

[54] **ELECTROPNEUMATIC CIGARETTE INSPECTION**

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[51] Int. Cl.....G01m 3/02

[58] Field of Search.....73/37, 45, 45.1, 45.2, 41, 73/45.3, 38

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[57] **ABSTRACT**

Cigarettes that are to be tested for defects are fed in succession, side by side, and equally interspaced, on a transfer means driven continuously and transversely to the cigarettes to temporarily drive each cigarette axially to position an end of each cigarette to be tested into a mouthpiece which communicates with a testing chamber containing a pressure transducer sensing element. The chamber communicates alternately and periodically with the atmosphere and with a pressurized gas source which establishes, in the chamber, a maximum value of pressure in relation with the condition of the cigarette being examined. A transducer responds to the maximum value of pressure with an electric signal that is correlated with a recurrence signal of constant frequency and a rejection signal is generated for the actuation of a device which expels, from the row of cigarettes tested, those cigarettes for which the maximum pressure value reached was less than a predetermined pressure value considered as a lower limit for the criterion of acceptance of the cigarettes under test.

9 Claims, 17 Drawing Figures

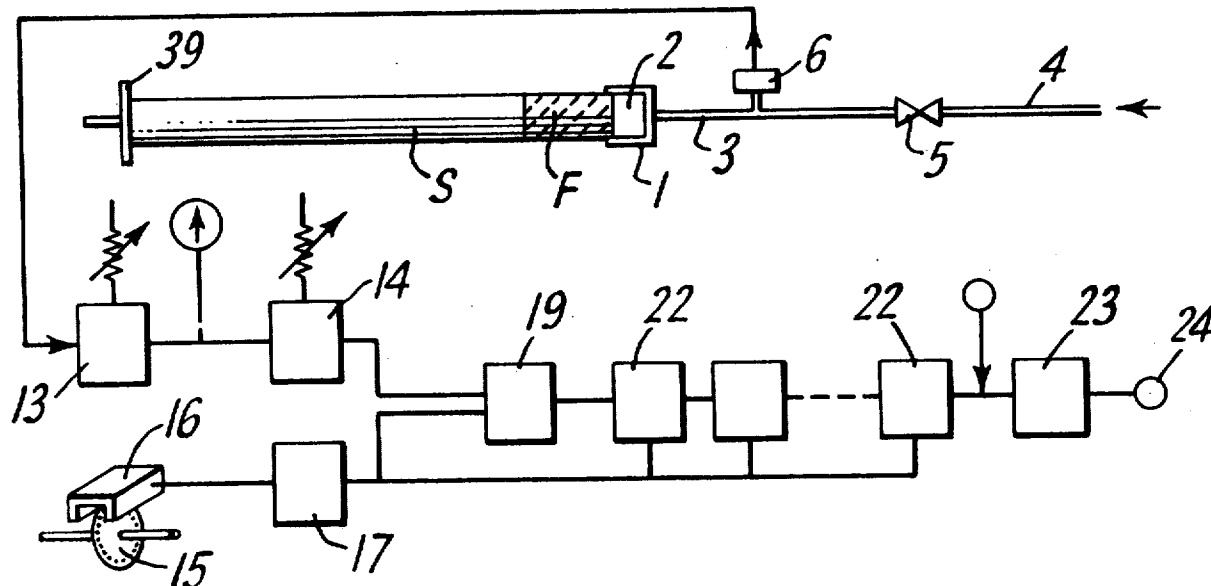


FIG. 1

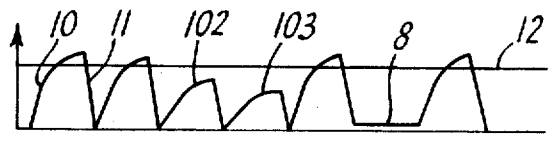
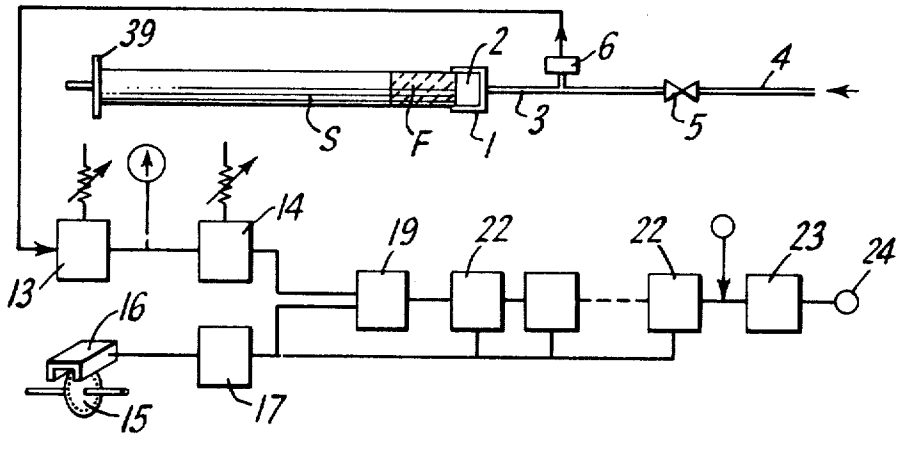


FIG. 2a

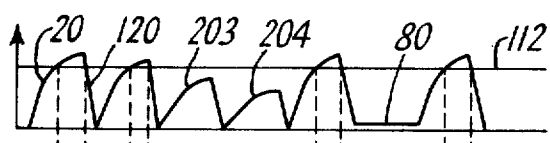


FIG. 2b

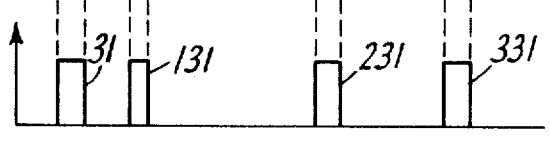


FIG. 2c

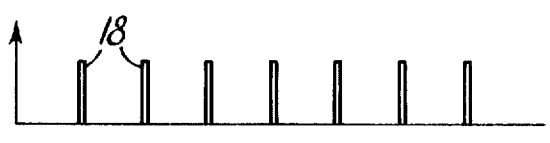


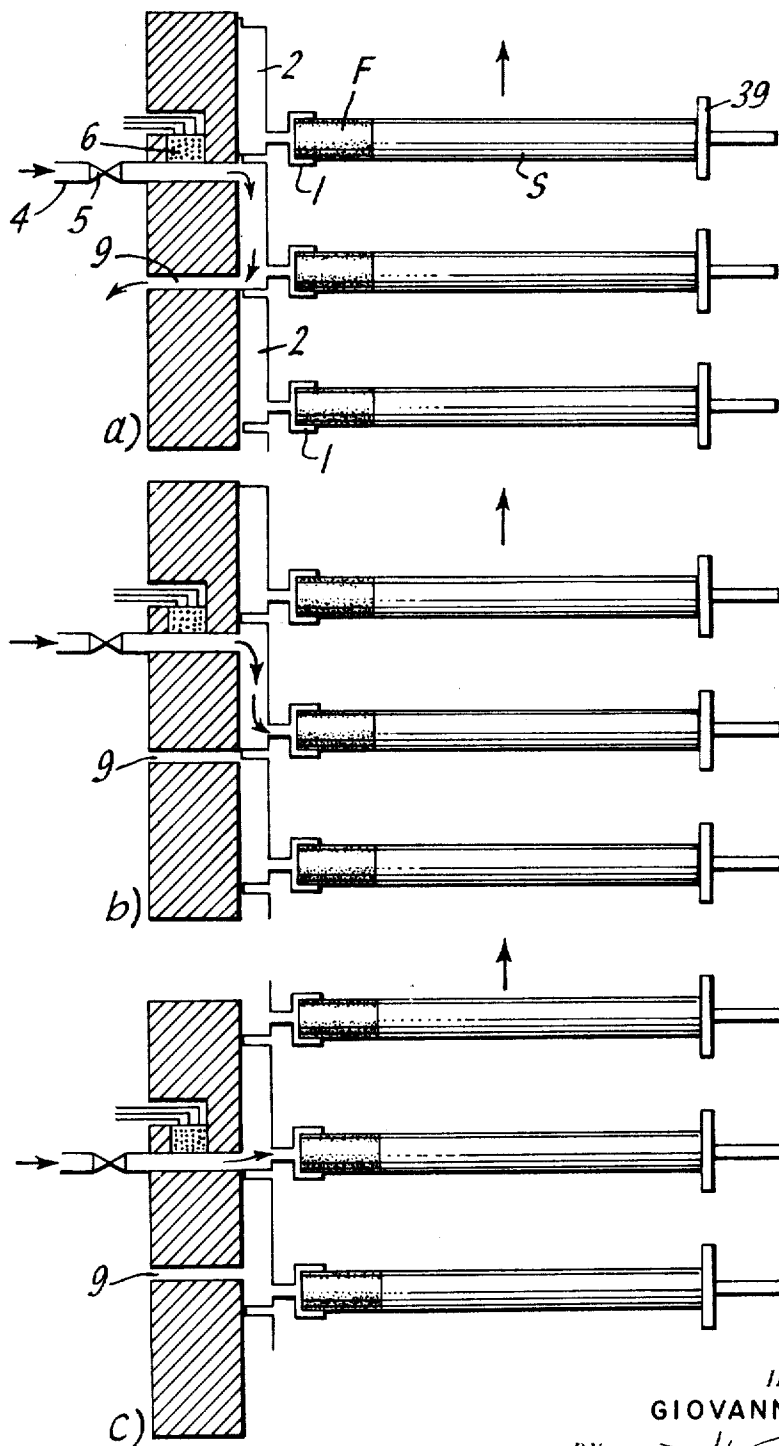
FIG. 2d



FIG. 2e

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FIG. 3

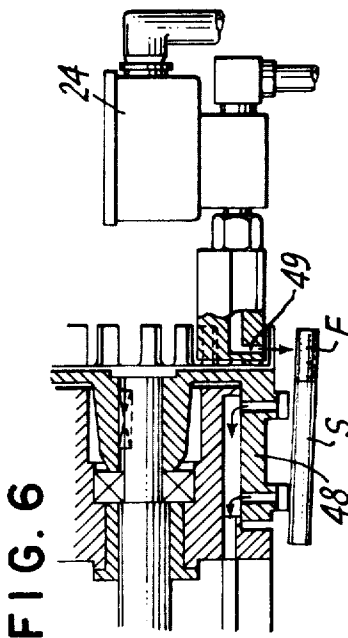
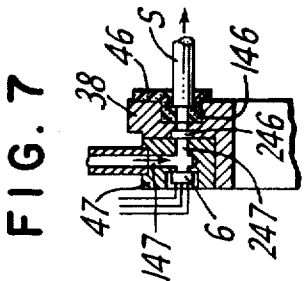
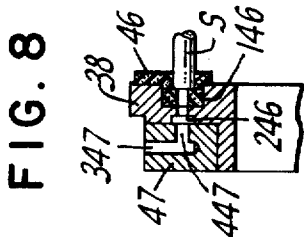
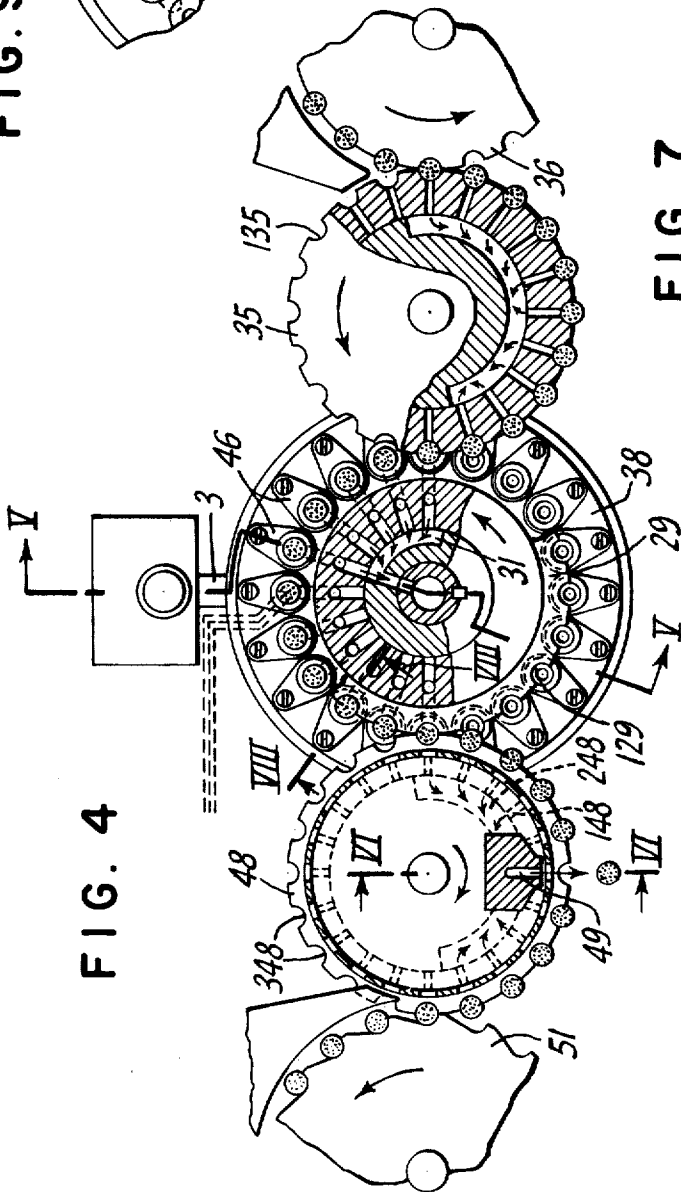
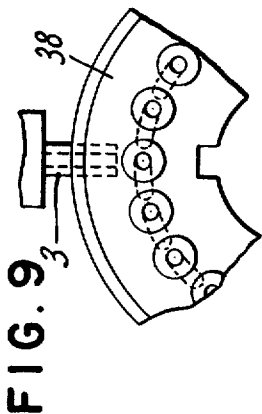


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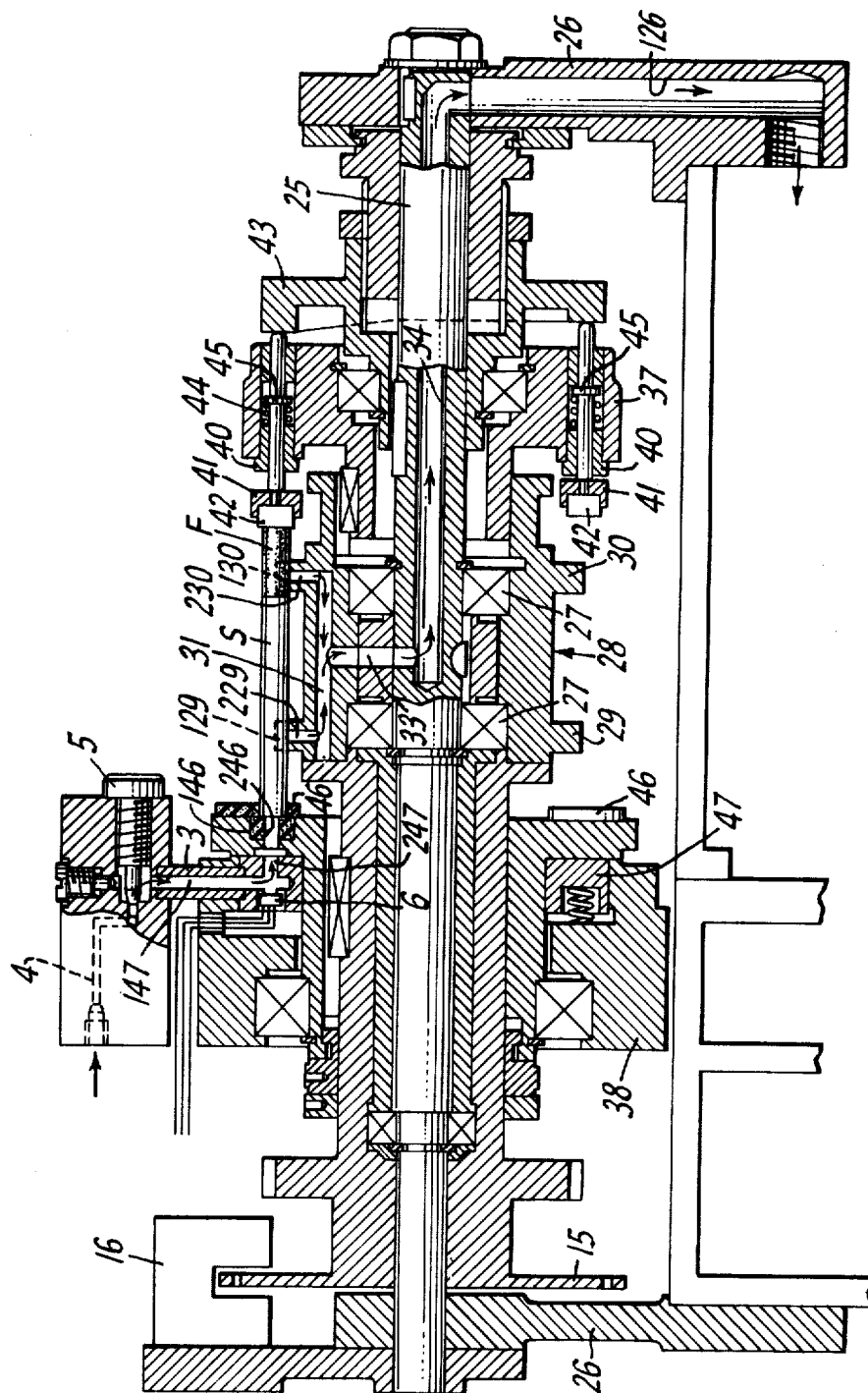
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FIG. 5

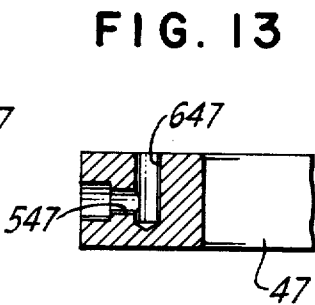
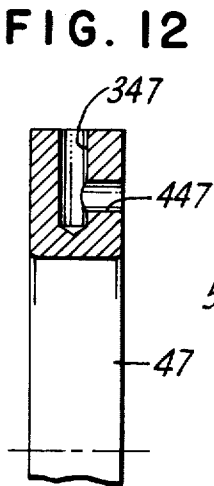
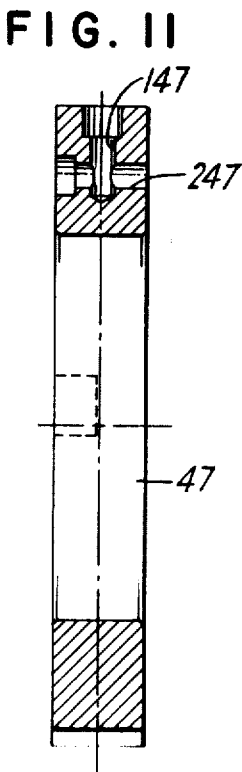
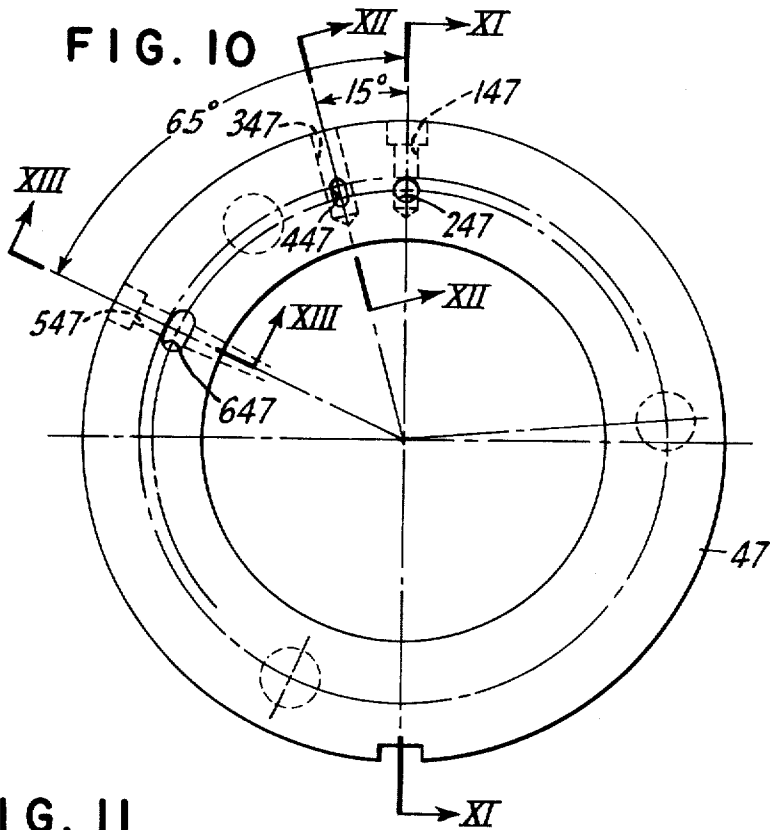


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ELECTROPNEUMATIC CIGARETTE INSPECTION

This invention relates generally to the automatic inspection of cigarettes and more specifically to a method and apparatus for electropneumatically inspecting cigarettes for the absence or presence of apertures or incisions within the cigarette paper and for alignment and sealing of the bands which connect a filter to a cigarette.

This invention relates to an improved method for testing cigarettes for flaws and defects which affect the draw of the cigarette by feeding, for example, at the filter tip end, a gas of controlled flow gas pressure wherein the deviations of the maximum value of the pressure of the gas from a predetermined constant pressure are converted into corresponding electric signals by means of any suitable electric transducer. The signals are then applied to an electronic logic circuit which compares them, for each cigarette tested, with a constant voltage signal which corresponds to a constant pressure value to generate an output signal for the subsequent actuation of a rejecting device each time a cigarette is found to be defective as determined by a cigarette for which the value of the applied pressure does not reach at least the value of the predetermined constant pressure.

In this invention, the cigarettes that are to be tested are fed in succession, side by side, and equally interspaced, on a transfer means driven continuously and transversely to the cigarettes to temporarily drive each cigarette axially to position the end of the cigarette to be tested into a mouthpiece which communicates with a testing chamber containing a pressure transducer sensing element. The chamber communicates alternately and periodically with the atmosphere and with a pressurized gas source which establishes, in the chamber, a maximum value of pressure in relation with the condition of the cigarette being examined. The transducer responds to the maximum value of pressure with an electric signal that is correlated with a recurrence signal of constant frequency and a rejection signal is generated for the actuation of a device which expels from the row of cigarettes tested those cigarettes for which the maximum pressure value reached was less than a predetermined pressure value considered as a lower limit for the criterion of acceptance of the cigarettes under test.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings wherein:

FIG. 1 is a block diagram of an electropneumatic cigarette inspection device in accordance with the principles of the invention;

FIGS. 2a-2e shows a group of signal wave forms generated by the structure illustrated in FIG. 1;

FIG. 3 illustrates an embodiment of structure in accordance with the principles of the invention in combination with a row of cigarettes that are being inspected;

FIG. 4 is a partially cutaway side elevational view, partially sectionized, of a continuous filter tip cigarette

selecting unit to which structure in accordance with the principles of the invention can be applied;

FIG. 5 is a cross sectional view of the device of FIG. 4 taken on lines V—V of FIG. 4;

FIG. 6 is a partially enlarged view in section taken along the lines VI—VI of FIG. 4 and which illustrates in greater detail a pneumatic ejector associated with a selector of FIG. 4 and actuated by a rejection signal in accordance with the principles of the invention;

FIGS. 7 and 8 illustrate to another scale two conditions of operation of the test chamber of the device of FIG. 4 respectively taken along the section radial lines V and VIII of FIG. 4;

FIG. 9 is a partial front view illustrating a portion of the pneumatic test assembly represented in longitudinal section in FIG. 5;

FIG. 10 is a front view of the fixed distributing ring associated with the analyzing unit illustrated in FIG. 5;

FIG. 11 is a sectional view of the ring of FIG. 10 taken along the line XI—XI;

FIG. 12 is a partial sectional view taken along the radial line XII of FIG. 10, and

FIG. 13 is a partial sectional view taken along the radial line XIII of FIG. 10.

With reference to the drawings, in particular to FIG. 1, a cigarette S that is to be tested is engaged, in a substantially airtight manner, with the filter tip end F of the cigarette positioned within mouthpiece 1 having a chamber 2 which communicates through a duct 3 with a source 4 of air which is maintained at a pressure somewhat higher than room or atmospheric pressure, through a reducing valve 5 which can be selectively adjustable. A pressure sensitive transducer 6 is coupled to duct 3 to generate on line 7 an electric signal representative of the difference of pressure existing between chamber 2 and the outside environment.

FIG. 2a is a diagram in which the abscissa indicates time and the ordinate indicates pressures in chamber 2, wherein atmospheric or room pressure is considered to be zero. When feeding pressurized air into chamber 2 through duct 3, the pressure sensitive transducer 6 will indicate the occurrence of zero pressure if a cigarette S and its associated filter tip F is not engaged in the mouthpiece or when the chamber 2 communicates directly with the atmosphere through a discharge duct. The corresponding pressure curve will, then, be represented by the horizontal line segment 8 which almost coincides with the zero pressure or atmospheric pressure line as the corresponding pressure stage between the chamber and the outside environment will be substantially neglectable. If, on the other hand, a cigarette is engaged in the mouthpiece and no other communication exists between chamber 2 and the atmosphere and, in addition, the other end of the cigarette is closed or blocked with a small compressing plunger or plate 39, one of the following two alternatives will occur. If the cigarette that is being tested is good as indicated by paper and cork that are undamaged, the adhesive between the paper and the cork is perfect and the filter plug F is present, the pressure will build up inside the cigarette, in chamber 2 and in duct 3 in a manner defined by ascending curve 10 which curve is similar to a curve which is obtained when charging an electric condenser in series with a resistor. In practice, it has been found that there is a short

time delay between the application of air to the cigarette and the build up of pressure within the cigarette.

As illustrated in the drawing (FIG. 2a), the pressure rises almost exponentially reaching a maximum value, depending on the cigarette sealing capacity, a moment before chamber 2 is coupled to communicate with the atmosphere through duct 9 (see FIG. 3) which effects an immediate pressure drop in chamber 2 as represented by line 11 of FIG. 2a).

A predetermined constant value of pressure as represented by the line 12 is established where cigarettes that are to be considered good are those for which the maximum pressure is not lower than the predetermined level while the defective cigarettes will be those for which the maximum value of the pressure rise curve (for example, 102, 103, FIG. 2a) is less than the predetermined level of pressure. The transducer 6 generates potentials which are proportioned to the magnitude of the pressure in duct 3 and chamber 2 and, in operation, can generate signals represented by the output curves (20, 203, 204, 80; see FIG. 2b). The transducer selected for use in this application should have a sensitivity capability of detecting pressure changes from zero to about 0.4 Kg./sq.cm the extremes of pressure normally experienced by the chamber 2.

The electric signal emitted by transducer 6 in response to a pressure existing in duct 3 is applied to electronic network means 13, 14. Within network means 13, 14, there is generated a constant value signal which corresponds to the value of the signal 112 which transducer 6 would generate if subjected to a given pressure level representative of pressure 12 of FIG. 2a. Thus, constant signal 112 constitutes a comparison signal with which the signal actually emitted by the transducer 6 is continuously compared. Thus, network means 13, 14 can be considered to be a comparator circuit designed to emit an output signal (see FIG. 2c) 31, 131, 231, 331 when the pressure in chamber 2 equals or exceeds the predetermined level 12. Obviously, as the pressure in chamber 2 varies, the comparator circuit will generate pulse signals. After the examination of one cigarette and before the examination of the following cigarette, the pressure in chamber 2 will be reset, brought to atmospheric pressure by temporarily establishing communication between chamber 2 and the atmosphere through duct 9 (see FIG. 3). Obviously, when this communication is established the signal from transducer 6 will drop immediately to zero, as indicated, for example, by line 120, in FIG. 2b.

However, signals such as 31, 131 and the like, which indicate the occurrence of a good cigarette and generated by the comparator circuit, cannot be utilized directly to discriminate between good cigarettes and defective cigarettes unless a synchronizing means is provided to compare the constant value signal 112 with the signal representative of the pressure in the chamber 2 when the pressure in the cigarette and, therefore, in chamber 2, is at its maximum.

In this embodiment, a synchronizing means is coupled to the inspection drum to generate the desired pulse signals. A disc 15 rigidly coupled to and driven by the drum is provided with a plurality of holes, each positioned equally from the center of the disc and from each other. The disc is interposed between a source of

light and a photoelectric cell to permit the holes to selectively allow light from the source of light to pass through a hole and energize its photoelectric cell. The photoelectric cell and the source of light are coupled to and supported by a block 16 positioned to cooperate with the disc 15. The impulses generated by the photocell are fed to a forming circuit 17 such as a one-slot multivibrator whose output consists of short rectangular pulse signals 18 (FIG. 2d). The pulse signals 18 are compared with the output signals of the circuit 13, 14 (signals 31, 131, 231, FIG. 2e) in a NOR circuit 19 which emits a uniform rectangular rejection signal 21, 121, 221, (FIG. 2e) only when an output signal from circuit 14 is not present (the recurrence frequency signals 18 being always present).

The rejection signals from NOR 19 are fed to and retained in an appropriate memory circuit 22, which can be in the form of a shift register. In the shift register, the information transfer or shift signal is obtained from the forming circuit or synchronous impulse generator 17 which generates a signal synchronized with the occurrence of the maximum pressure reached in test chamber 2. After the occurrence of n steps of the movable support which carries the cigarettes that are to be tested and which corresponds to the passage of and testing of n cigarettes, the pulse signals 21, 121, 221 and so on will appear at the output of the memory circuit if the associated cigarette is to be rejected. The pulse signals are fed to a power amplifier 23 or the like to actuate a suitable actuating transducer 24 to reject the defective cigarettes.

The system described above can be utilized with any cigarette conveying and handling device having cigarettes that are to be tested. In particular, it can be coupled to and used with the structure as illustrated in FIGS. 4 to 13 of the drawings. Referring specifically to FIGS. 4 to 13, a horizontally positioned hollow shaft 25 is fitted between and rotatably supported by two supports 26. A reel or drum 28 which has two peripherally positioned interspaced annular flanges 29, 30 shaped to provide two respective sets of cradle-shaped recesses or pockets 129, 130 is rotatably coupled through bearings 27 to shaft 25. Radial holes 229, 230 are provided in the flanges 29, 30 at the bottom of the recesses. These holes lead to a manifold 31 which communicates through a duct 33 with a passageway 34 aligned with the axis of fixed shaft 25. Shaft 25 contains an open end connected to a source of suction through a duct 126. The vacuum applied to the holes 229, 230 is sufficient to hold by suction a cigarette S in the cradle (129, 130). Manifold 31 extends angularly in drum 28 for a certain arc length to limit or define the suction area to a predetermined arc of rotation of the drum 28.

Drum 28 receives the cigarettes from transfer drum 35 having flutes 135 to hold cigarettes S by suction (FIG. 4). Suction to the flutes 135 is discontinued at that point where the drum 28 meets drum 35. Drum 35 receives cigarettes from drum 36 whose flutes are not subjected to nor coupled to receive suction. The drum or reel 28 is interposed between and coupled to rotate with a first disc 37 and a second disc 38. Disc 37 supports a ring of small plungers 39, equal in number to that of the housings of reel 28 and positioned parallel with the axis of rotation of the reel 28 and angularly equispaced between each other. Each of the plungers

39 is slidably coupled to a bushing 40 of disc 37 and each has, at one end, on the side facing the end of cigarette S, a support member 41 which is secured to a block 42 of soft rubber or any other material capable of coming into airtight engagement with the end of the cigarette. The other end of each of the plungers 39 is held in contact with a fixed cam 43 by means of a helical spring 44 acting in compression and positioned around the plunger between one end of bushing 40 and a flange 45 of plunger 39. Thus, rotation of cam 43 relative to plungers 39 causes block 42 to be urged outward to engage against an end of a cigarette to enable the cigarettes to slide axially on cradles 129, 130. On the other side of reel 28, the disc 38 which is integral with the reel 28 supports a ring of mouthpieces 46 each aligned to cooperate with one of the plungers 39. Each mouthpiece 46 constitutes the front retaining element for a perforated block 146 of rubber or other material embedded in a complimentary recess formed in disc 38.

Mouthpieces 46 communicate with respective circumferentially elongated and angularly equispaced chambers 246, arranged in a ring fashion in disc 38. The disc 38 rotates with reel 28 and is in close contact with fixed distributing ring 47 which supports radial hole 147 and axial hole 247 which communicate with each other.

Pressure transducer 6 is arranged at the bottom of hole 247 and can be coaxial to said hole. During the rotation of disc 38, hole 247 communicates in turn with the perforated blocks 146 and, consequently, with the end of a cigarette S which will have been inserted tightly into mouthpiece 46 by the axial movement or displacement of the cigarette caused by the corresponding displacement of plunger 39, whose end 139 is at the moment positioned on the most protruding part of fixed cam 43. Fixed ring 47, when angularly spaced, for instance, by 15° from the axis of hole 147 (see FIGS. 8 and 12) couples a radial hole 347 and an axial hole 447 which communicate with each other and with the atmosphere to the passageway 246 to re-set the pressure in the cigarette to atmospheric pressure after the cigarette has been inspected. In an angular position that is greater than the distance of hole 147 and on the same side as holes 347 and 447 and, for instance, at a displacement of 65° from that hole, a fixed ring 47 presents a radial hole 547 and an axial hole 647 which communicate with each other and with a source of compressed air. The air is under pressure sufficiently to cause the inspected cigarettes S to be ejected from the mouthpieces 46.

The inspected cigarettes are transferred from the flutes of reel 28 into those of drum 48 where they are held by suction through radial ducts 148 which communicate with a suction manifold 248 composed of a portion of a circumferential extension of drum 48. The defective cigarettes are rejected on this drum. Rejection is effected by means of a jet blast of compressed air from a nozzle 49 mounted to direct the jet of air radially out in the neighborhood of one of the heads of drum 48. In the Figures, the jet is positioned adjacent one of the sides from which the filter F of a cigarette S housed in a flute or groove of the drum protrudes axially outward. The jet is controlled by the opening of solenoid valve 24 which is energized by the output

signal from power amplifier 23, to pneumatically reject the cigarette which had caused the rejection signal. To prevent those cigarettes S that are housed in the flutes of the drum 48 positioned adjacent to the flute that contains the defective cigarette from being subjected to the action of the rejecting jet, the drum is provided with a ring of axially extending ribs 50 angularly equispaced and each arranged in the center line between one flute 348 and the next occurring flute.

The jet, when activated, passes between adjacent ribs to effect the removal of the defective cigarette only which is driven away from drum 48.

The good cigarettes are transferred from the flutes 348 of drum 48 to the flutes of a drum 51 which then feeds them, for example, to a cigarette tray filter.

Obviously, many modifications and variations of the present invention are possible in the light of the above teaching. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A device for electropneumatically inspecting cigarettes for detecting defects which attenuate or affect cigarette draw resistance comprising means for continuously advancing a row of cigarettes to be tested, means for sequentially applying to one end of each cigarette of the row and during this continuous advance a controlled-flow gas pressure, means for generating a signal for each cigarette representative of the minimum pressure that would occur with an acceptable cigarette, a transducer coupled to respond to the gas pressure fed to an end of a cigarette to generate a signal which varies with the instantaneous values of the pressure applied, first network means coupled to compare the signal from said transducer with said signal representative of minimum pressure which would occur with an acceptable cigarette and emit a signal of validity every time the transducer generates a signal representative of a pressure equal to or greater than the predetermined constant value signal means for generating recurring frequency signals synchronized with the testing rate of the cigarette and a second network means coupled to detect the presence or absence of validity signals in concurrence with the recurring frequency signals and to emit a rejection signal every time a validity signal in phase with the associated recurring frequency signal is not present.

2. The structure of claim 1 wherein said transducer is responsive to pressure changes occurring between zero and 0.4 Kg/sq.cm.

3. The structure of claim 2 wherein said second network means which emits the rejection signal comprises a two input "NOR" type of gate to generate a signal during the concurrence of a corresponding recurring signal at the input terminals.

4. The structure of claim 3 including the structure of a memorizing shift register circuit coupled to receive at the input the rejection signals emitted by said "NOR" type of gate and feed said signals after a predetermined time to a cigarette rejecting element.

5. The structure of claim 4 including a one-slot multivibrator coupled to generate said recurring frequency signals and a photoelectric cell circuit coupled to initiate activation of said one-slot multivibrator.

6. The structure of claim 5 wherein said means for continuously advancing a row of cigarettes to be tested and the means for sequentially applying to at least one end of each cigarette a controlled flow gas pressure comprising a fluted reel, a fixed hollow shaft coupled to rotatably support said fluted reel and through which there can be exerted on the cigarettes a retaining pneumatic suction along a selected arc of rotation of the reel, two head discs coupled to said reel, one of said discs serving as a support for a ring of plungers aligned with the flutes of the reel, a fixed axial cam coupled to move said plungers axially in sequence with each cigarette until said cigarette is engaged in a corresponding mouthpiece mounted on the other disc in alignment with the flutes of the reel and communicating chambers arranged in a ring fashion on said other disc, said other disc being positioned to slide against a fixed distributing ring, pressure test passageway cou-

pled to said distributing ring for housing the transducer coupled to receive a regular flow of pressurized air fed to an end of a cigarette.

7. The structure of claim 6 including a passageway coupled to said distributing ring to selectively couple said chamber with the atmosphere to return the pressure sensed by said transducer to zero.

8. The structure of claim 7 including a passageway selectively coupled to a source of pressurized air to disengage a cigarette from a flute of a reel.

9. The structure of claim 8 wherein said photoelectric cell circuit comprises a disc driven by said reel and having cut-outs arranged in the form of a circle wherein each cut-out of said circle of cut-outs of the disc initiates the generation of a trip signal for the actuation of the multivibrator.

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