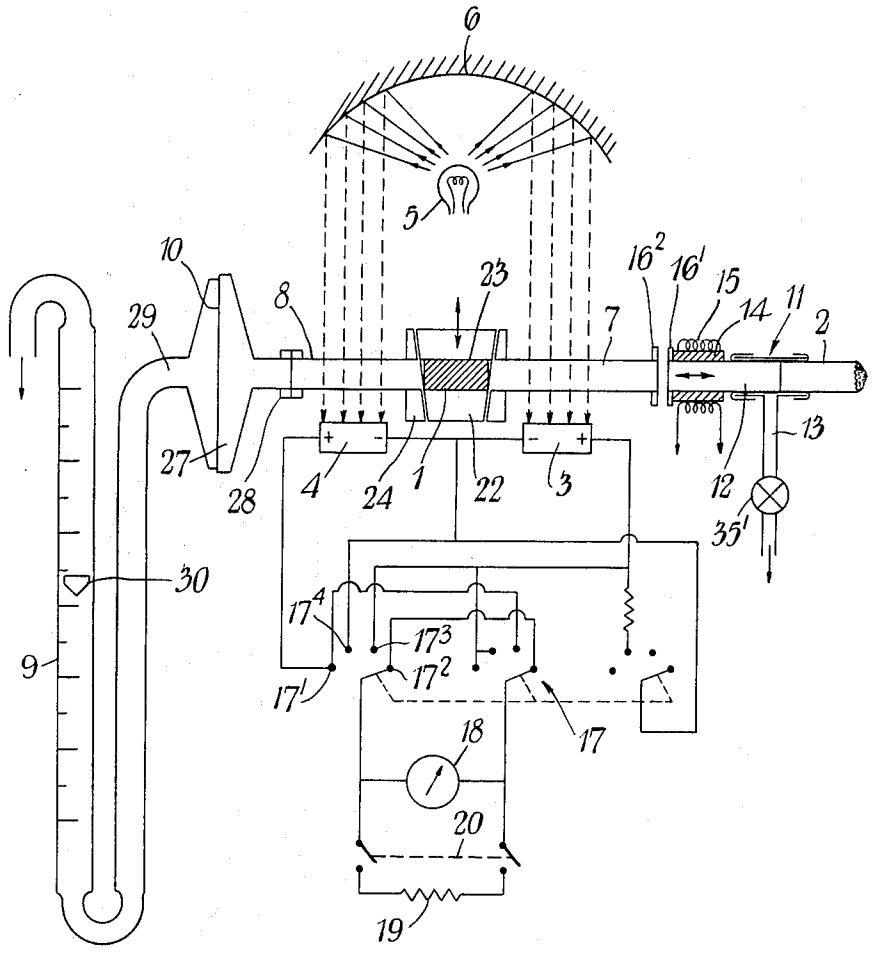


FIG. 1

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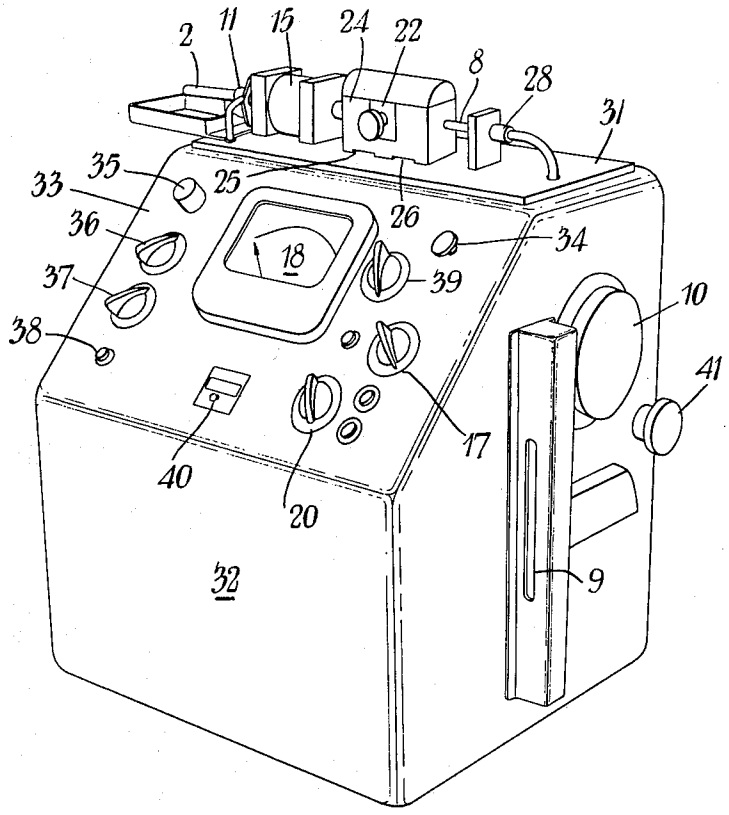


FIG.2

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TESTING OF CIGARETTE FILTERS

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6 Claims. (Cl. 73—38)

This invention concerns improvements relating to the testing of cigarette filters. Normally the criteria for the performance of a cigarette filter are the efficiency of the removal of smoke constituents and the pressure drop in the filter plug. Conventional methods of assessing the former criterion are generally time consuming and require repetition to achieve reasonable results.

According to the present invention, appratus for testing a cigarette filter comprises means for passing cigarette smoke through the filter and photometric means for measuring the density of the smoke before and after its passage through the said filter. With such apparatus, the efficiency of the filter can be accurately, quickly and directly measured without requiring the application of chemical techniques. Consequently, it permits of a rapid quality assessment of cigarette-filter plugs as a routine operation during their manufacture and/or during subsequent operations thereon. Furthermore, the apparatus lends itself to other forms of test, such as the measurement of pressure-drop characteristics and it can be used for these measurements on filter plugs or rods and cigarettes, respectively, or on a cigarette having a filter plug attached thereto. In either case the cigarette rod may be lit or unlit, thus permitting the determination of the full characteristics in a short time and in a single apparatus. Finally, the apparatus can be made in compact or portable form.

The photometric means may comprise two light-responsive devices, such as photo-voltaic cells, illuminated by beams from a common source, reflected by, say, a parabolic reflector. Suitably, the smoke is carried through the beams in transparent tubes forming part of a passage system of which one end is adapted for holding a burning cigarette, while the other end is in communication with a suction pump, a holder for the filter being connected between the said two tubes. With this arrangement, the efficiency of the filter can be assessed from the difference in output or in response of the two devices due to the lesser obscuration of that light-responsive device which is downstream of the filter.

One embodiment of the invention by way of example will now be more fully described with reference to the accompanying drawings, in which:

FIGURE 1 is a diagram of the apparatus, and

FIGURE 2 a perspective view of a practical form of such apparatus.

Basically, the method of measurement of the efficiency of a filter plug **1** (FIGURE 1) is to place it in an airstream, carrying smoke from a lighted untipped cigarette **2** and to view the airstream by a first photovoltaic cell **3** before it passes through the plug **1** and by a second such cell **4** after it has passed through the said plug. The cells **3**, **4** are connected electrically in opposition and are illuminated from the same light source, as illustrated an electric lamp **5** mounted in a parabolic reflector **6** which projects two equal beams of parallel rays onto the cells through glass tubes **7**, **8** in which the airstream flows. With this arrangement, if the outputs of the cells **3**, **4** are adjusted to balance exactly when there is no smoke in the air stream, then the difference in obscuration of the cells, when smoke is present, due to the effect of the

filter plug **1** will be a measure of the efficiency of the said plug in removing smoke from the airstream. Two plane mirrors may be used instead of the parabolic mirror **6**.

For testing filter plugs under conditions approximating to those of their normal use, it is desirable that provision should be made for the production automatically of a predetermined puffing cycle on the cigarette **2**. For this purpose, it is convenient that a continuous airstream should be produced by suction through the tube **8**, plug **1** and tube **7**, but that the cigarette **2** should be applied to the tube **7** and subjected to the suction intermittently under the control of timing means. The suction is produced by an electrically driven vacuum pump (not shown) connected to the tube **8** by way of a flow-regulating valve, a simple flowmeter **9** and a filter **10**.

For holding the cigarette **2** in readily releasable fashion, a so-called balloon type of gripping device **11** is provided. This comprises a flexible sleeve mounted at one end on a tube **12** and adapted for receiving the cigarette in the other. The annular space in the sleeve is connected through a tube **13** and past a manually controlled cock **35'** to the suction side of the aforesaid pump. On the application of suction to the said space, the sleeve will be expanded to permit of insertion or removal of a cigarette. When the suction is cut off, the sleeve will contact to grip the cigarette.

For producing the puffing effect on the cigarette **1**, the tube **12** is arranged to be axially movable to bring it into and out of close butting relation with the tube **7**. To this end, the tube **12** is formed with or secured in an iron core **14** slidable in a solenoid **15** whose energization is controlled by the aforesaid timing means. On energisation of the solenoid, the core **14** is moved to the left to cause the tube **12** to seat against the tube **7**, suitably by way of metal and nylon sealing surfaces of flanges 16^1, 16^2 respectively. On de-energization of the solenoid, the core **14** and the tube **12** are urged to the right by a restoring spring or springs (not seen).

Automatic timing means may consist simply of a known transistor time circuit designed to produce closure of the energizing circuit of the solenoid **15** for, say 2 seconds in each 30 seconds. Provision may be made for adjusting the circuit to give alternative puffing times, for instance a choice of 2 or 3 puffs in each 30 seconds. Alternatively the timing means may comprise a slow-turning synchronous motor which drives either a cam controlling contacts in the solenoid circuit or a disc with a slot through which a photo-transistor device is periodically illuminated by a light source, the said device, in conjunction with a thermistor and a capacitor, then causing a relay to operate and energise the solenoid for a predetermined period. Whatever the timing means employed, provision may be made not oly of a switch for switching the timing means on and off, but also of an over-riding manual switch by which the solenoid can be kept energized at will, for example when the cigarette is being lit and also for non-automatic timing. A resettable counter for indicating the total number of puffs may be operated from the timing means or the solenoid-energizing circuit.

The cells **3** and **4**, for example selenium or other barrier-layer cells, are connected, in the measuring position 17^1 of a switch **17**, in series opposition through an indicating meter **18**, which will give a reading dependent upon the difference between the outputs of the cells, that is upon the difference in their obscuration, which is dependent in turn upon the efficiency of the filter plug **1**. The meter **18** may be a microammeter suitably calibrated in terms of filter efficiency. In addition to an "off" position 17^2, the switch **17** has two "check" positions 17^3 and 17^4 which are used for setting up the apparatus accurately. For controlling the range of the apparatus, one or more shunts **19** may be connected

across the meter 18 by means of a range switch 20. If photo-emissive cells or photo-multipliers are used in place of the cells 3, 4, amplifying means may be introduced between them and indicating and/or recording means, for example an ammeter or a print-out type of voltmeter.

The lamp 5 and other components may be fed from the power supply through a self-regulating constant-voltage transformer, which avoids trouble due to mains-voltage fluctuation. The lamp 5 is supplied through a variable resistor by which the intensity of illumination and the sensitivity can be adjusted. The solenoid 15 is fed from this transformer through a bridge rectifier. For balancing the cells 3, 4 initially, so that the meter 18 reads zero with no smoke passing, the reflector 6 may be arranged to be angularly adjustable, together with the lamp, about the middle of the said lamp. This adjustment can be effected through worm gearing by a control knob.

To facilitate the introduction and removal of the plug 1, a self-sealing wedge-shaped holder 22 having a bore 23 is arranged to be slidable into and out from a small housing 24. The bore 23 is made long enough to accomodate any length of plug normally used. To enable plugs of smaller diameters to be tested, a number of adaptor sleeves of appropriate internal diameters may be provided. The housing 24 is also provided with slots 25, 26 (FIGURE 2) into which analogue masks simulating known obscuration conditions can be slipped, so as to come between the light source 5 and cells 3, 4 respectively. By using the check positions of the switch 17 and such analogue masks, the apparatus can at any time be aligned to given known conditions. Consequently, the operational accuracy of the apparatus is not dependent on the long-term stability of the initial adjustments made when setting it up.

The filter 10, which is intended to be a total filter for particulate matter, may comprise a removable paper filter disc. The filter housing 27 is connected to the tube 8 by a realeasable union at 28. If it may be desired to measure the draw resistance of the plug 1 at the same time as its efficiency, a U-tube manometer or other pressure-drop measuring means may be connected to, or adapted for being plugged into, the pipe 29 beyond the filter 10. The flow-meter 9 may be of known type, comprising a rotatable float 30 in a tube which widens very slightly upwardly.

FIGURE 2 illustrates a practical arrangement of the apparatus, in which the tubes 7, 8 solenoid 15, housing 24 and associated parts are arranged on the top 31 of a cabinet 32 in which are disposed the lamp 5 and reflector 6, the pump, timing means, transformer and other associated electrical components. The main controls are grouped around the meter 18 on a sloping upper front panel 33. The convenient disposition of other parts of the apparatus is shown in the figure. In addition to the switches 17 and 20, the main controls include knobs 34 and 35 for operating the above-mentioned valve for regulating the air flow and the cock 35' for controlling the cigarette holder 11 respectively, on/off switches 36 and 37 for the pump and timing means respectively, a press-button switch 38 for over-riding the automatic timing means an operating knob 39 for the resistor controlling the sensitivity, the puff-counter 40 and a control knob 41 for the angular adjustment of the reflector 6.

The above-described apparatus has the additional advantage that it provides facilities for a variety of other test purposes in addition to the specific testing of the filtration efficiency of filter plugs or filter-rod material. Inter alia, it can be used for testing the resistance to air flow of filter materials or of cigarettes, for generating a smoke-laden airstream under controlled conditions, for removing solid materials from such an airstream, for comparing smoke yields from different types of cigarettes under the same smoking conditions and for investigating the profile (that is the change in smoke concentration over the period of a puff) of the smoke stream from a cigarette under given conditions. For some of these purposes, no plug 1 need be placed in the apparatus and only one of the cells 3 and 4 need be in circuit.

The apparatus can be readily portable and only required to be plugged into a source of supply of electricity.

I claim:

1. Apparatus for testing the efficiency of a cigarette filter comprising: a pneumatic system having a longitudinal passage; a removable filter holder releasably coupled with the pneumatic system and having means for releasably holding a cylindrical filter with its axis in coaxial relationship with respect to the longitudinal passage; the pneumatic system having transparent tube sections on each side of said filter holder; cigarette puffing means for smoking a cigarette having means for releasably mounting the cigarette and having further means for intermittently passing cigarette smoke to simultate a puffing effect through the filter by way of the pneumatic system and said transparent tube sections; photometric means for measuring the change in the cigarette smoke density before and after it passes the cigarette filter; said photometric means having a first light responsive means for measuring the density of the smoke viewed through one of the transparent tube sections and a second light responsive means for measuring the density of the smoke viewed through the other transparent section respectively before and after the smoke passes through the filter.

2. Apparatus according to claim 1, wherein the filter holder is wedge-shaped and is slidable into a housing so as to bring a filter-holding bore into communication with passage system.

3. Apparatus according to claim 1, wherein the photometric means comprises two photo-voltaic cells connected in series opposition through a current measuring instrument.

4. Apparatus for testing the efficiency of a cigarette filter comprising: a passage system having a first end and a second end for passing cigarette smoke through a filter; photometric means for measuring the density of the smoke before and after it passes through the filter, the smoke being conducted past the photometric means in transparent tubes forming part of said passage system; a removable filter holder for the filter being connected between said transparent tubes; the first end of said passage system comprising a cigarette holder for burning a cigarette and suction means including a suction pump communicating with the second end of said passage system for continuously applying suction to said second end and said cigarette holder being adapted to be brought into communication with said passage system and said transparent tubes; and timing means for intermittently communicating the cigarette holder with said passage system and the transparent tubes so that a puffing effect is produced on the cigarette.

5. Apparatus for testing the efficiency of a cigarette filter comprising: a passage system having a first end and a second end for passing cigarette smoke through a filter; photometric means for measuring the density of the smoke before and after it passes through the filter, the smoke being conducted past the photometric means in transparent tubes forming part of said passage system; a removable filter holder for the filter being connected between said transparent tubes; the first end of said passage system comprising a cigarette holder for burning a cigarette and suction means including a suction pump communicating with the second end of said passage system for continuously applying suction to said second end and said cigarette holder being adapted to be brought into communication with said passage system and said transparent tubes; a cigarette tube adjacent one of the transparent tube sections for releasably holding a cigarette; and electromagnetic means for axially

moving said cigarette tube into and out of sealed communication with the adjacent transparent tube section so that a puffing effect is produced on a cigarette.

6. Apparatus for testing the efficiency of a cigarette filter comprising: a pneumatic system having a longitudinal passage; a removable filter holder releasably coupled with the pneumatic system and being movable transversely of the longitudinal passage and having means for releasably holding the cylindrical cigarette filter with its axis in a coaxial relationship with respect to the longitudinal passage; said passage having transparent tube sections on each side of said holder; said holder being wedge-shaped and slidably mounted in said passage system so as to bring the filter into communication with the longitudinal passage of said system, cigarette puffing means for smoking a cigarette and having means for releasably mounting the cigarette and having further means for intermittently passing cigarette smoke to simulate a puffing effect through the filter by way of the pneumatic system and photometric means for measuring the change in cigarette smoke density before and after it passes through the cigarette filter; said photometric means having a first light responsive means for measuring the density of the smoke viewed through one of the transparent sections and a second light responsive means for measuring the density of the smoke viewed through the other transparent section respectively before and after the smoke passes through the filter.

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