Sept. 23, 1969 B. L. HESTER 3,468,416

PNEUMATIC METHOD AND APPARATUS FOR TESTING CIGARETTES TO DETECT LOOSE ENDS AND MISSING FILTER TIPS

Filed Dec. 5, 1967 2 Sheets-Sheet 1

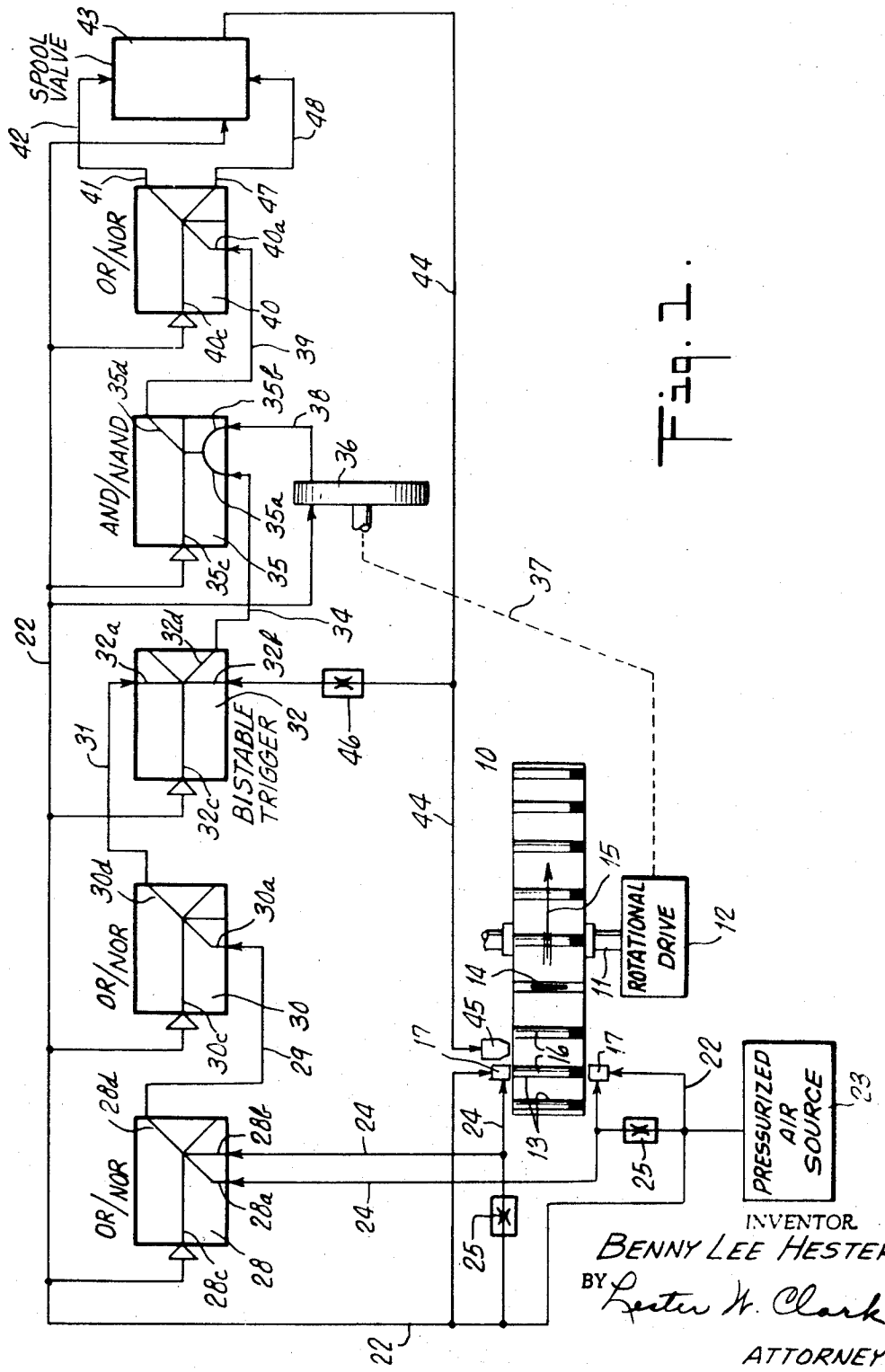


Fig. 1.

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Filed Dec. 5, 1967 2 Sheets-Sheet 2

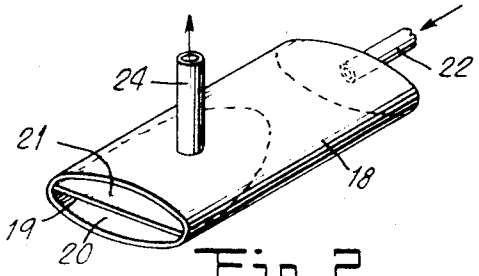


Fig. 2.

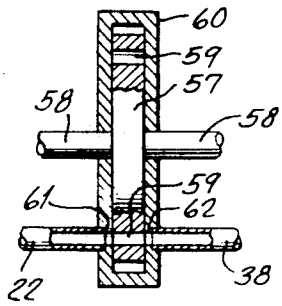


Fig. 5.

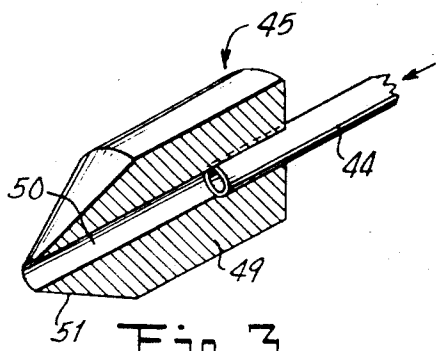


Fig. 3.

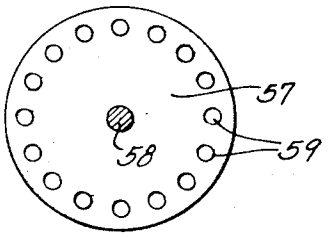


Fig. 6.

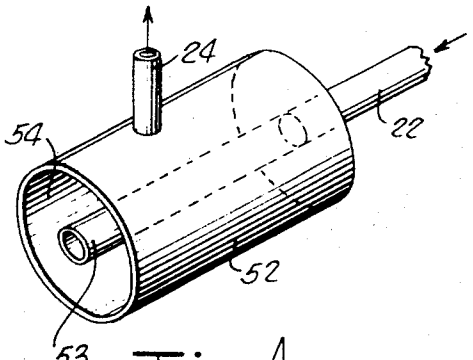


Fig. 4.

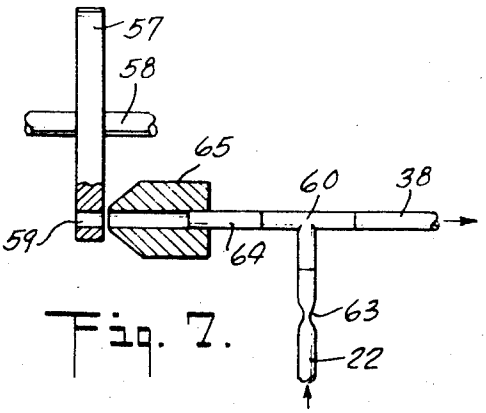


Fig. 7.

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United States Patent Office 3,468,416
Patented Sept. 23, 1969

3,468,416

PNEUMATIC METHOD AND APPARATUS FOR TESTING CIGARETTES TO DETECT LOOSE ENDS AND MISSING FILTER TIPS

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Int. Cl. B07c 1/10, 1/14
U.S. Cl. 209—74 15 Claims

ABSTRACT OF THE DISCLOSURE

The apparatus and method shown and described tests cigarettes for loose packing at one end or the absence of a filter tip at the other end. Stationary nozzles are positioned at the ends of cigarettes moving on a conveyor at constant velocity, and each nozzle directs toward the adjacent end of the cigarette both an air jet flowing at a relatively high pressure and an adjacent jet flowing at a lower pressure. The pressure of the lower-pressure air jet is indicative of the acceptability or non-acceptability of the end textural fabrication of the cigarette (i.e. whether the tobacco packing in the end texture is loose or tight or whether a filter tip is present or absent). A substantial change of pressure of the low-pressure jet indicates a defective or non-acceptable end textural fabrication and effects storage of a defect indication. Within the elapsed time interval between movement of successive cigarettes to the test position, and preferably at approximately the center of such interval, a stored defect indication is used to identify a cigarette producing such indication as by ejecting the cigarette from the conveyor.

BACKGROUND OF THE INVENTION

The present invention relates to the field of automated cigarette manufacture. It is particularly concerned with detecting cigarettes having a loosely packed end or one from which a filter tip is missing and ejecting these defective cigarettes from a conveyor.

Prior art mechanisms for detecting loose ends of cigarettes have commonly incorporated mechanical feelers. Examples of these prior art mechanisms are shown in the patents to Best, No. 2,284,117 and Powell, No. 3,116,478. Where a mechanical feeler is used, either the motion of the cigarette must be stopped while the feeler supporting mechanism reciprocates the feeler toward and away from that cigarette, or the feeler mechanism must travel along a path parallel to the cigarette for a considerable portion of the length of that travel as in the Best patent. The mechanisms of the prior art have not been satisfactory, especially with the newer cigarette machines which deliver cigarettes at rates of 1500 to 3000 per minute. Thus a satisfactory mechanism must test approximately fifty cigarettes per second, and the prior art structures are not capable of performing that many measurements accurately at such high test rates. An improved structure using stationary test air jets to effect immediate ejection of an end-defective cigarette moving past the test position at constant velocity is disclosed and claimed in the copending application of Colin S. McArthur, Ser. No. (D–7292), and assigned to the same assignee as the present application.

SUMMARY OF THE INVENTION

Cigarettes are tested for a loose end or the absence of an end filter tip, both of which as may be considered as generically involving an unacceptable end textural fabrication of the cigarette, by directing jets of compressed air toward the cigarette ends. A pressure measurement is made in or closely adjacent to the nozzles through which

the jets issue. The tips of the nozzles are closely spaced from the adjacent ends of the cigarette. The nozzles are stationary at a test position, and the cigarettes move at constant velocity past the test position. The air pressure within the test nozzle or the air pressure at a region closely adjacent the jet orifice of the nozzle varies with the condition of the end packing of the cigarette or with the presence or absence of an end filter tip thereon. If the packing is loose or a filter tip is missing, the air pressure at the point of pressure sensing will be different from that prevailing when the end of the cigarette is tightly packed or possesses a filter tip. Such change of pressure effects storage of a defect indication, and the latter is used after the cigarette has moved beyond the test position to control an eject mechanism for removing from the cigarette conveyor the cigarette which produced the change of pressure.

In a preferred embodiment, storage of a defect indication is accomplished by a fluidic form of bistable trigger, and subsequent utilization of the stored indication for cigarette ejection is effected by a fluidic AND device under concurrent control of the bistable trigger and a fluidic timing device which preferably establishes the cigarette eject position at one-half pitch (i.e. one-half the cigarette spacing on the conveyor) after the cigarette test position. The cigarette eject control is accompanied by reset of the fluidic bistable trigger in preparation for test of the next succeeding cigarette.

DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically represents the structure of a cigarette test apparatus embodying the present invention in a preferred form;

FIGS. 2 and 3 respectively illustrate the constructions of an inspection nozzle and a reject nozzle, and FIG. 4 illustrates the construction of a modified form of inspection nozzle, suitable for use in the FIG. 1 apparatus;

FIG. 5 illustrates in partially cross-sectioned plan view, and FIG. 6 in elevational view, the construction of a fluidic timing device used in the FIG. 1 apparatus; and

FIG. 7 schematically represents a modified form of timing device also suitable for use in the apparatus of FIG. 1.

DETAILED DESCRIPTION.—FIGS. 1–3

FIG. 1 schematically represents the construction of a cigarette testing apparatus embodying the present invention in a preferred form. In the manufacture of cigarettes by automated cigarette machines, the cigarettes are conventionally made in duel length with a central integral filter tip of plug and are then cut in the middle to provide two filter tip cigarettes. After the cutting operation, the cigarettes are placed on a conveyor of the drum or chain type which carries them to a pick-up station or automatic tray filler. At this transfer point, it is desirable automatically to inspect the cigarettes for a loose or poorly filled end and for missing filter tips. Thus as shown by way of example in FIG. 1, the cigarettes are loaded, by means not shown, onto a conveyor drum **10** having conventional construction and which is rotationally supported upon a shaft **11** and is rotationally driven by a suitable drive source **12** conventionally including an electric drive motor coupled to the shaft **11** through a step-down gear system. The periphery of the drum **10** is provided with equally spaced semi-cylindrical and longitudinally extending grooves **13** in each of which a filter tip cigarette is placed and conventionally retained by groove slots **14** coupled to a conventional vacuum pump (not shown).

The drum **10** rotates in clockwise direction as viewed from the source **12** and as indicated by the arrow **15**. As it rotates, the ends of cigarettes **16** positioned and held in the drum grooves **13** move at constant velocity past opposed test heads **17** which are stationarily located at a test position. Each test head includes an inspection

nozzle which may have the construction illustrated in FIG. 2 and which includes a metallic housing **18** of elliptical cross section closed at one end and open at the other. An elongated sheet metal curvelinear diaphragm **19** is positioned within the open end of the housing and extends across its major elliptical axis, the diaphragm edges being hermetically secured to the interior surfaces of the housing. The diaphragm **19** provides separate internal chambers **20** and **21**. The chamber **20** of each nozzle is supplied through a conduit **22** with compressed air from a pressurized and pressure regulated air source **23**, and the chamber **21** is supplied through a conduit **24** and a fluidic resistor **25** with reduced pressure air from the source **23**. The pressure of the air supplied to the chamber **20** is of the order of five to ten pounds per square inch, while the pressure of the air supplied to the chamber **21** is just sufficiently high to keep this chamber clear of tobacco particles or other foreign materials which might tend to clog it and may be of the order of one-half pound per square inch.

Each inspection nozzle housing **18** is oriented with the major elliptical axis of its cross section generally parallel to the direction of movement of the cigarette ends past the test position. The end of the inspection nozzle is spaced a small distance preferably of the order of 1/32" from the adjacent end of the cigarette, and the high velocity air jet issuing from its chamber **20** is directed to a restricted area of the cigarette end located radially of the drum **10** and inwardly from the axis of the cigarette. The width of the inspection nozzle **18** at its major elliptical axis is comparable to and preferably slightly less than the width of the restricted end cigarette area against which the high velocity air jet is directed at the test position. As more fully explained in the aforementioned McArthur application, the pressure of air in the inspection nozzle chamber **21** is influenced by the relatively fixed value of spacing between the end of the nozzle housing and the end of the cigarette, and this spacing is selected to provide a preselected value of air pressure for an acceptably tightly packed end textural cigarette fabrication or when a filter tip is present on the cigarette. A non-acceptable loosely packed end textural fabrication of the cigarette or the absence of a filter tip, however, causes the air pressure in the nozzle chamber **21** to change. For the preferred value of spacing given just above, the change of air pressure is one which decreases rapidly from the preselected value as the cigarette moves into the test position and thereafter increases rapidly back to the preselected value as the cigarette moves beyond the test position and as the side peripheral surface of the drum **10** between the grooves **13** moves into opposing relation to the end of the inspection nozzle. This change of air pressure in the nozzle chamber **21** is enhanced or accentuated by the tendency of the high velocity jet issuing from the nozzle chamber **20** to remove loose particles of tobacco from the non-filtered end of cigarettes exhibiting non-acceptable loosely packed end textural fabrication. If desired, and as explained in the aforementioned McArthur application, the end of the inspection nozzle may have a greater spacing of the order of 1/10" from the end of the cigarette in test position. For this value of spacing, the preselected air pressure in the nozzle chamber **21** has a small negative value of the order of .05 pound per square inch gauge for acceptably tightly packed end textural fabrication of the cigarette or in the presence of a filter tip thereon. A non-acceptable loosely packed end textural fabrication or the absence of a filter tip then produces an initial increase of air pressure toward and above atmospheric pressure as the cigarette moves into test position and this is followed by a return to the negative air pressure as the cigarette moves beyond the test position.

Whenever such change of air pressure is produced in the inspection nozzle chamber **21** of either inspection nozzle due to the movement past the test position of a cigarette having a non-acceptable end textural fabrication, the brief pulse of increasing air pressure in the inspection chamber **21** is supplied as a control pulse through an associated conduit **24** to an individual control port **28***a* or **28***b* of a conventional OR/NOR fluidic device **28**. The latter may have a construction and character of operation shown and described in "Fluidic Systems Design Guide," published by the Fluidonics Division of the Imperial-Eastman Corporation of Chicago, Ill. (copyright 1966). Air is supplied from the pressurized air source **23** to an air supply input port **28***c* of the device **28** as indicated, and the air pressure control pulse applied by either inspection nozzle to the individual control port **28***a* or **28***b* of the device **28** causes air to be diverted for the duration of the control pulse from its air supply input port **28***c* to an air pressure output port **28***d* which is connected by a conduit **29** to an air pressure control port **30***a* of a similar OR/NOR device **30**. In this, the device **28** operates to provide at its output port **28***d* amplification of the pressure and volume of the air pressure pulse supplied to its control port **28***a* or **28***b*. The amplified air pressure control pulse thus supplied to the OR/NOR device **30** causes the latter to divert air of amplified pressure and volume from its supply input port **30***c* to an air pressure output port **30***d* which is connected by a conduit **31** to an air pressure control port **32***a* of a conventional fluidic bistable trigger device **32**. The latter likewise may have a construction and operation more fully described in the publication last mentioned. The device **32** is of a bistable type which, in response to the pulse of air pressure supplied to its control port **32***a*, is set to and remains in a state such that air from its air supply input port **22***c* is diverted to an output port **32***d*. Recalling that the diversion of such air to the output port **32***d* of the device **32** is occasioned by a pulse of increasing air pressure which is supplied by one of the test heads **17** to one of the gas pressure control ports **28***a* or **28***b* of the OR/NOR device **28**, by reason of the sensing of a non-acceptable end textural fabrication of or absence of a filter tip on a cigarette moving past the test position, the test heads **17** in effect produce a defect indication which is stored by what may conveniently be considered a stable defect-storage state of the bistable trigger device **32** and by reason of such state air is diverted to the output port **32***d* of the latter.

Air pressure diverted to the output port **32***d* of the device **32** is supplied through a conduit **34** to one input control port **35***a* of an AND/NAND device **35**. A timing device **36**, described more fully hereinafter and which is mechanically driven from the rotational drive source **12** as indicated by the broken line **37**, supplies to a conduit **38** from the air source **23** an air pressure timing pulse each time that a cirgarette on the drum **10** has moved a preselected distance from the test portion as, for example, a distance equal to one-half pitch or spacing of the grooves **13** on the drum periphery. These timing pressure pulses are supplied to a second air pressure control port **35***b* of the AND/NAND device **35**. Whenever the defect indication storage state of the bistable trigger device **32** supplies pressurized air through the conduit **34** to the first air pressure control port **35***a* of the AND/NAND device **35**, a timing pulse supplied through the conduit **38** to the other air pressure control port **35***b* of the latter causes the device **35** to divert air (supplied from the air source **23**) from its air supply input port **35***c* to an output port **35***d* of the device **35**. This diverted pressurized air is supplied through a conduit **39** to an air pressure control port **40***a* of an OR/NOR device **40** having the same construction and mode of operation as the devices **28** and **30**. Since pressurized air is supplied by the AND/NAND device **35** to the conduit **39** only for the duration of a timing pressure pulse supplied by the timing device **36** through the conduit **38**, the resultant air pressure pulse in the conduit **39** causes the OR/NOR device **40** to divert for the duration of

this pressure pulse pressurized air from its air supply input port 40*c* to an output port 41.

This air pressure pulse is supplied through a conduit 42 to a conventional spool valve 43 and causes the latter to supply a pulse of pressurized air from the air source conduit 22 to an output eject conduit 44. The latter is connected to an eject nozzle 45 which utilizes the pressure pulse to develop a high velocity air jet pulse effective to eject from the drum 10 the end-defective cigarette which effected storage of the defect indication in the bistable trigger device 32. If cigarettes are retained in the grooves 13 of the drum 10 by a negative pressure vacuum exerted through the vacuum slots 14, the pressurized air supplied through the conduit 44 will break this vacuum on the end-defective cigarette by a conventional structure, not shown, to permit its ejection from the conveyor drum 10. The pressurized air pulse in the conduit 44 is also supplied through a fluidic resistor 46 to a fluid pressure control port 32*b* of the bistable trigger device 32 to reset the latter to its stable non-defect-storage state by which air is diverted from the output port 32*d*, and air pressure is thereupon removed from the conduit 34, in preparation for storage of a further defect indication upon movement of a succeeding cigarette past the test position of the test heads 17. When the pressurized pulse in the conduit 39 terminates at the end of the timing pulse supplied by the timing device 36, the OR/NOR device 40 diverts air from its input supply port 40*c* to an output port 47 which through a conduit 48 controls the spool valve 43 to terminate air pressure supply to the output conduit 44. The apparatus is thereupon conditioned to make a further test upon the end textural fabrication of the next cigarette moved on the drum 10 to the test position of the test heads 17.

The construction of a suitable form of the eject nozzle 45 is illustrated in FIG. 3. It is comprised by a solid member 49 of cylindrical cross section having an axial bore 50 in which the output conduit 44 is inserted and secured in position in any suitable manner. The member 49 terminates in a conically tapered nose portion 51 which serves to reduce undesirable jet turbulence.

FIG. 4

A modified form of inspection nozzle suitable for use in the FIG. 1 arrangement is illustrated in FIG. 4. It includes a hollow cylindrical housing 52 closed at one end and open at the other. The pressurized air input conduit 22 extends through and is secured in an axial aperture of the closed end wall of the housing, and provides an open-ended high velocity air jet nozzle 53 terminating approximately in the plane of the open end of the housing 52. The concentric chamber 54 between the nozzle 53 and the interior surfaces of the housing 52 communicates with the conduit 24 and provides the low-velocity pressure-sensing air jet corresponding to that of the chamber 21 of the FIG. 2 construction. The diameter of the housing 52 is approximately the same as the major axis width of the FIG. 2 nozzle, and when replacing the latter in the FIG. 1 apparatus the FIG. 4 nozzle exhibits essentially the same operational characteristics.

FIGS. 5–7

The construction of the timing device 36 is illustrated in FIGS. 5 and 6 and includes a disc 57 rotatably supported on a shaft 58 and provided with a series of equally spaced peripheral apertures 59 extending axially parallel to each other and to the shaft 58. The disc 57 is closely confined by and rotates within a housing 60 having opposed wall apertures 61 and 62 coaxially aligned with each other and with the disc apertures 59 as the latter move successively into opposing relation to the apertures 61 and 62. Positioned and secured within the wall aperture 61, and terminating in closely spaced relation to the adjacent surface of the disc 57, is the end of a length of the pressurized air conduit 22. The end of the conduit 38 is similarly positioned and secured in the wall aperture 2. As the disc 57 rotates within the housing 60, a timing pulse of pressurized air flows from the conduit 22 to the conduit 38 each time that an aperture 59 of the disc becomes aligned with the housing apertures 61 and 62. This occurs, as earlier explained and by reason of the mechanical drive of the disc from the drive source 12, preferably when a cigarette has moved approximately one-half pitch beyond the test position of the test heads 17. The duration of each timing pulse varies with the ratio of the diameter of the apertures 59 to their peripheral spacing and this ratio is preferably selected to have a fractional value only sufficiently large as to provide a consistently reliable timing control of rejection operation by the eject nozzle 45 and of reset of the bistable trigger device 32.

A modified form of timing device has a construction schematically represented in FIG. 7 and utilizes the disc 57 rotatably supported on the shaft 58 and provided with the peripheral apertures 59 as described in relation to FIGS. 5 and 6. A T-coupling member 60 connects the pressurized air conduit 22, provided with a fluidic resistor restriction 63, to the conduit 38 as shown. One arm of the T coupling member 60 supports a short length of conduit 64 terminating in a nozzle 65 of the FIG. 3 type and having the end of its nose portion closely spaced to the side surface of the disc 57 in alignable relation to successive ones of the disc apertures 59. The pressure of air supplied from the pressurized air conduit 22 to the conduit 38 increases in the latter during each brief interval when the end of the nozzle 65 is effectively closed by the wall surface of the disc 57 between successive ones of the apertures 59, but air pressure in the conduit 38 is briefly reduced by the airflow restrictive resistor 63 each time that an aperture 59 of the rotating disc 57 becomes aligned with the end of the nozzle 63. The length of the positive air pressure timing pulses thus supplied to the conduit 38 varies with the spacing between the apertures 59 of the disc 57. The disc may if desired be enclosed within a housing having aligned wall apertures as described in relation to FIGS. 5 and 6, in which event the nozzle 65 extends through one of the aligned wall apertures to terminate in closely spaced relation to the surface of the disc 57 as earlier explained while the other of the wall apertures remains open to atmospheric pressure.

While I have shown and described a preferred embodiment of my invention, other modifications thereof will readily occur to those skilled in the art.

I claim:

1. An apparatus for testing the ends of cigarettes comprising:

(a) means defining a path of movement for cigarettes to be tested;

(b) test head means adjacent at least one of the ends of cigarettes on said path; and

(c) means for ejecting defective cigarettes from said path; wherein the improvement comprises;

(d) a stationary open-ended nozzle included in said test head means and positioned with the open end of said nozzle spaced from the adjacent end of cigarettes moving on said path;

(e) means for supplying pressurized gas to said nozzle to provide a gas jet directed out of the open end thereof and against the adjacent end of cigarettes on said path to test their end textural fabrication;

(f) memory means having defect and non-defect storage states;

(g) means responsive to an end-textural-indicative gas pressure produced by the jet of said nozzle at a test position of said cigarettes in said path of movement for actuating said memory means to said defect state thereof whenever said indicative gas pressure varies substantially from a predetermined value corresponding to that produced by acceptable end textural fabrication of a cigarette; and

(h) timing means operative in timed relation to the movement of said cigarettes past said test position for actuating said ejecting means in response to each

defect storage state of said memory means and for concurrently restoring said memory means to said non-defect storage state thereof.

2. An apparatus as defined in claim 1, wherein said test head means is stationary and said path defining means moves cigarettes at substantially constant velocity past said test position and a preselected time interval elapses between movement of successive cigarettes to said test position, and wherein said timing means in responding to the state of said memory means effects said actuation of said ejecting means accompanied by said restoration of said memory means after an elapsed time equal approximately to one-half of said preselected time interval beginning with movement of a cigarette from said test opsition.

3. An apparatus as defined in claim 1, wherein said test head means includes two open-ended stationary nozzles having the open end of each spaced from individual adjacent ends of cigarettes moving on said path, wherein said gas supply means supplies pressurized gas to both of said nozzles to provide gas jets directed against both ends of cigarettes on said path concurrently to test both ends thereof for end textural fabrication, and wherein the end-textural-indicative gas pressure produced by the pet of each said nozzle at said test position actuates said memory means to said defect state thereof whenever either of said indicative gas pressures varies substantially from said predetermined value.

4. An apparatus as defined in claim 1 wherein said memory means is comprised by a bistable device settable to a stable defect-storage state by said gas-pressure responsive means and settable to a stable non-defect-storage state by said timing means.

5. An apparatus as defined in claim 4 wherein said memory means is comprised by a bistable fluidic device having an fluid supply input port, having two fluid-pressure control ports, and having two fluid-pressure output ports to individual ones of which fluid is bistably diverted from said input port under control of a fluid pressure pulse at individual ones of said control ports.

6. An apparatus as defined in claim 5 wherein said bistable fluidic device is set to said defect-storage state thereof by a fluid pressure pulse applied to one of said control ports by said gas-pressure responsive means and is set to said non-defect-storage state thereof by a fluid pressure pulse applied to the other of said control ports by said timing means concurrently with actuation of said ejecting means.

7. An apparatus as defined in claim 6 wherein said test head means is stationary and said path defining means moves cigarettes at substantially constant velocity past said test position and a preselected time interval elapses between movement of successive cigarettes to said test position, and wherein said timing means in responding to the state of said memory means effects said actuation of said ejecting means accompanied by said restoration of said memory means after an elapsed time equal approximately to one-half of said preselected time interval beginning with movement of a cigarette from said test position.

8. An apparatus as defined in claim 6 wherein said timing means includes an AND fluidic device having a fluid supply input port, having two fluid-pressure control ports, and having two fluid-pressure output ports from one of which fluid is diverted from said input port to the other output port by concurrent fluid pressures applied to said control ports.

9. An apparatus as defined in claim 8 wherein said bistable fluidic device in said defect-storage state thereof supplies fluid pressure to one of said control ports of said AND fluidic device and said timing means supplies a fluid pressure pulse to said other control port of said AND fluidic device to effect actuation of said ejecting means

and concurrent setting of said memory means to said non-defect storage state by diversion of fluid pressure from said fluid supply input port of said AND fluidic device to said other output port thereof.

10. An apparatus as defined in claim 9 wherein said test head means is stationary and said path defining means moves cigarettes at substantially constant velocity past said test position and a preselected time interval elapses between movement of successive cigarettes to said test position, and wherein said timing means in responding to the state of said memory means effects said actuation of said ejecting means accompanied by said restoration of said memory means after an elapsed time equal approximately to one-half of said preselected time interval beginning with movement of a cigarette from said test position.

11. The method of testing an end of a cigarette to determine the acceptability of an end textural fabrication thereof, wherein the improvement comprises the steps of:

(a) moving a succession of cigarettes at relatively constant velocity past a test position;

(b) directing at least one jet of pressurized gas from an open-ended stationary nozzle toward an end area of a cigarette approximately in said test position;

(c) measuring during movement of cigarettes past the test position an end-textural-indicative gas pressure produced by the jet of said nozzle;

(d) storing a defect indication whenever said indicative pressure measurement changes substantially from a preselected pressure value indicative of an acceptable end textural fabrication of a cigarette;

(e) producing control time indicia after each cigarette has moved a preselected distance beyond the test position and before a succeeding cigarette has moved to the test position; and

(f) using said stored defect indication under control of said time indicia concurrently to identify each cigarette producing said defect indication and to remove said stored defect indication from storage.

12. The method defined by claim 11 wherein said control time indicia are produced when said each and said succeeding cigarettes are in position spaced approximately equally from said test position.

13. The method defined by claim 11 wherein said control time indicia have durations short in relation to the time interval elapsing between movement of successive cigarettes into said test position.

14. The method defined by claim 11 wherein two jets of gas at different velocities are directed by said nozzle toward said cigarette end and the pressure of gas in the lower-velocity air jet provides an end-textural-indication and is measured and used to effect storage of said defect indication.

15. The method defined by claim 11 wherein jets of pressurized gas from open-ended stationary nozzles are directed toward both end areas of a cigarette approximately in said test position, wherein measurement is made of the end-textural-indicative gas pressure produced by the jet of each said nozzle, and wherein a defect indication is stored whenever either of said indicative pressure measurements changes substantially from said preselected pressure value.

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ALLEN N. KNOWLES, Primary Examiner

U.S. Cl. X.R.

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