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(54) APPARATUS PROVIDING INDICATION OF TOBACCO ROD FIRMNESS

(71) We, PHILIP MORRIS INCORPORATED, a corporation organised and existing under the laws of the state of Virginia, United States of America, of 100 Park Avenue, New York, New York 10017, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to cigarette making machinery and more particularly to apparatus providing a continuous output indication of the relative firmness of a tobacco rod during manufacture of cigarettes.

In monitoring the firmness of tobacco rods in cigarette manufacture, the industry has made extended use of compacimeters (compactness meters) whereby exacting "off-line" measurements can be made on manufactured cigarettes without intervention in the making process. In its further efforts to provide tobacco rod firmness information more contemporaneous with cigarette manufacture, and thereby to permit adjustment or correction of the parameters of the making process concurrently with information gathering, the industry has looked further to various "on-line" systems and apparatus. Versions of pneumatic apparatus are shown in U. S. Patents No. 3,411,513, No. 3,595,067, No. 3,633,590 and No. 3,850,029 and in British Patent No. 1,372,056. These devices are (1) of the type employing floating nozzles issuing pressurized air onto the cigarette wrapper and measuring either deformation of the wrapper or displacement of the nozzle based on changes in back pressure, or (2) of the type providing a pressurized on-line chamber arrangement and observing pressure changes caused by variations of firmness or dimensions of cigarettes passing therethrough.

Alternative, non-pneumatic approaches to firmness measurement are set forth in U.S. Patent No. 2,667,172 and British Patent No. 1,437,935. These devices look toward the use of tobacco rod forming elements of existing maker machinery for the additional function of providing output indication of rod firmness. In this U.S. patent, an elongate short tongue includes strain gages positioned proximate its compression foot and distal from the short tongue support clamp or beam. These gages are in spaced longitudinal alignment whereby longitudinal pressures exerted by tobacco against the tongue may be sensed. This sensing apparatus is separate in function and operation from the tobacco rod firmness sensing apparatus. The latter apparatus comprises a single active strain gage, also disposed between the tongue support beam and foot and adapted to provide an output indication of vertical strain placed on the short tongue, i.e., movements of its foot transverse to the direction of movement of tobacco engaged thereby. The British patent relates also to specially constructed short tongues, disclosing a first embodiment wherein the compression foot of a short tongue is split into two successive longitudinal sections, each having a separate support flange with one support flange having a strain gage thereon, and a further embodiment wherein the longitudinally forward of such compression foot sections is further split into three circumferential segments, each having an independent support flange with a strain gage thereon. Such support flanges are stems having one end terminating at the compression foot and an opposite end terminating at the tongue cantilever support beam.

According to the invention there is now provided cigarette making apparatus having a garniture for imparting curvature to a garniture tape and to cigarette paper and tobacco disposed on the tape, a short tongue

including a foot engageable with the tobacco and cooperative with the garniture to form the tobacco into a tobacco rod and a cantilever support beam fixed at one end and supporting the foot at the other end thereof so that the foot is capable of movement in accordance with changes in firmness of the tobacco rod, and at least one strain gage support on the support beam to give indications of stress changes in the beam consequent upon such movements of the foot.

The firmness indication provided in accordance with the invention may be further amplified by nominal modification of the support beam of the existing short tongue of commercial equipment and still further by particular circuit interconnection of plural pairs of strain gage elements.

Pursuant to the invention, the strain gage or gages are located on the cantilever beam itself, an approach disparate from that of the U.S. Patent 2,667,172 and British Patent No. 1,437,935 which provide for strain gage placement beyond such beam, and necessitate a specialized short tongue structure. In its attainment of firmness indication of an accuracy commensurate with that of off-line apparatus, the invention detects changes in the condition of flexure of such beam responsive to compression foot movement.

The output stress change signals of the cantilever beam-support strain gages may be employed to control a meter or like indicating instruments, may be recorded or may serve to control tobacco supply or like on-line apparatus.

The invention will be further understood from the following detailed description of preferred embodiments of the invention and from the drawings wherein like reference numerals identify like parts throughout, and wherein:

Fig. 1 is a schematic illustration of cigarette making apparatus in present commercial use.

Fig. 2 is a perspective view of the short tongue of the Fig. 1 apparatus.

Fig. 3 is a perspective view of the Fig. 2 short tongue adapted in accordance with the invention for tobacco rod firmness measuring.

Fig. 4 is a perspective view of another short tongue modified for use with the invention.

Fig. 5 is a partial plan view of the short tongue of Fig. 4 with plural strain gages employed in accordance with the invention.

Fig. 6 is a schematic side illustration of the Fig. 4 short tongue in its quiescent position.

Fig. 7 is an exaggerated illustration of the condition of flexure of the beam member of the Fig. 4 short tongue.

Fig. 8 shows a circuit for use in providing a tobacco rod firmness indication.

Fig. 9 shows a further circuit arrangement wherein plural pairs of strain gages are employed.

In Fig. 1, cigarette making apparatus, known as the MK8 Cigarette Maker and commercially available from the Molins Company, is shown schematically to include a tobacco chimney 10 from which tobacco is blown onto a perforated vacuum belt 12 driven by rollers 14 and 16 to convey the tobacco T supported by the belt 12 to a trimmer knife assembly 18 supported for movement toward or away from the conveyed tobacco to vary the amount of tobacco on the belt 12 in accordance with a cigarette weight (density)-based control signal.

To the left of the roller 14, such Molins apparatus includes an elongate garniture 20 defining an open channel extending longitudinally and of generally semi-cylindrical configuration. An endless garniture tape or belt 22 is fed to the upstream tobacco input mouth 20*a* of the garniture and transported through the garniture by a drive wheel 24 over idler rollers 24*a*-24*e*. Cigarette paper 26 is fed to the mouth 20*a* on top of the tape 22 from a supply roll or bobbin 28 over idler rollers 28*a*, 28*b* and 24*d*. Tobacco falls from the belt 12 onto the paper 26 as vacuum is removed from the belt. On entry of the tape 22 in the garniture channel, the garniture imparts a generally semi-cylindrical shape thereto, a like shape being thereby imparted to the paper 26 and the tobacco deposited thereon from the belt 12, the open semi-circular cross-section of the tape, paper and tobacco being shown in Fig. 6.

The short tongue 30 of such Molins apparatus (Figs. 1 and 2), comprising a compression foot 32 and a cantilever beam member or arm 34, is located downstream of the garniture mouth 20*a*. This unit is cooperative with the garniture to impart generally cylindrical form to the tobacco to form a tobacco rod. To this end, the compression foot 32 is formed with an open channel extending longitudinally and also of generally semi-cylindrical configuration, the open semi-circular cross-section of such channel being shown in Fig. 6. One end of the beam 34 is fixedly secured, as by a bolt 36 to a base 38 (Fig. 2) and the opposite end of the beam 34 is integral, or otherwise in supporting relation, with the stem 32*a* of the compression foot 32.

As the formed tobacco rod leaves the short tongue 30, a length of cigarette paper extends tangentially from the paper-wrapped rod. A paster wheel 40 applies an adhesive to such extending length of paper whereupon a unit 42 folds such pasted length over and a unit 44 heat seals the rod. The sealed continuous rod now passes through a nuclear density gage 46 and is then cut by

a rod cut-off mechanism 48.

In Fig. 3, strain gages 50 and 52 are supported, in accordance with the invention, on opposed sides 34*a* and 34*b* of the beam 34 at locations on the beam at which it exhibits flexure on movements upwardly from a quiescent position, i.e., a position wherein no upward stress is in the beam.

Strain gages 50 and 52 are preferably employed with a beam 34′ (Fig. 4) which differs from the beam 34 of Fig. 3 by inclusion of a longitudinal extent 34′*a* of reduced cross-sectional area with respect to portions 34′*b* and 34′*c* of the beam 34′ extending longitudinally adjacent such extent 34′a. In this construction, a strain gage 50 is supported on a land 34′*f* of the beam extent 34′*a* and a strain gage 52 is supported thereunder on a land 34′*g*. Preferably, separate strain gage elements 50*a* and 50*b* are supported on the land 34′*f*, as shown in Fig. 5. The underside opposed land supports strain gage elements 52*a* and 52*b* (not shown in Fig. 5).

In the aforesaid quiescent position of the beam 34 or beam 34′ the compression foot 32 is supported thereby to engage a tobacco rod of substantially less diameter *d* than a predetermined desired diameter, as is shown schematically in Fig. 6, in such manner that the strain gages on opposed surfaces of the beam exhibit equal electrical resistance. Thus, in Fig. 6 the tobacco rod R is of such predetermined diameter *d* and the beam 34 is in such position that it is unflexed. Fig. 7 shows schematically and in an exaggerated manner, a movement of the beam 34′ upwardly from its quiescent position, occasioned by the foot 32 engaging a rod having a diameter greater than the diameter *d*, wherein flexure of the beam 34′ elongates the land 34′*g* and contracts the land 34′*f*. As a result, the strain gage(s) on the land 34′*g* is subjected to tension while the strain gage(s) on the land 34′*f* is subjected to compression. On movement of the compression foot 32 and its support beam downwardly from its Fig. 7 position, as occurs when the engaged tobacco rod firmness decreases from that applying in Fig. 7, compression in the strain gage(s) on the land 34′*g* will increase while tension in the strain gage(s) on the land 34′*f* will increase.

As will be appreciated, the lands 34′*f* and 34′*g* experience greater surface extent change for a given flexure condition in the beam 34′ than the longitudinally adjacent beam portions 34′*b* and 34′*c*. Accordingly, the beam construction shown in Figs. 4-6 enables the strain gages to exhibit a change in resistance for a given beam flexure exceeding that resistance change which they would exhibit were they supported, as in the Fig. 3 embodiment, on surfaces of the beam not of reduced cross-sectional area.

Where used in the embodiment shown in Fig. 3 or the embodiments shown in Figs. 4-6, a single pair of strain gages (50, 52) are connected in the manner shown in Fig. 8, i.e., they are series-connected and supplied with voltage from a suitable power supply P.S. with an output signal being provided at terminals T1 and T2, indicative of the voltage across an exclusive one of the strain gages. By such connection of the single pair of strain gages, mounted in plural on the cantilever beam 34 or 34′ and in a manner exhibiting respectively opposite changes in stress condition for change in flexure condition of the beam, an amplified signal is obtained at terminals T1 and T2. Thus, if the strain gage 50 is compressed, thereby decreasing its resistance, while the strain gage 52 is subjected to tension at the same time, thereby increasing its resistance, the voltage across the terminals T1 and T2 will increase in compound manner, i.e., increasing on the one hand, by decrease in the resistance of the strain gage 50 and, on the other hand, by an increase in resistance of the strain gage 52. As will be further seen, based on such signal amplification, less sensitivity to change is required in the associated detector equipment, for example, rod firmness indicating meter M, and the signal-to-noise ratio may desirably be increased.

Where strain gages are employed in pairs on opposed sides of the beam 34 or 34′ as shown in Fig. 5, the gages are connected as in Fig. 9. A full bridge circuit includes one branch having the gage elements 50*a* and 52*a* connected in series, and another branch having the gage elements 52*b* and 50*b* connected in series, the branches being connected in parallel between terminals T3 and T4. A power supply is connected across T3 and T4 and an output signal is provided by terminals T5 and T6, T5 being connected to the junction J1 of the gage elements 50*a* and 52*a* and T6 to the junction J2 of the gage elements 50*b* and 52*b*.

The reversed order of connection of the strain gages in the Fig. 9 circuit provides signal amplification increased above that of Fig. 8. In such reversed order, one gage element (50*a*) on the upper beam side is in the upper portion of the first branch and the remaining upper beam side gage element (50*b*) is in the lower portion of the second branch. One gage element (52*b*) on the lower beam side is in the upper portion of such second branch and the remaining lower beam side gage element (52*a*) is in the lower portion of such first branch.

Assuming the change in flexure conditions in Figs. 6 and 7 to be the tobacco rod firmness change under examination, the resistances of the gage elements 50*a* and 50*b* will decrease and the resistances of the gage

elements 52*a* and 52*b* will increase. The voltage at the junction J1 with respect to the terminal T4 will increase in magnitude and the voltage at the junction J2 with respect to T4 will decrease in magnitude by that same amount. The voltage change between T5 and T6 will thus be twice that seen at either junction separately.

Considering the beam 34′ to be stable in its first flexure condition in Fig. 7 and the tobacco rod firmness then to change such that the beam assumes a second flexure condition between its Fig. 7 and Fig. 6 states, tension in the gage(s) on the land 34′*g* decreases from that applying in the first flexure condition, i.e., the relative compression thereof increases from that applying in the first flexure condition. Similarly, in the second flexure condition compression in the gage(s) on the land 34′*f* decreases, i.e., the relative tension increases therein. Otherwise stated, movement of the foot 32 is accompanied by stress changes of opposite sense (compression vs. tension) in the respective top and bottom strain gage(s).

In practising the invention, the strain gages are preferably foil strain gages, such as are commercially available as model number MA-06-062AA-120 (gage factor 2.075) from Micro-Measurements Division of Vishay Intertechnology, Inc., Box 306, Romulus, Michigan.

WHAT WE CLAIM IS:

1. Cigarette making apparatus having a garniture for imparting curvature to a garniture tape and to cigarette paper and tobacco disposed on the tape, a short tongue including a foot engageable with the tobacco and cooperative with the garniture to form the tobacco into a tobacco rod and a cantilever support beam fixed at one end and supporting the foot at the other end thereof so that the foot is capable of movement in accordance with changes in firmness of the tobacco rod, and at least one strain gage supported on the support beam to give indications of stress changes in the beam consequent upon such movements of the foot.

2. Apparatus as claimed in claim 1 wherein the beam has an intermediate region of reduced cross-sectional area and the strain gage or gages is or are mounted in such region of reduced cross-section.

3. Apparatus as claimed in claim 1 wherein first and second strain gages are supported on opposite sides of the beam in such locations that the first strain gage exhibits a stress change of sense opposite to that exhibited by the second gage on movement of the foot.

4. Apparatus as claimed in claim 2 wherein the first and second strain gages are supported on opposite sides of the beam region of reduced cross-section in such locations that the first strain gage exhibits a stress change of sense opposite to that exhibited by the second strain gage on movement of the foot member.

5. Apparatus as claimed in claim 3 or 4 wherein the first and second strain gages are connected in series, and means are provided for applying a voltage across the series circuit and for providing an output signal indicative of the voltage across a selective one of the strain gages.

6. Apparatus as claimed in claim 3 or 4 wherein each of the strain gages comprises first and second strain gage elements, and wherein the first element of the first strain gage and the first element of the second strain gage are connected in a first series circuit and the second element of the second strain gage and the second element of the first strain gage are connected in a second series circuit in parallel with the first series circuit, and means are provided for applying a voltage across the said parallel circuit and for providing an output signal indicative of the voltage difference between the respective junctions of strain gage elements in the first and second series circuits.

7. Apparatus as claimed in any preceding claim wherein the support beam is integral with the foot.

8. Cigarette making apparatus with reference to any of Figs. 3 to 9 of the drawings.

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1568972 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

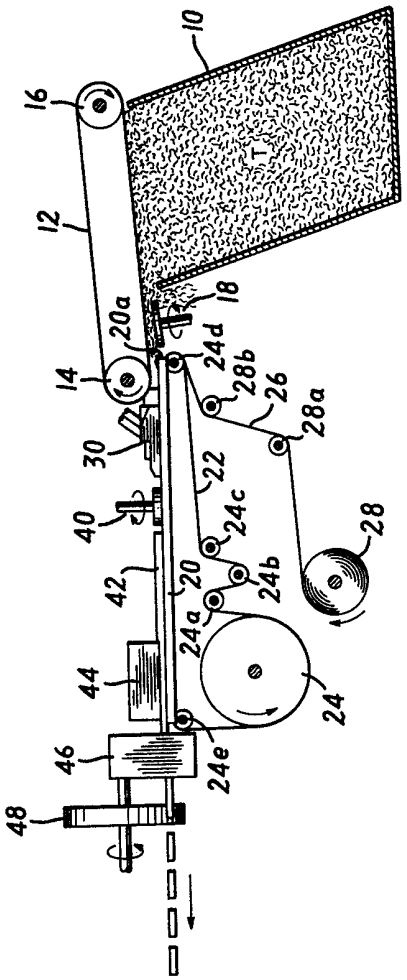

FIG. 1

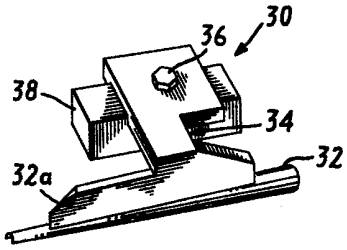

FIG. 2

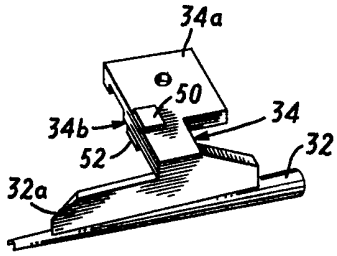

FIG. 3

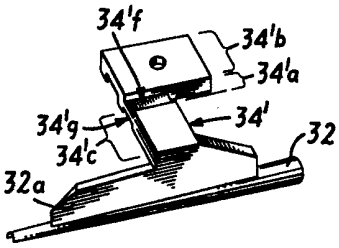

FIG. 4

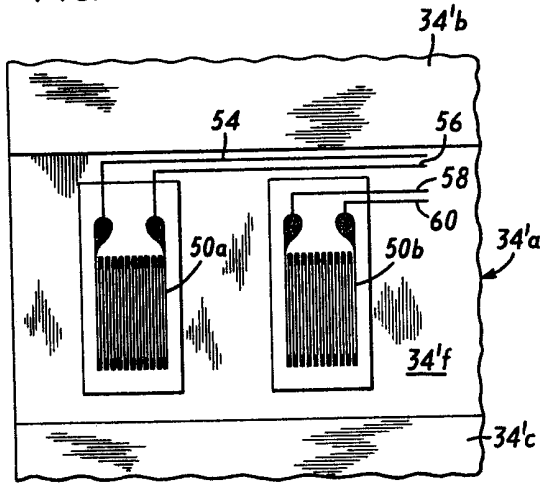

FIG. 5

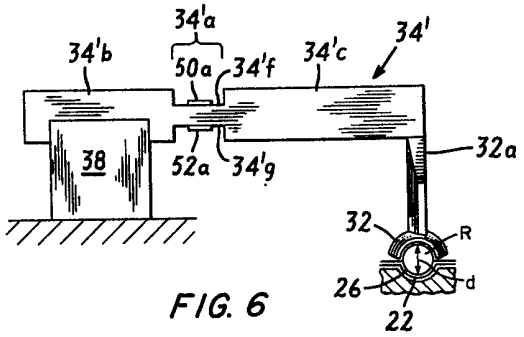

FIG. 6

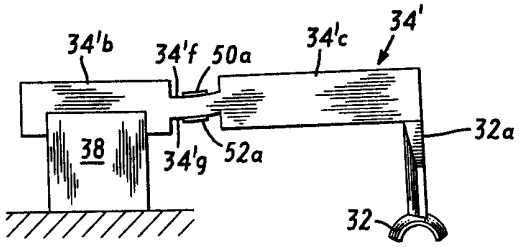

FIG. 7

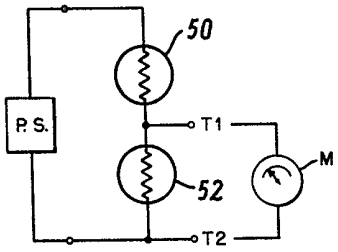

FIG. 8

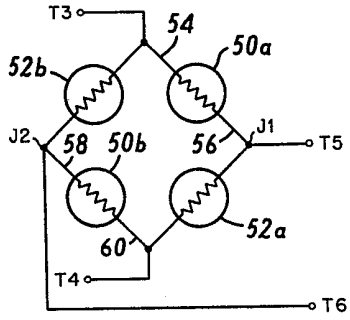

FIG. 9