United States Patent

[11] 3,584,501

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[21] Appl. No. **810,610**
[22] Filed **Mar. 26, 1969**
[45] Patented **June 15, 1971**
[73] Assignee **American Machine & Foundry Company**
[32] Priority **Apr. 3, 1968, Jan. 2, 1969**
[33] **Italy**
[31] **6926 A/68 and 6703 A/69**

[54] **APPARATUS FOR CIGARETTE INSPECTION**
2 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **73/45.1**
[51] **Int. Cl.** **G01m 3/26**
[50] **Field of Search** 73/45.1, 45.2, 41, 37, 38

[56] **References Cited**

UNITED STATES PATENTS

3,395,570	8/1968	Kochalski	73/45.2
3,408,858	11/1968	Keading et al.	73/45.2
3,418,844	12/1968	Wahle	73/45.1
3,426,582	2/1969	McArthur et al.	73/45.1
3,447,679	6/1969	Molins et al.	209/73

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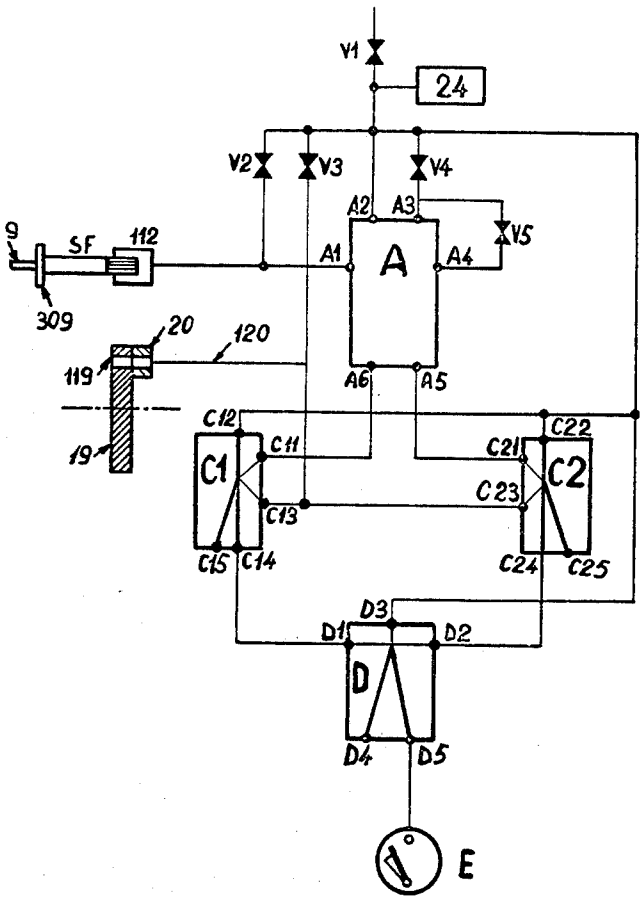
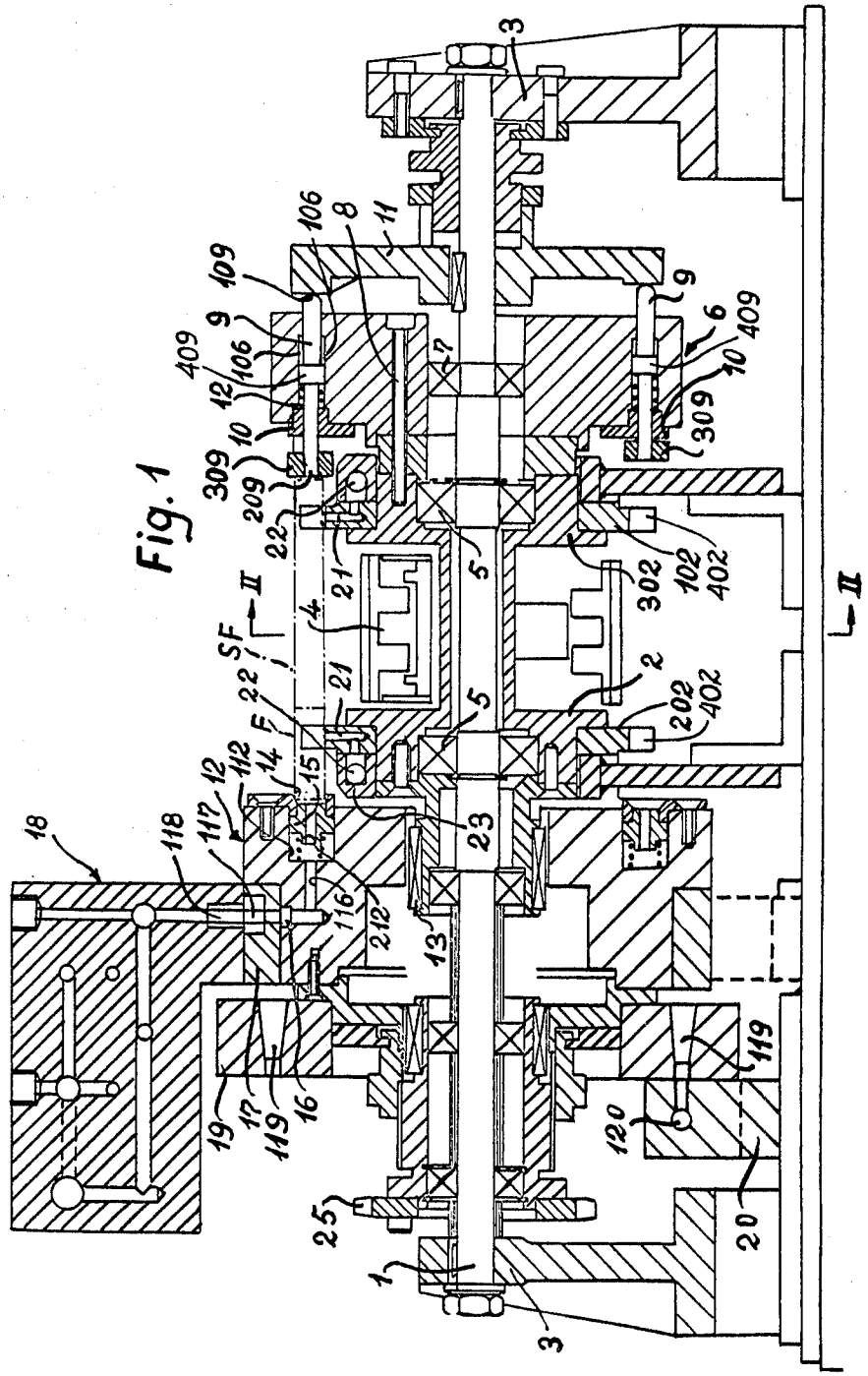
ABSTRACT: Cigarettes that are to be inspected are fed serially to aligned pockets of two sprocket wheels and retained in position by suction. Thereafter, the cigarettes are shifted axially in the pockets by a plunger-cam-type of structure to position an end of a cigarette into a mouthpiece and against a perforated plug. Fluid under pressure is caused to flow through the perforated plug and through the cigarette to the atmosphere. The pressure of the fluid at the perforated plug is determined by the throttling effected by the cigarette. The pressure of the fluid at the perforated plug is compared to a constant pressure in a fluidic logic circuit, variations greater than a predetermined value indicating the presence of a defective cigarette.





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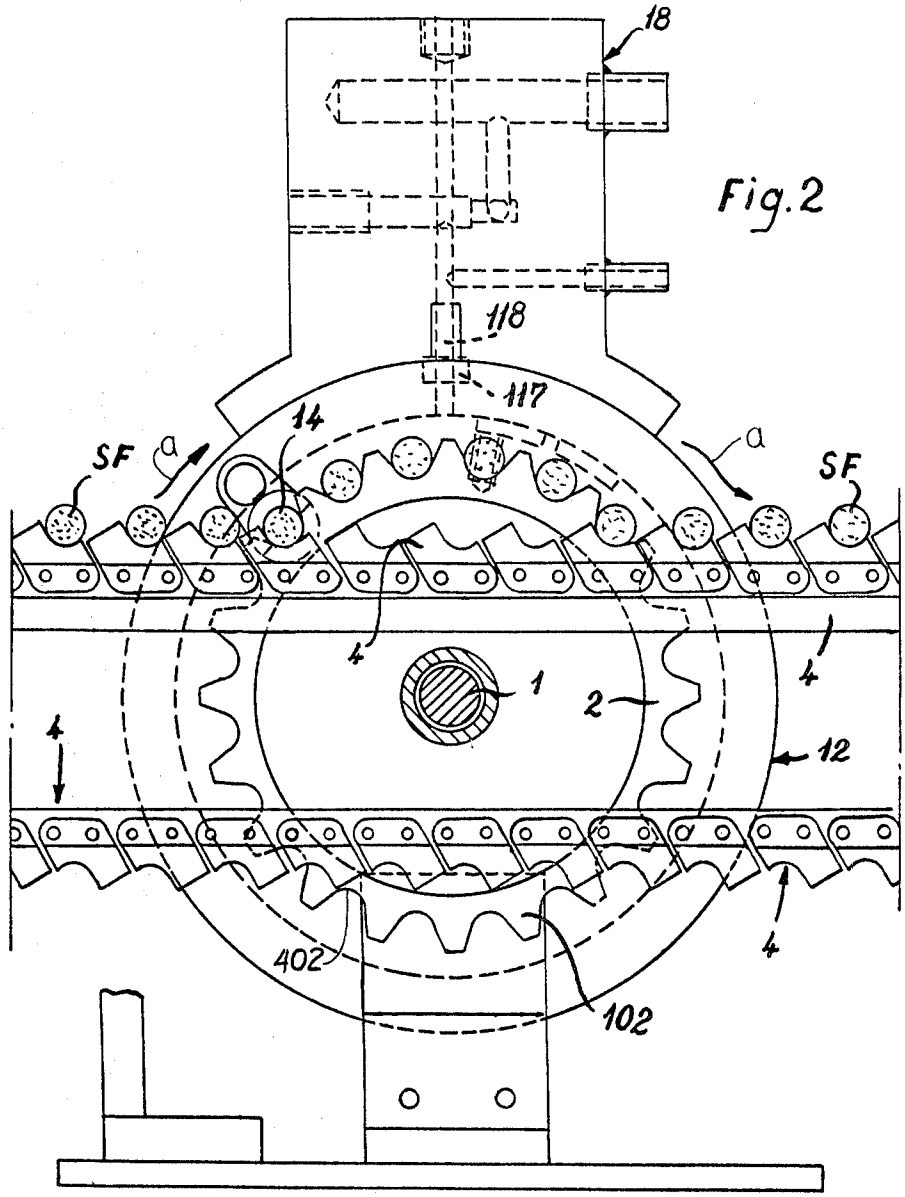

Fig. 2

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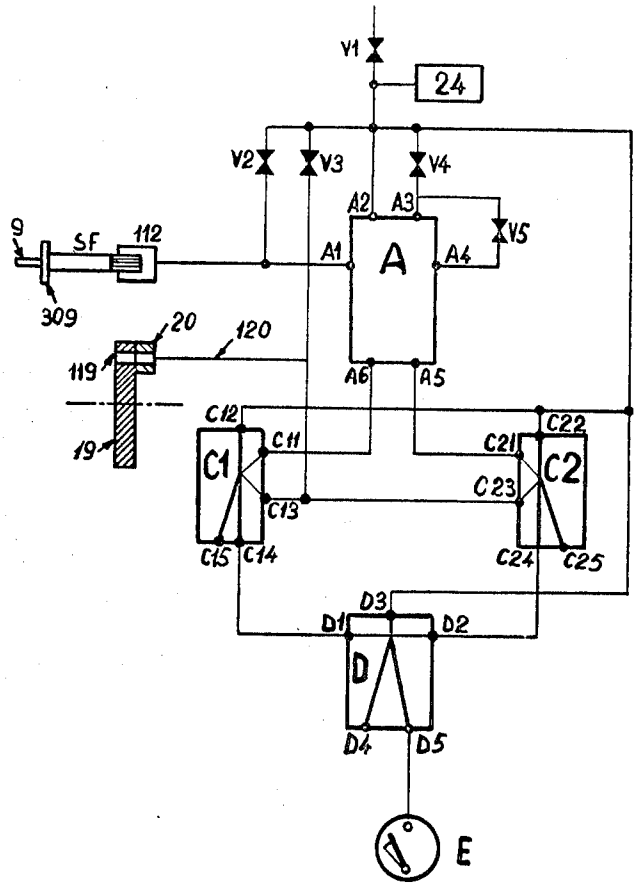

Fig.3

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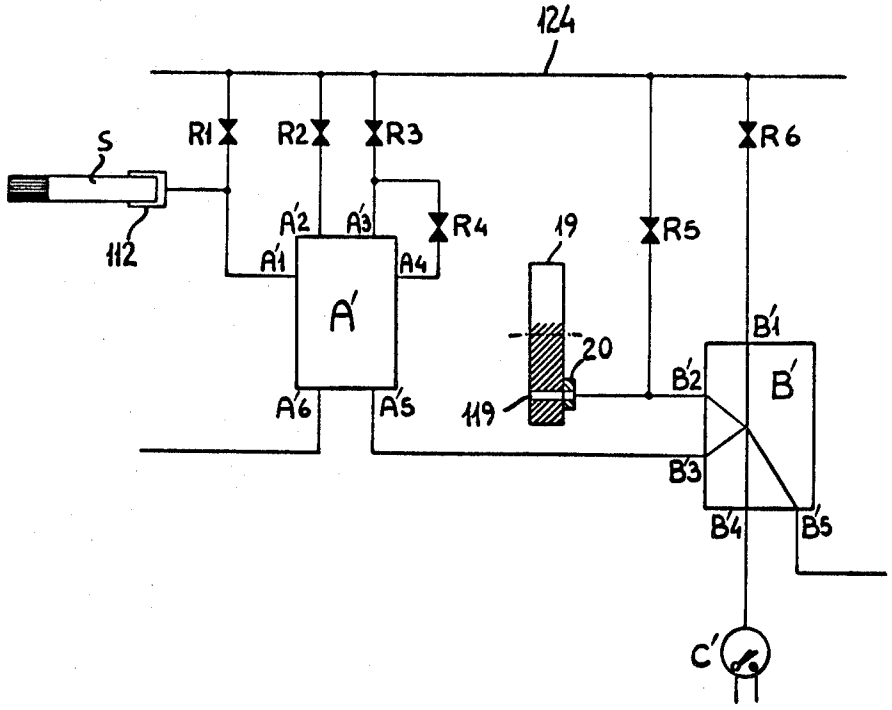
Fig. 4



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APPARATUS FOR CIGARETTE INSPECTION

This invention relates to a method and an apparatus for inspecting cigarettes and, in particular, for determining the presence or absence of defects which affect "pressure drop" or the quality of draw.

The present invention is particularly useful in checking tipped and untipped products for incisions or apertures in the paper or faults in the rolling of the wrapper which connects the filter to the cigarette.

The present invention provides a method comprising applying a fluid pressure to one end of each cigarette to be inspected, for example, the filter tipped end, comparing the variations in this pressure as it passes through or into the cigarette with a predetermined constant pressure, obtaining a signal indicative of a defective cigarette at a predetermined pressure variation and rejecting the defective cigarette in response to said signal. Preferably, the pressurized fluid is applied to an input or a fluidic logic circuit and the variations of this pressure in relation to a predetermined constant pressure existing in a branch of a fluid logic circuit directly causes the emission of the rejection signal from this circuit.

The invention further provides apparatus comprising a testing chamber provided with at least one mouthpiece into which end of a cigarette may be inserted, means for supplying to the chamber a fluid, preferably compressed air of predetermined pressure, the actual pressure in said chamber being related to the condition of integrity of the wrapper of the cigarette to be inspected, logic circuit means capable of responding to this actual pressure and emitting signal indicative of any variation from the predetermined pressure caused by a defect in the tested cigarette and means for rejecting at some predetermined remote position the defective cigarette which has determined the emission of said signal. In a preferred form of the invention, the aforesaid logic circuit comprises logic fluidic elements, the signal entering said circuit consisting of the actual air pressure in the aforesaid testing chamber.

The present invention provides a method and apparatus for the continuous serially testing of individual cigarettes for any type of defect. As a consequence, the testing may be accomplished at virtually the last stage of production and just prior to packaging. This is particularly beneficial in the production of filter-tipped cigarettes where the major portion of defects occur almost at the final stage of formation where the double rod cigarette is cut into individual lengths through the filter plug. The present invention will be used after the cigarette is thus cut.

These and other features of the invention and the resulting advantages may be understood from the following detailed description in which the method is described with reference to the exemplative form of apparatus shown in the attached drawings, wherein:

FIG. 1 is a longitudinal section of an automatic cigarette inspection apparatus;

FIG. 2 is a simplified cross section of said apparatus, taken on lines II–II of FIG. 1;

FIG. 3 illustrates schematically a form of a fluidic logic circuit, suitable for use with the inspection apparatus.

FIG. 4 illustrates schematically a second form of fluidic logic circuit.

Turning to the description of the apparatus, there will be seen in FIGS. 1, and 2, a horizontal shaft 1 fixedly mounted between two vertical supports 3. A rotatable sprocket wheel 2 mounted on bearings 5 is secured to the shaft, approximately along its centerline. The sprocket wheel 2 comprises a sleeve 302 having opposed flanged ends to which are fastened coaxial spaced discs 102 and 202. The two discs 102 and 202 are provided with a plurality of uniformly spaced circumferential teeth forming together a plurality of pockets 402 for receiving individual cigarettes SF. Cigarettes SF are fed in sequential order to the sprocket wheel 2 by an endless chain conveyor 4 also provided with notches or receptacles for holding the cigarette in spaced relationship relative to the pitch of the pockets 402 on the sprocket wheel 2. The chain 4 extends between the spaced discs 102 and 202 so as to provide a conveyor leading to, as well as from, the sprocket wheel 2. The chain 4 is of a lateral dimension to permit the ends of the cigarettes SF to protrude over its sides into the trajectory of rotation of the pockets 402.

The rotation of sprocket wheel 2 and the motion of the notched chain 4 are so synchronized that when cigarettes SF arrive at ascending side (left-hand side of FIG. 2) of the sprocket wheel 2, they are lifted and picked up, one after the other, from chain 4 by two side discs 102, 202 whereby each cigarette SF is accommodated in a particular pocket 402 and conveyed along an arcuate path shown by arrow A and subsequently transferred again into a notch of the chain 4 on the opposite or descending side of sprocket wheel 2. The inspection of cigarettes SF is made, as indicated hereafter, during the stay of the cigarettes in the pockets of sprocket wheel 2.

Returning to FIG. 1, a freely rotatable drum 6 is mounted on ball bearing 7 concentrically about shaft 1 and is secured to one side of the sprocket wheel 2 by fastener screws 8. The drum 6 is provided with a set of laterally extending plungers 9, each slidably positioned within a bushing 10. The plungers 9 are equal in number to the number of pockets 402 and are uniformly spaced near the periphery of drum 6, parallel to the axis of rotation in direct correspondence to the pockets of shaft 1. Each of the plungers 9 comprises a rearward end 109 and a forward end 209 between which is a collar 409 adapted to ride within a transverse seat 106 fashioned in the drum 6. A spring 12 is provided between the collar 409 and the bushing 10 to normally urge the plunger 9 rearwardly away from the sprocket wheel 2 into sliding engagement with the surface of a circular cam 11 fixed by suitable key means to shaft 1. The front of the plunger 9 is provided with a flat disc or button 309. The cam 11 is provided with a profile extending axially so that as the sprocket wheel 2 and the attached drum 6 is caused to rotate about the shaft 1, the plungers 9 riding on the face of the cam 11 will reciprocate in an axial direction parallel to the shaft 1. Consequently, the plunger 9 will position any cigarette within the pocket 402 and by its button end 309 seal the cigarette end against the flow of air.

On the opposite side of sprocket wheel 2, there is mounted a second drum 12 which is also freely rotatable about the shaft 1. The drum 12 is secured to the sprocket wheel 2 by at least two pairs of fluted wedgelike elements 13 which allow longitudinal adjustment of the drum 12 axially of the shaft 1 so as to enable it to accommodate a variety of sizes of cigarettes. A plurality of mouthpieces 14, in number equal to the pockets of the sprocket wheel 2, are set within a bore 112 comprising the pneumatic testing chamber, within the edge face of the drum 12 and are arranged parallel to the axis of shaft 1 and uniformly adjacent the circumference. Slidably mounted within each bore 112 is a perforated plug 15 normally biased by a spring 212 into engagement with the inner edge of the mouthpiece 14. The cigarettes SF are adapted to be pushed by the plunger 9 on causation of the cam 11 as noted previously into the mouthpiece 14 and against the plug 15. Thus the cigarette will be held in the pocket 402 of the sprocket wheel 2 and is seated at both its ends in engagement with the plunger 9 and plug 15.

The drum 12 is also provided with a series of radial holes 16 corresponding to each of the bores 112. An axial hole 116 extends between the bore 112 and the hole 16. Mounted to the periphery of the drum 12 is a fixed ring 17 to which is fastened a distributing block 18. The ring 17 is in fluidtight sliding engagement with the periphery of the drum 12 and is provided with a hole 117 located to communicate with each of the radial holes 16 as the drum 12 rotates relative to it. The distributing block 18 also contains a radially aligned hole 118 communicating with the hole 117 and is connected to a source of pressurized fluid 24 (FIG. 3) and comprises, in essence, the manifold of a fluidic logic circuitry by which testing of the cigarette is accomplished. The exact circuit of the pneumatic distributor will be seen later with reference to FIG. 3.

A circular plate 19 is attached to drum 12 and rotates conjointly with it. The plate 19 is provided with a plurality of spaced axially transverse holes 119 corresponding to the number of mouthpieces 14 and is secured to the drum 12 by suitable adjustable fastening means enabling it to be axially moved along shaft 1 together with the drum. Suitable bearings allowing the plate 19 to be rotated about shaft 1 are also supplied. Secured to the frame of the machine is a block 20 having a bore 120 communicating with a conventional source of compressed air (not shown) and also aligned so as to communicate serially with the holes 119 when the plate 19 rotates about the shaft 1. The faces of block 20 and plate 19 are smooth and in direct abutment so as to be airtight.

To ensure perfect positioning of the cigarettes in the pockets 402 and subsequently perfect alignment into its respective mouthpiece, the teeth of each of discs 102 and 202 are provided with radial holes 21 which communicate with an arcuate chamber 22 within which a predetermined degree of vacuum or negative pressure is maintained. The chamber 22 is fashioned by a pair of spaced rings 23 fixed to the shaft 1. The rings 23 abut in airtight relationship against the sprocket wheel 2 so as to communicate with the hole 21 and extend in arcuate fashion around shaft 1 for less than the full 360° circle. The arcuate extent of the rings 23 is such that the suction or vacuum is applied to the pocket 402 to pick up the cigarette from the chain 4 and to hold it during its ascent and descent back on to the chain during the testing cycle. The chamber 22 formed by rings 23, is, however, blocked so that suction is interrupted during the period of the cycle of the sprocket wheel 2 when the cigarettes SF are plunged into the mouthpiece 14.

Completing the structure of the present device is a pulley wheel 25 by which the sprocket wheel 2 and its associated attached members may be rotated by connection in a conventional manner to a source of power.

In operation, the elements described are arranged so that the cigarettes fed on chain 4 are serially delivered to the pocket 402 held thereon by suction applied through chamber 22 during their ascent, shifted axially in the pockets 402 by action of the plunger 9 riding on cam 11 so as to firmly seat in the mouthpiece 14 against the plug 15. At this point the radial chamber 16 communicating with the mouthpiece 14 comes into communication with the bore 18 of the distributor 18 whereby compressed fluid is caused to flow into the testing chamber 112 and then through the cigarette passing out into the atmosphere. Inspection of the cigarette takes place at this time on the basis of the value of the pressure then existing in chamber 112 and a signal-produced indicative of any faulty defective cigarette. After inspection, the cigarettes descend and are redeposited on the chain 4. The position of a defective cigarette on the chain is caused to be memorized and thereafter removed as a result of a signal derived from the testing procedure, while the perfect cigarettes are carried forward to be packaged.

By referring now to FIG. 3, the testing of the individual cigarettes will be observed. Pressurized fluid is fed from a pneumatic source 24 to the chamber 112 through a throttling valve V_2. Throttling is also effected through the insertion of a cigarette in the mouthpiece 14. Consequently, for all regular or not defective cigarettes, a predetermined constant pressure is established within chamber 112 as a result of the combined throttling action, while for defective cigarettes, the pressure within chamber 112 will be significantly less due to loss of throttling through the defective cigarette. Thus, by comparing the actual pressure in the chamber 112 with a fixed pressure sample (preferably equal to the combined throttling action with a perfect cigarette) an output may be obtained indicative of any variations in pressure and consequently of a defective cigarette. This output may be employed to constitute the input of a logic circuit capable of emitting a signal which can be memorized and later employed for ejection of the defective cigarette.

The input component A of the logic circuit of FIG. 3 is substantially the fluidic equivalent of an electronic circuit, for example, of the type known as Schmitt Trigger, in which the actual pressure in chamber 112 is applied at the inspection input A1 and compared with another constant threshold pressure applied at the inspection input A4 and derived from the source 24 through the series-connected throttling valves V4 and V5. The feed of the comparison circuit A is effected at inputs A2, A3 and means of compressed air coming from the same source, partly directly (A2) and partly through throttling V4.

Of the two outputs A5, A6 of the Schmitt Trigger A, output A5 is connected to input C21 of a two-input fluidic logic NOR gate component C2 whose input C22 is directly connected to the source 24. The other inspection input C23 is fed by the same source 24 through throttling valve V3.

Another two-input NOR gate (C1) is connected symmetrically in relation to gage C2. As a matter of fact, the inspection input C11 is connected to the other output A6 of A, while the other inspection input C13 is fed in common with C23. Also supply input C12 is obtained directly from source 24, analogously to input C22 of C2. Outputs C14 and C24 of components C1 and C2 are connected respectively to inputs D1 and D2 of Bistable component D and feed to these inputs the corresponding inspection jets of the respective component. Outputs C15 and C25 of NOR gates C1, C2 discharge directly to the atmosphere.

Feeding of Bistable D is effected at input D3 directly from source 24. The output D4 of Bistable device D communicates with the atmosphere while output D5 is connected to a transducer E which converts the pneumatic pulses into electric signals. This transducer is connected to a magnetic memory which, for example, may consist of a magnetic tape adhering to the periphery of the rotating disc 19. To this magnetic memory is connected the aforesaid rejection device which may comprise a pneumatic, electric or mechanical actuating valve. Indicated in the layout of the pneumatic logic circuit of FIG. 3 are disc 19 provided with holes 119 and block 20 in which a duct 120 is provided which is also fed by source 24 through throttling valve V3. It is evident that during the rotation of disc 19, the compressed air in the ducts downstream of valve V3 is expelled to the atmosphere whenever a hole 119 of disc 19 passes in front of the opening of hole 120.

The logic fluidic circuit which has been described operates in the following manner. The pressure existing in chamber 112 is continuously controlled by fluidic device A which, at all times, effects the comparison of this pressure with a threshold pressure obtained from the source of pressurized and stabilized air 24 by means of valves V5 and V4. An output pressure at A6 or A5 respectively will depend on whether pressure at A1 is either higher or lower than that at A4. An output pressure at A5 corresponds to a perfect cigarette, while the second possibility corresponds to a defective cigarette. However, the pressure existing in chamber 112 is subjected to multiple fluctuations, according to the position of radial chambers 16 in relation to hole 118. These fluctuations cause corresponding pressure switchings at A5 and A6. NOR gate C1 (or C2) which has no pressures at any of the two inputs C11, C13 (or C21, C23) will have a pressure at output C14 (or C24) which will exist as long as duct 120 will remain at atmospheric pressure through hole 119. This hole is kept open during the time strictly required for the memorization of the state of outputs of A on Bistable device D.

The pressure pulses at output C14 indicate that the cigarette is defective and since they are applied at the input D1 of the Bistable device, they cause the switching of the output pressure from D4 to D5 unless this switching has already occurred as a result of the fact that the preceding cigarette was also defective. The output pressure at D5 causes the actuation of the pneumatic-electric transducer E connected to the magnetic memory which will actuate the rejection of the defective cigarettes by means of the appropriate device. Output of the Bistable device D will be once again switched at D4 starting from the first cigarette which will follow the defective ones.

Since sprocket 2 continues to rotate and has fixed to it disc 19 and drums 6 and 12, as soon as the logic circuit has completed the cigarette inspection, duct 120 is closed by disc 19 whereby pressure downstream of valve V3 increases thus switching the outputs of the two NOR GATES C1, C2 to C15 and C25 which discharge to the atmosphere. Circuit D remains, therefore, memorized in the preceding state until the arrival of the next cigarette, After examining the cigarette, plunger 9 retracts on the fixed cam 11 and the calibrated spring 212 can thus push back the inspected cigarette SF in pocket 402 which, while proceeding with its rotation, will return the cigarette to the notched chain 4. In the meantime, another cigarette will be inserted into the corresponding mouthpiece for a successive cycle of inspection.

As described, the embodiment shown in FIG. 3 comprises one Schmitt Trigger-type element (A), two NOR gates (C1, C2), one Bistable device (D) and one pneumoelectric transducer (E). In FIG. 4, there is shown a simplification of this circuit, with the consequent improvement of the time of response of the fluidic element inspection circuit. This improved circuit comprises only one Schmitt Trigger-type element A', one NOR gate type element B' and one pneumoelectric transducer C'. Otherwise, it is connected to the apparatus previously described in a similar way as the circuit of FIG. 3.

The circuit shown in FIG. 4 operates in the following manner. The Schmitt Trigger and NOR gate (A' and B') respectively are connected to a pressurized air feed line 124, by means of ducts which are individually equipped with adjusting valves R1, R2 through R6, through which pressure can be reduced to the desired value. The Schmitt Trigger A' is connected at one side-input A'1 with cigarette inspection chamber 112. At the opposite side-input A'4, a constant pressure signal is introduced. This signal is substantially determined by adjusting valve R4 and determines in turn the tripping threshold of the trigger A'. Inputs A'2 and A'3 of the trigger A are connected with the pressurized air feed network 124 through reduction valves R2, R3 and constitute, respectively, the main and secondary feed inputs of Schmitt Trigger A'.

By comparing the inspection input pressure A'1 and A'4, the main air current of the component entering at A'2 will be deviated towards output A'5 or output A'6, depending on whether inspection pressure at A'1 prevails over tripping pressure at A'4 or vice versa. If the flow exits at A'6, it is discharged in the free atmosphere while if it exits at A'5, it is brought to inspection nozzle B'3 of the NOR gate component B'. Inspection nozzle B'2 of the latter component is connected with block 20 which is stationary in relation to the timing wheel 19.

Input B'1, connected with the air feed line 124 through reduction valve R6, represents the input of the main flow of component B'. In case of a defective cigarette, the main flow-entering component A' will be discharged to the atmosphere by means of output A'6. Consequently, there will be on signal entering at B'3 in NOR gate component B or coming from output A'5 of Schmitt Trigger component A'. Therefore, as soon as timing takes place, that is, as soon as the pressure-entering duct B'2 is discharged to the atmosphere through the hole of wheel 19, there will be no signal in either inspection nozzles B'2, B'3 and the main flow entering at B'1 will discharge at B'4 towards transducer C', emitting a rejection signal which, in this case, will act on the memory for the subsequent rejection of the defective cigarette. If the cigarette is perfect, the main flow of A' is discharged from A'5. The flow is caused to act on the main flow of component B' entering at B'1 causing it to deviate towards output B'5 communicating with the atmosphere.

One of the major advantages of the present invention will be seen from the operation just described. Namely, the cigarettes are actually inspected during a period of relative nonmotion between the sprocket wheel 2 and the testing chamber or apparatus. This enables a longer time period to be given to the testing and creates a more accurate device than heretofore known.

It will also be observed that only a single length cigarette (i.e., a fully completed cigarette) is tested, thereby avoiding the problem of rejecting multiple lengths when only a single cigarette is faulty. It is preferred that when filter-tipped cigarettes are tested, that the tipped end is inserted in the mouthpiece, thus reducing the possibility of damage to the cigarette ends.

It is to be understood that the invention is not limited to the form which has been illustrated and described but that many changes could be made, mainly as regards construction. In particular, although the pressure-drop inspection apparatus, according to the invention, has been described as associated to a particular transferring device which picks up the cigarette to of inspected from a notched conveyor and returns it to said conveyor after inspection, in order to effect this inspection in conditions of absence of relative motion between said device and the cigarettes to be inspected, it is to be understood that the pneumatic inspection system could be applied in conjunction with any cigarette transportation device or system without departing from the spirit of the invention as defined in the appended claims.

We claim:

1. Apparatus for testing the integrity of an individual finished cigarette, comprising a pneumatic pressure chamber, means for inserting one of the ends of a cigarette to be tested in said chamber, the other end of said cigarette being exposed to the atmosphere, means for applying a pressurized fluid to said chamber to pass through said cigarette to the atmosphere, the pressure residing in said chamber being dependent upon the throttling effect of said cigarette, a Schmitt Trigger-type fluidic component, a first inspection input of said Schmitt Trigger-type fluidic component coupled to receive an adjusted airflow through an adjusting valve also connected to feed an adjusted airflow to the testing chamber of one of the ends of the cigarettes being tested, while a second inspection input of said Schmitt Trigger-type fluidic component is coupled through series-connected adjusting valves to an airflow which determines the tripping threshold of said Schmitt Trigger-type fluidic so that when the flow at said first inspection input descends below a tripping threshold said Schmitt Trigger-type fluidic components trips and deviates the main flow to an output coupled to discharge to the atmosphere while, when the flow at said first inspection input is higher than the tripping level the output of the main flow from said Schmitt-type trigger fluidic component occurs through an output which is connected with an input of a NOR Gate type fluidic component having two inputs, and a pneumoelectric transducer for rejecting a cigarette when the pressure residing in said chamber varies from the predetermined pressure level.

2. An apparatus according to claim 1, in which the other input of the Nor Gate type fluidic component is coupled to receive a constant flow which is adjusted by a valve periodically set to communicate with the atmosphere every time a hole of a timing wheel is positioned to communicate with a flow discharge duct provided in a corresponding block in synchronism with the presence of a cigarette to be inspected in the testing chamber, so that the NOR Gate type fluidic component will discharge directly to the atmosphere every time the cigarette being inspected is acceptable, and Nor Gate-type of fluidic component will discharge through and actuate a pneumoelectric transducer when the cigarette being inspected is not acceptable in order to send a signal to a memory for the subsequent rejection of the defective cigarette.