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CIGARETTE MANUFACTURING MACHINE AND CONTROL SYSTEM THEREFOR

ZIGARETTENHERSTELLUNGSMASCHINE UND STEUERSYSTEM DAFÜR

MACHINE DE FABRICATION DE CIGARETTES ET SYSTEME DE COMMANDE CORRESPONDANT

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This invention relates to the manufacture of filter cigarettes and to control systems for controlling the cigarette rod making and filter tipping machines.

Cigarette rod making machines and filter tippers are well known. Commonly, cigarette rods made by a rod maker are passed automatically to a filter tipper over a transfer apparatus. The filter tipper adds a filter to the cigarette rod and wraps tipping paper around the combination. The finished cigarettes are then passed to a packaging station.

More recently, production speeds have been increased by manufacturing double length cigarette rods. These double length rods are transferred to the tipper as a whole. As part of the transfer process, the cigarette rod is split at its mid-point, the two single rod lengths separated and a double length filter inserted between the separated rod length. Tipping paper is wrapped around the whole and the filter is then cut at its mid-point to produce two completed cigarettes. As these cigarettes are arranged in the tipper in opposite directions, one of the cigarettes is then rotated before the completed product is passed to the packaging machine.

US 3,793,512 (Hauni-Werke Korber & Co) provides a method and apparatus for monitoring the operation of tobacco processing machines by discrete detectors. Malfunctions of parts or groups of parts cause the detectors to produce signals in response. The signals are used to stop one or more machines as well as to operate devices which count and record the number of malfunctions. The idle time is also recorded.

Traditionally, cigarette manufacturing machines have been essentially mechanically driven and controlled. The various motion/rotating devices in the machines are driven through appropriate gear boxes from a main drive. In recent years there has been a move to replacing some of this bulky drive train with a series of independent servo motors which are synchronized with one another.

We have appreciated that there are many aspects of the cigarette production process which are not controlled adequately by existing machinery.

The present invention aims to address the above-mentioned deficiencies in the prior art.

According to the invention there is provided a cigarette manufacturing apparatus comprising: a tobacco rod maker for making double length tobacco rods; a tipper for applying filters to tobacco rods to form filter tipped cigarettes; a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper; wherein each of the tipper and the rod maker comprises a plurality of devices for monitoring and/or affecting parameters of the rod maker, the tipper or the cigarettes being manufactured; a controller for controlling the plurality of devices on the tipper and the rod maker; and a field bus, the plurality of devices and the controller being connected to the field bus.

The invention also provides a cigarette manufacturing apparatus comprising: a tobacco rod maker for making double length tobacco rods; a tipper for applying filters to tobacco rods to form filter tipped cigarettes; a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper; wherein each of the tipper and the rod maker comprises a plurality of devices for monitoring and/or affecting parameters of the rod maker, the tipper or the cigarettes being manufactured; a controller for controlling the plurality of devices on the tipper and the rod maker; and a second controller for providing tipper, rod maker and cigarette information to an operator and for communicating input data from the user to the first controller.

The invention further provides a cigarette manufacturing apparatus comprising: a tobacco rod maker for making double length tobacco rods; a tipper for applying filters to tobacco rods to form filter tipped cigarettes; a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper; a plurality of synchronised servo motors each for driving a respective operation in the tipper or the rod maker; wherein each of the tipper and the rod maker includes a plurality of devices for monitoring and/or affecting parameters of the rod maker, the tipper or the cigarettes being manufactured; a motion control device for controlling the plurality of synchronised motors; a system controller for controlling the plurality of devices on the tipper and the rod maker, the motion control device being connected to the system controller; and a field bus, the plurality of devices and the controller being connected to the communications network.

In one embodiment of the invention it is preferred that the synchronised motors are servo motors. Preferably, the communications network is a field bus-type network.

The invention also provides a cigarette manufacturing apparatus comprising: a tobacco rod maker for making double length tobacco rods; a tipper for applying filters to tobacco rods to form filter tipped cigarettes; a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper; wherein each of the tipper and the rod maker comprises a plurality of devices for monitoring and/or affecting parameters of the rod maker, the tipper or the cigarettes being manufactured; a control network, the plurality of devices being coupled to the control network; a first controller connected to the control network for controlling the plurality of devices on the tipper and the rod maker;
The invention also provides a method of controlling the manufacture of cigarettes by an apparatus comprising a tobacco rod maker and tipper interconnected by a rod transfer apparatus, the method comprising the steps of: providing a field bus and a machine controller connected to the field bus; connecting a plurality of devices to the field bus, for monitoring and/or affecting parameters of the rod maker, the tipper or the cigarettes being manufactured; monitoring the field bus from the controller for data from the devices; and adjusting one or more parameters of the tipper or rod maker in accordance with the information content of the data received.

Embodiments of the invention have the advantage that the entire cigarette manufacturing process is controlled as a whole. In the prior art, the rod makers and the filter tippers are controlled individually which we have appreciated is undesirable. Preferably, devices to be controlled in both the rod maker and the tipper are all linked on a common field bus which is controlled by a common controller. This has the advantage that machine wiring is minimised yet permits improved communication between devices on the fieldbus and the controller.

Preferably, both the tipper and the rod maker have human machine interfaces (HMI's) which can receive data from and send data to the fieldbus via the controller. Preferably, the HMIs are controlled by a different controller from the devices on the field bus. The control data may be accessed, for example, through a TCP/IP link to a factory local area network (LAN) or beyond enabling remote diagnostics. The separation of the data ensures that the integrity of the manufacturing process can not be compromised, for example through unauthorised users on the LAN.

Embodiments of the invention have the advantage that production speeds may be greatly increased. Embodiments of the invention have the advantage that many adjustments may be made to the machine without stopping production which would hitherto have required substantial down times. For example, the phasing of the maker to the tipper. When ramping up to full speed the phasing can be changed during ramp-up to give a higher quality cigarette during this time. In addition the ratio of the garniture belt to the suction tape can be varied to allow different brands having different parameters to be manufactured without stopping the machine. The position of the manufacturer's print information on the cigarettes can be varied according to defined parameters as can the position of the densed end in the tobacco rod. This facilitates a switch of production to a different brand with different brand specifications. By eliminating the majority of the mechanical linkages and replacing these with intelligent devices such as intelligent servomotors, and distributed control, quieter operating may be achieved which is beneficial to users of the machinery.

Embodiments of the invention have the additional advantage that there is a greater mean time between failures and, in the event of failures, there is a smaller mean time to repair. The mean time to repair is partly reduced by the presence of the HMI which has access to diagnostic data from devices on the field bus enabling quick fault diagnosis and quick identification of faulty components for replacement. In addition, diagnosis may be made from a remote site, for example over the factory business LAN or Intranet.

An embodiment of the invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a schematic view of a front end of a cigarette rod maker showing the hopper arrangement of drums and rollers which transfer tobacco to the suction chamber;

Figures 2 and 3 show schematically a hopper suitable for use in the cigarette rod maker of figure 1;

Figure 4 shows schematically one embodiment of a roller for use in the hopper of figures 2 and 3;

Figure 5 is a schematic view of the suction chamber showing apparatus for controlling the rod density;

Figure 6 is a schematic cross section of the apparatus of figure 5 on the line 6-6 in figure 5;

Figure 7 is a detailed view of one embodiment of part of the apparatus of figure 5;

Figure 8 is an exploded view of the apparatus of figure 7;

Figure 9 is a detailed cross sectional view of a second embodiment of the apparatus of figure 5;

Figure 10 is a schematic view of the maker from the suction band to ejection of completed double length rods;

Figure 11 is a perspective view of a transfer apparatus showing a kicker used to transfer rods from the rod maker;

Figure 12 is an enlarged view of a portion of the apparatus of figure 11;
Figure 13 is a plan of the kicker assembly of figure 11;
Figure 14 is a front view of the assembly of figure 13;
Figure 15 is a plan of the kicker wheel;
Figure 16 is a front view of the kicker wheel;
Figure 17 is a section A-A of figure 16;
Figure 18 is a plan of the suction housing;
Figure 19 is a front view of the suction housing;
Figure 20 is a rear view of the suction housing;
Figure 21 is a schematic view of the drum assembly of the transfer apparatus of the cigarette manufacturing machine embodying the inventions;
Figure 22 is a rear perspective view of a transfer apparatus with the cover removed;
Figure 23 is an exploded view of parts of the transfer apparatus;
Figure 24 is a perspective view of the receiving drum of the transfer apparatus;
Figure 25 is a perspective view of the suction housing for the receiving drum;
Figure 26 is a perspective view of the tipper;
Figure 27 is a front schematic perspective view of the rodmaker with the positions of certain motors shown;
Figure 28 is a rear schematic perspective view of the rodmaker with the positions of certain motors shown;
Figure 29 is a rear perspective view of the tipper with the positions of certain motors shown;
Figure 30 is a schematic view of a first embodiment of the control system for the tipper and rod manufacture showing the field bus;
Figure 31 is a schematic view of a second embodiment of the control system for the tipper and rod manufacture showing the field bus;
Figure 32 is a view of the main menu displayed on the tipper HMI;
Figure 33 is a view of the prepare maker screen displayed on the maker HMI;
Figure 34 is a view of the parameter adjust screen displayed on the maker HMI;
Figure 35 is a view of the phase shift screen displayed on the maker HMI;
Figure 36 is a view of the prepare tipper screen displayed on the tipper HMI;
Figure 37 is an overview of the relationship between various screens displayable on the tipper and maker HMIs;
Figure 38 is a flow chart indicating the major steps in the control process;
Figure 39 is a flow chart of showing the steps in the general start up routine;
Figure 40 is a flow chart showing the steps in the tipper start up routine; and
Figure 41 is a flow chart showing the steps in the maker start up routine.

[0020] The basic operation of the cigarette rod making machine and the tipper will first be described.

[0021] The cigarette rod making machine manufactures double length cigarette rods and transfers these to a tipper which further cuts the double rods and inserts a double length filter between the rods. Tipping paper is then applied and the finished cigarette pairs are severed, alternately re-oriented, tested and sent for further processing.

[0022] Figure 1 shows, schematically, the front end of a tobacco rod maker. This is only one example of the front end of the maker and other front ends may be used. Cut tobacco is fed initially into the back of a hopper 10. A top mesh drum 1, which has a vacuum drawn through it, carries the tobacco to a paddle wheel 2 which closes the hopper well. A sensor 3 in the hopper well detects whether there is a sufficient quantity of tobacco in the hopper. The vacuum to the mesh drum 1 is turned off when the hopper sensor 3 is covered by tobacco and is switched on when the sensor becomes uncovered. A guard door 4 is provided at the top of the hopper through which tobacco recovered from spillages etc. may be added. A tamper plate 5 is fitted in the hopper well which is pushed into the well at regular intervals to stop the tobacco from becoming compacted. A permanent magnet 6 is fitted under the paddle wheel 2 to remove any ferrous material from the tobacco stream.

[0023] The hopper may be of purely conventional design as shown in figure 1 or, modified as shown in figures 2 to 4. In the hopper of figure 2, a spiked metering roller 7 located at the bottom of the hopper well carries the tobacco from the hopper dropping it in the area behind a pair of carded drums 8,9 which will be described in due course.

[0024] In the hopper of figures 2 to 4, a delivery roller 12 is disposed across the inlet of the hopper. The circumferential surface of the roller 12 has spikes 14 to engage with tobacco entering the hopper. In one embodiment of the machine the roller 12 is mounted on a driven shaft 16 and comprises four separate roller sections 12a,b,c,d. At the bottom of the hopper the two rotatable carded drums 18 (only one drum is shown) are disposed. Between the level of the delivery roller 12 and the carded drum 18, in a location corresponding to the desired maximum level of tobacco in the hopper, a generally horizontal row of four photo sensitive cells 20a,b,c,d is disposed. Each cell 20a,b,c,d is connected to an actuator for a respective roller section 12a,b,c,d, and each cell is at a point in the hopper wall vertically below the projection of the respective roller section onto the hopper side wall.

[0025] In use, tobacco enters the hopper 10 from above. All the delivery roller sections 12a,b,c,d rotate to distribute incoming tobacco onto the rotating carded drum 18 which forms the floor of the hopper. This situation, shown in figure 2, obtains so long as the level of tobacco in the hopper remains below the level of all the photo sensitive cells 20a,b,c,d. At the bottom of the hopper the two rotatable carded drums 18 are disposed. Between the level of the delivery roller 12 and the carded drum 18, in a location corresponding to the desired maximum level of tobacco in the hopper, a generally horizontal row of four photo sensitive cells 20a,b,c,d is disposed. Each cell 20a,b,c,d is connected to an actuator for a respective roller section 12a,b,c,d, and each cell is at a point in the hopper wall vertically below the projection of the respective roller section onto the hopper side wall.

[0026] Once the level of tobacco has fallen below the level of the activated photo sensitive cells, the disengaged roller sections are reengaged and rotate, distributing tobacco to those regions once more. If desired, reengagement of roller sections may be delayed for a fixed time after the respective photo sensitive cell is deactivated, allowing the level of tobacco in the region monitored by the activated cell to drop below the desired maximum.

[0027] The signal sent by a photo sensitive cell on activation can cause the respective roller section to engage the driven shaft in any of several ways. For example, the signal can cause an electromagnetic clutch within the roller section to engage the driven shaft, causing the roller section to rotate. Alternatively, the signal can cause a solenoid to move a key in one of the shaft or the roller section into a keyway in the other; the relative rotation of the driven shaft and the unengaged roller section will bring the key and keyway into opposition so that engagement takes place.

[0028] Figure 4 shows a pneumatic clutch arrangement. A delivery roller 12 comprises four roller sections 12a,b,c,d (the spikes of the roller are not shown). The driven shaft 16 on which the roller 12 is mounted has passageways 24a,b,c,d each of which opens in the circumferential wall of the shaft 16 away from the roller 12 and each of which ends in an actuator chamber 26a,b,c,d which opens in the circumferential wall of the shaft 16 adjacent a respective one of the roller sections 12a,b,c,d. Each actuator chamber 26a,b,c,d houses a friction block 28a,b,c,d which engages sealingly with the side walls of the chamber 26a,b,c,d but is free to move in the chamber toward and away from the respective roller section 12a,b,c,d. In the embodiment shown, two of the channels 24a,b open in the circumferential wall of the shaft 16 to one side of the roller 12 and two to the other side.

[0029] A source of compressed air (not shown) is connected to each of the passageways 24a,b,c,d by air supply pipes 30a,b,c,d. The supply pipes 30a,b,c,d are connected to the passageways 24a,b,c,d in such a manner that the shaft 16 can rotate without rotation of the supply pipes. The connection may be such that each supply pipe 30a,b,c,d is in constant communication with a respective passageway 24a,b,c,d throughout a revolution of the shaft 16. This can be achieved by providing a plenum block 32 circumferentially around the shaft 16 through which the air supply pipes 30a,b,c,d pass. The ends of the supply pipes adjacent the shaft each end in a respective circumferential plenum chamber 34a,b,c,d, each of which is in constant communication with the respective passageway 24a,b,c,d as the shaft rotates. Alternatively it can be that the communication is broken as the shaft rotates, the open ends of the channels
being sealed during the rest of the revolution of the shaft by means not shown such as sealing blocks extending circumferentially around the shaft 16 through which the air supply pipes 30a,b,c,d pass.

[0030] In use, when no signal is received from one of the sensors 20a, indicating an acceptable level of tobacco in the part of the hopper covered by that sensor, a valve (not shown) in the respective air supply pipe 30a is open admitting air under pressure into the circumferential plenum chamber 34a in the plenum block 32 and thence into the respective passageway 24a in the rotating shaft 16 and the actuator chamber 26a at the other end of the passageway 24a. The raised air pressure in the actuator chamber 26a urges the friction block 28a in the actuator chamber 26a against the wall of the respective roller section 12a, causing it to rotate with the shaft 16.

[0031] If the sensor 20a sends a signal indicating a build up of tobacco in the part of the hopper covered by that sensor, the valve in the air supply pipe 30a closes. The air pressure in the actuation chamber 26a returns to atmospheric as air leaks out of the passageway 24a, so that the friction block 28a is no longer urged against the wall of the roller section 12a, thus disengaging that section from the shaft 16 so that the roller section stops rotating. It will be appreciated that the other roller sections 12b,c,d are disengaged and engaged in the same way in response to a signal or the lack of a signal from the respective sensors 20b,c,d in the hopper.

[0032] The signal from the activated cell can pass through a processing device which then sends a signal to the respective roller section. It will also be appreciated that the cell may be activated to send a signal when it is not detecting tobacco, and cease to send the signal or send a different signal when it detects tobacco.

[0033] Referring back to figure 1, the tobacco metering roller 7 draws tobacco from the hopper 10 creating a constant head. The metering roller 7 is controlled by three photo electric sensors (PECs)36,37,38 which are arranged the such that the metering roller speed is increased if any of the three sensors cannot see tobacco, so ensuring a constant head.

[0034] From the metering roller 7, tobacco is passed between the carded drum rollers. The upper of those rollers 8 is a small carded drum and the lower a large carded drum 9. The lower, large, carded drum 9 picks up the tobacco and carries round until it meets the small carded drum 8. These drums rotate relatively slowly and are synchronised to the main drive. The gap between the two carded drums allows a uniform quantity of tobacco to pass through. Excess tobacco is formed into a roll by the contra-rotation of the two carded drums. The tobacco is then passed to a pair of picker and winnower rollers 41, 42 which rotate at a relatively high speed and throw the tobacco into an air stream to transport it to a suction band. The picker roller operates by picking tobacco from the large carded drum 9 and passing it under the winnower roller 41 which accelerates the tobacco to a perforated rotating collector tube 43. Suction passing through the collector tube 43 picks up the tobacco and carries it round into the airstream passing up a chimney 44. Air from a small fan is blown up a scroll 45 fitted under the collector tube which blows the strands of tobacco up the chimney. Heavier particles of tobacco, stem and birdseye fall through the airstream into the stem collector 46. Air is also sucked up the chimney by a large fan which pulls the strands up to a perforated band. The velocity of the air can be altered by reducing the air flow entering the chimney. The velocity of the airflow is altered to suit the product being used.

[0035] The hopper section has a synchronised drive controlling the large carded drum and a variable speed drive controlling the tobacco metering roller or delivery bands, which can have a variable set point dependent on the machine speed.

[0036] The tobacco passed up the chimney is held on the underside of a suction band which carries it forward to a garniture. The depth of tobacco held on the band is trimmed by ecreteur discs to the correct depth.

[0037] Referring to figures 5 to 9, an endless suction band 47 passes longitudinally through the chamber 40 in the direction shown by the large arrow in figure 5. The suction band 47 is preferably driven by a servomotor synchronised with the other motor drives and is permeable to air but substantially impermeable to tobacco. Alternatively it may be mechanically linked. The chamber 40 has a top wall 49, a bottom wall 49′, side walls 50,50′, and end walls 48,48′. The bottom wall 49′ extends from the downstream end wall 48′ of the chamber 40 toward the upstream end wall 48, but stops short. A downwardly extending wall 51 depends from the upstream edge of the bottom wall 49′ and defines together with a downward extension 52 of the upstream end wall 48 of the chamber, a chimney 54 through which tobacco is introduced into the chamber. The side walls 50,50′ are substantially parallel to the longitudinal axis of the chamber 40. The end walls 48,48′ are substantially transverse to the longitudinal axis of the chamber 40. The suction band 47 enters the chamber 40 through an entry port 56 in the end wall 48 and leaves the chamber 40 through an exit port 56′ in the end wall 48′. A fan (not shown) is provided to draw air through the chimney 54 and the suction chamber 40; tobacco is fed to the chimney and entrained in the air.

[0038] A rotary stepper motor 58, which includes a gearbox, is disposed outside the suction chamber 40 and attached to a side wall 50 of the chamber 40. The spindle 60 of the motor 58 passes through a hole 62 in the wall 50 of the chamber 40. The motor 58 is attached to the wall 50 of the chamber 40 so that the spindle 60 is free to rotate and so that no oil leaks from the motor 58 into the suction chamber 40 through the hole 62. The free end 64 of the spindle 60 is in the chamber 40 above the suction band 47 and above the bottom wall 49′. The free end 64 of the spindle is connected to the mounting end 66 of a finger 68 extending radially outward of the spindle. The free end 70 of the finger 68 contacts the upper surface of the suction band 47. An ecreteur 72 is situated below the suction band 47 and after the end 70 of the finger 68. A density determining means downstream of the suction chamber 70 determines the density...
of newly made tobacco rods (not shown) by a conventional beam attenuation method and sends a control signal to a
 weight control computer and thence to the motor 58.

[0039] Figure 7 shows in detail a first embodiment of the finger 68 and the motor 58. Figure 8 is an exploded view
of the components of the finger 68 and the motor 58 of the embodiment illustrated in figure 7.

[0040] The free end of the finger 68 defines a segment of a circle so that the surface of the finger 68 that contacts
the band 47 is curved. This finger shape has been found to prolong the life of the suction band 47. Preferably, the
surface of the finger 68 that contacts the band 47 is hardened or has a hard insert. More preferably the surface of
the finger 68 that contacts the suction band 47 is nitrided or coated with tungsten carbide or ceramic.

[0041] The finger 68 is mounted on the motor spindle 64 by a bolt 74 passing through an open ring 76 at the mounting
end 66 of the finger. A tolerance ring 78 fits between the open ring 76 and a housing 80 by which the motor 58 is
attached to the wall 50 of the suction chamber 40. An O-ring seal 82 between the housing 80 and the chamber wall
50 prevents air or tobacco passing between the housing and the chamber wall. A U-cup seal 84 between the motor
spindle 60 and the housing 80 prevents oil leaking from the motor 58 into the chamber 40 and prevents tobacco entering
the motor 58. Screws 86 attach the motor 58 to the housing 80. Screws 88 attach the housing 80 to the wall 50 of the
chamber 40. A reference point sensor (not shown) is disposed above the finger 68 and an over rotation sensor (not
shown) below the finger 68.

[0042] The motor may be of any type but is preferably a stepper motor or other proportional actuator device such as
a solenoid actuator or LVD device.

[0043] Figure 9 shows in detail a second embodiment which is similar to the embodiment of figures 7 and 8 but in
which the finger 68 is coupled to the motor 58 and gearbox by an extension shaft 90. An end 92 of the extension shaft
90 is hollow and accommodates the spindle 60 of the motor 58. The extension shaft is attached to the motor spindle
60 and extends from it towards the wall 50' of the chamber 40. The other end 94 of the extension shaft 90 passes
through the open ring 76 at the mounting end 66 of the finger 68. A cap 96 fits over the end 94 of the extension shaft
90 and abuts the mounting end 66 of the finger 68. The cap 96 is attached to the extension shaft 90 by a screw 98
that passes through the cap 96 and into the end 94 of the extension shaft 90. The cap 96 ensures that the finger is
retained on the extension shaft 90. In this embodiment, the housing 80 of the motor 58 extends into the chamber 40
through the hole 62 in the wall 50' towards the other wall 50 to form a hollow cylindrical sheath 100. The extension
shaft 90 passes through the hole 62 in the wall 50' towards the other wall 50 to form a hollow cylindrical sheath 100.
The extension shaft 90 passes through, and extends beyond the hollow cylindrical sheath 100. The distal end 102 of the hollow
cylindrical sheath 100 (relative to the motor 58) is adjacent to a tolerance ring 104 mounted on the extension shaft.
The tolerance ring 104 seals the gap between the distal end 102 of the hollow cylindrical sheath 100 and the mounting
end 66 of the finger 68.

[0044] As in the first embodiment, the O-ring seal 82 prevents air or tobacco passing between the housing 80 and
the chamber wall 50'. A U-cup seal 106 between the extension shaft and the hollow cylindrical sheath prevents oil
leaking from the motor 58 into the chamber 40 and prevents tobacco entering the motor 58. It will be appreciated that
the motor spindle and the extension shaft are protected from the abrasive effect of tobacco by the hollow cylindrical
sheath 100, the tolerance ring 104, the mounting end 66 of the finger 68, and the cap 96 which together cover the
motor spindle 60 and the extension shaft 90.

[0045] As in use, the suction band 47 is driven by the synchronised servomotor unidirectionally so that it moves relative
to the suction chamber 40 in a direction parallel to the longitudinal axis of the chamber in the direction shown by the
large arrow in figure 5. As the suction band 47 is driven, air is drawn into the suction chamber 40, by means not shown,
through the chimney 54. Tobacco (not shown) entrained in the air is drawn onto the suction band 47 upstream of the
bottom wall 49'. Excess tobacco drawn onto the suction band 47 is removed by the ecreteur 72 driven by a synchronised
servo motor. Tobacco remaining on the suction band 47 after trimming is formed into a continuous tobacco rod. The
density determining means measures the density of tobacco in the newly made tobacco rod by the conventional beam
attenuation method. If the density of the newly made tobacco rod is too high, the density determining means sends a
signal to the motor 58 and causes the motor 58 to rotate the spindle 60 clockwise (as the spindle is viewed along its
axis towards the motor 58). Rotation of the spindle 60 causes the finger 68 to rotate and the free end 70 of the finger
68 to move clockwise (viewed as before). Clockwise movement of the free end 70 of the finger 68 causes it to move
downwards towards the ecreteur 72. As the end 70 of the finger 68 moves towards the ecreteur 72, the suction band
47 moves towards the ecreteur 72. Movement of the suction band 47 towards the ecreteur 72 increases the amount
of tobacco cut away by the ecreteur 72. Consequently, less tobacco remains on the suction band 47 than before and less

[0046] If the density of the tobacco rod is too low, the density determining means sends a signal to the motor 58 and
causes the motor 58 to rotate the spindle 60 anticlockwise (as the spindle is viewed along its axis towards the motor
58). Anticlockwise movement of the end 70 of the finger 68 causes it to move upwards away from the ecreteur 72. As
the end 70 of the finger 68 moves away from the ecreteur 72 the suction band 47 remains in contact with the finger 68
and moves away from the ecreteur 72. Movement of the suction band 47 away from the ecreteur 72 reduces the amount
of tobacco cut away by the ecreteur 72. Consequently, more tobacco remains on the band 47 than before and more
tobacco is delivered by the band 47 to the tobacco rod, which is thus denser. The continuous tobacco rod is cut into double length tobacco rods.

Each time the apparatus is switched on, the finger 68 is set to a reference position sensed by the reference point sensor. The reference position is chosen so that the amount of excess tobacco removed from the suction band by the ecreteur is approximately correct. If the finger rotates too far towards the ecreteur, the over rotation sensor sends a signal to the motor 58 which then resets the position of the finger 68 to the reference position. The finger is prevented, therefore, from operating for prolonged periods in the wrong position.

Referring now to figure 10, the linear speed of the suction band 47 is defined by the length of the tobacco rod of the cigarette to be made and the production rate of cigarettes. The densed end is formed just before trimming, this is done by a single rotating cam that compresses tobacco in the stream.

The cam 110 rotates at one revolution per two linear cigarette lengths of travel along the suction band. The ecreteur or trimming discs 112 are set so that their peripheral speed is slightly greater than the linear rod speed and the height of the tobacco stream with respect to the trimmer discs 112 is controlled by the weight control unit (not shown). Trimmed tobacco is returned to the hopper by, for example, a spiral screw and shaker tray transport mechanism.

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The trimmed tobacco, with formed densed ends, is then passed to a garniture 114 where the tobacco rod is made up. The garniture includes a belt driven by a synchronised servomotor which draws wrapping paper 116 from a bobbin. The stream of tobacco is deposited on this paper and the rod is formed by the shape of the garniture which wraps the paper around the tobacco stream. Adhesive from a reservoir is applied to the edge of the paper by an applicator nozzle 118, the adhesive is set by passing the rod under a temperature controlled heater bar 120. At this point, the machine is making a continuous cigarette rod with densed ends at either one tobacco or two tobacco lengths along it.

The cigarette wrapping paper fed into the garniture is drawn off the bobbin by a pair of pinch rollers. The average linear speed of the paper must equal the linear speed of the garniture belt. However, when a bobbin is exhausted it is necessary to stop the paper to splice automatically the next paper bobbin. To achieve this, the bobbin speed is increased before the splice to fill a paper reservoir to enable constant running of the rod maker during the splice operation. After the splice, the bobbin speed is increased gradually to a linear speed just below garniture speed to exhaust the paper reservoir. When the reservoir is exhausted the paper speed will be increased until it again equals the garniture speed. The bobbin drive may be an independent servo drive which receives machine speed signals from the master axis drive on the machine and uses a further signal from a dancing arm to apply speed correction by sensing paper tension.

The cigarette paper is then passed through a printer on its way from the bobbin to the garniture at which stage manufacturer's information such as brand name is printed by a print wheel on to the cigarette. The print wheel may have four impressions and is therefore controlled to rotate once every four rod lengths. The printer may have its own synchronised servo motor. This permits the print position to be advanced or retarded, to improve quality, not by changing the length of the paper run, as is done conventionally, but by changing the phase between the printer and garniture tape servo motors through software parameters.

The finished continuous rod is then passed to a knife cut-off unit 124 which includes a knife blade mounted on the periphery of a rotating drum. The drum is driven by a servomotor to which the linear drive speed is synchronised such that drum rotates once every two cigarette rod lengths so as to cut the rod stream into double length rods. It is essential that the cut is through the centre of the densed end. Thus, there is an exact relationship between the garniture belt drive, the dense end cam and the knife, both in relative speed and position.

The rod must be running at a constant speed with respect to the cutter otherwise the cigarette length will vary. However, as the cigarette length may vary, from brand to brand, changing the rod length is achieved by changing software parameters which define the speed and position relationships of the respective servo drives.

The cutter includes a mechanical sharpening and deburring system to keep the knife blade sharp after each revolution. A knife advance mechanism maintains knife position replacing lost knife material during grinding and deburring operations.

The continuous rod is supported during the cutting operation by a conventional ledger 126.

Before the cut, the tobacco rods are passed through a nucleonic or other density measuring device 122. The rod density is measured electronically and any deviation from predetermined limits will cause the band above the ecreteur discs to be raised or lowered accordingly. The rods then pass a sensor which causes the first few rods of a run to be ejected to maintain quality control. The rods then pass to a kicker wheel which accelerates the rods to a transfer apparatus for transfer to the tipper. The kicker rotates once per two cut lengths (that is per two double length rods) and its diameter is such that the rotational speed of the periphery is higher than the linear rod speed to achieve the acceleration. The kicker, shown in figures 11 to 20, picks the rods off the rail and transfers them to the receiving drum of the transfer apparatus. The kicker shown in figures 11 and 12 is a helical kicker and the kicker shown in figures 13 to 20 is an in-line kicker. Either may be used.

The receiving drum has a cover and receives rods from the kicker at high speed. The rods are received in
flutes on the drum and decelerated and held by a series of suction holes along the length of the flutes. The flutes have flared ends to make it easier for the rods to be received from the kicker in the flutes.

The kicker assembly comprises a main housing 200 which is mounted on the rod maker. At an end of the housing is a drive 210 which is driven from the rod maker drive via a shaft at the far end of the housing (not shown) through a timex pulley and belt (not shown). The drive transfers drive via a drive belt 212 to a second, kicker shaft 214. Both the drive shaft and the kicker shaft have toothed belt wheels 216 on which the drive belt is mounted. The belt 212 is retained inside a belt housing 218 to which is fixed a suction housing 220. The belt housing is pivotable about the drive 210 to set the kicker wheel at the correct height above the rod maker vee-rail. Attached to the belt housing is a bar 217 to which is fixed a guide plate 219. The guide plate is held above the vee-rail behind the kicker wheel and prevents the trailing ends of rods flicking up as the leading edge is picked up by the kicker wheel. It also acts to keep the rods in line. The suction housing is shown in figure 20 and comprises a solid flange having a central aperture 222 and a hub 224 which is connected to the belt housing. A suction passage 226 is formed in the periphery of the flange at a position between the central axis of the flange and the front face. The suction passageway passes through the flange to a suction reservoir 228 or the rear of the flange. The reservoir 228 is provided to ensure a constant suction as will be described. The reservoir 228 is connected to a suction pump (not shown).

At a position adjacent and slightly behind the suction aperture (in the direction of rod movement) is a second passageway 229. This passageway 229 is a rod release passageway and is connected to an air supply (not shown) at the rear of the flange, the rod release passageway 229 passing through the flange approximately parallel to the suction passageway. The air supply pushes air through the rod release passageway to break the suction applied by the suction passageway to release rods from the kicker.

Over the suction flange, which is static, is arranged a kicker wheel 230. The kicker wheel comprises a front face 232, a peripheral flange 234 and a hub 236. The hub passes through the central aperture 222 of the suction flange and is fixed to the kicker shaft 214 for rotation therewith. The peripheral flange is not continuous but divided into two sections of equal length by a pair of flats 238. Each flange section has a groove 240 running along its length with a series of equally spaced holes 242 formed at the base of the groove. The grooves are arranged off the centre of the flange such that they overlie the suction and rod release passageways of the suction flange, and such that when mounted on the housing, the grooves overlie the centreline 250 (fig 13) of tobacco rods on the vee-rail of the rod maker.

In use, the kicker wheel 230 rotates above the rods on the vee-rail. The suction provided through the holes in the grooves picks individual rods from the rail and the rotation of the kicker wheel accelerates the rods towards the receiving drum. The reservoir in the suction flange ensures that the suction is maintained. As the suction is communicated through holes in the groove, the suction is effectively being switched on and off as the holes pass over the suction aperture. The reservoir mitigates against a loss of suction which might cause a rod to be released from the kicker. This is particularly important with double length rods whose increased weight requires a greater suction.

A rod will be released from the kicker when a flat on the kicker periphery passes over the suction passageway releasing the suction. However, there is a tendency for there to be some residual suction which can lift the tip of the rod. As can be seen from figures 11 and 12, the clearance between the flutes of the receiving drum and its cover is small and a raised tip could be damaged by the cover or, in the worst case, be prevented from entering the receiving drum causing the whole manufacturing line to break down.

The air blown through the rod release passageway ensures that any residual suction is broken and that the tip of the rod is exactly parallel with the receiving drum flutes when it is released. This ensures that the rod is successfully transferred from the vee-rail to the receiving drum.

Referring to Figures 21 to 25, the rods from the kicker are passed to a receiving drum 334. Rods are introduced onto the receiving drum from a direction parallel to the axis of rotation of the drum. Alternatively, a helical kicker could be used which would transfer rods in the same direction. The receiving drum is a fluted drum having 18 tapered flutes 336 around its periphery, each of which receives an individual rod from the kicker 232. The outer sleeve of the receiving drum is shown in figure 24.

A conventional receiving drum has 36 flutes. The 18 flutes of the drum 334 have mouths which are wider than conventional flutes facilitating transfer from the kicker at high speeds. It will be appreciated that to operate at 8000 cpm, the receiving drum must rotate at 222.2 rpm giving a capacity of 4000 double length rods per minute.

Each of the flutes has a tapered receiving end 338 which assists in guiding the rod into position. It will be appreciated that the angle of the taper may be selected to provide the best transfer within the constraint of having 18 wide flute mouths 340 around the periphery of the drum. Thus, the flutes are formed of two portions, a rod braking and holding portion 341 which is narrow and sufficiently long to hold a double length rod and a tapered portion 338 which is shorter than the rod holding portion and tapers from the mouth 340, at which it is several times the width of the narrow portion, to the rod holding portion.

The rods arrive at the drum from the kicker at high speed. The flutes include a row of vacuum holes 347 through which air is sucked to brake the rods and to hold them in position in the drum. Preferably, the vacuum holes extend along the length of the rod holding portion into the tapered portion of the flute along the centre longitudinal axis.
A back cutting plate 370, having apertures 372, 374, 376 is arranged on the front of the housing 352 so that upper aperture 372 and central aperture 374 overlie corresponding apertures 378, 380 in the housing for the interme-

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500
diate and cutting drums respectively. The back cutting plate is positioned between the housing and the intermediate and cutting drums. All of the drums include suction housings to enable the rods to be held in their flutes. Suction housing 382 for the intermediate drum is received in location aperture 378 in the transfer housing 352 and the intermediate drum is arranged on the suction drum. A location ring 386 is provided to enable a conventional Max 80 receiving drum mounting to be used with the intermediate drum. The location ring is necessary as the Max 80 receiving drum is intended to be used with a variable height Hauni Spider, as a result of which the drum mounting plate, here the back cutting plate 370, is designed to pivot about the cutting drum. That plate is now fixed ensuring constant centres.

[0083] Suction housing 383 for the separation drum locates in location aperture 384 in the housing.

[0084] The drive for the receiving drum and the suction for all the drums are conventional and are not described here.

[0085] The arrangement of the flutes in the various drums is such that the rods pass along the centre line of the transfer point. The use of chamfered or tapered flute leads of twice the normal width, and the accompanying reduction in the number of flutes, together with the increased length of receiving drum and the use of vacuum holes along the entire length of the flutes results in a transfer apparatus that can reliably transfer double length rods using a kicker rather than a spider.

[0086] The tipper is shown schematically in figure 26. This diagram also shows elements of the transfer apparatus which have the same reference numerals and will not be described again. The tipper 400 includes a hopper 402 which holds a reservoir of filters for supply to the filter drum. The filter hopper may be fed manually from trays or automatically from automatic trays or from a plug shooter. The filter rods in the hopper may be of four or the six up configuration, that is four filter tips per rod or six filter tips per rod which means they will be cut into two or three double length rods to be inserted between the separated single length rods on the filter assembly drum. Thus each six up filter rod will eventually provide the filters for six cigarettes. The filter rods are deposited into the grooves of a filter cutting drum 404 from the hopper where they are cut by knives into two or three double length filters which are inserted between the cigarette rods on the filter assembly drum.

[0087] The tobacco rods are joined to the filters by tipping paper which is supplied from a bobbin 408 which is loaded manually on to the tipper. The tipping paper is drawn from the bobbin by a drive roller 410. The bobbin has a free end which is fed into a splicer unit. Splicing of the full bobbin onto the end of an expended bobbin is carried out automatically. As a consequence the machine does not have to stop to replenish bobbins. Loading of the bobbins is manual.

[0088] The tipper also includes a gluing unit 412 which supplies glue from a reservoir to the tipping paper which is then cut into single length strips by an arrangement of 11 or 8 knives. Individual glued strips are then fed on to the rod/filter-rod combinations on the swash plate drum. A heated rolling block is then used to wrap the tipping paper around the rod/filter tip combinations and to set the adhesive to make a double length cigarette. The double cigarette is then cut through the centre line of the filter to form two single length cigarettes which are opposed. The cutting drum includes a rejection port through which can be rejected rod pairs in between which no filter has been inserted. Also rejected are tipped cigarettes which include the cigarette wrapping paper splice or the filter tipping paper splice. The finished cigarettes on one side of the machine are passed to a turning drum which reverses the cigarettes so that all the cigarettes are facing the same direction. This facilitates further processing.

[0089] After the tipping unit, the finished cigarettes are passed to an inspection unit which comprises an inspection drum where the cigarettes are subjected to a leakage test to check for holes or imperfections in the paper. This test is carried out by blowing compressed air through the cigarette and measuring the pressure drop across the cigarette. The compactness of the cigarette and the presence of a filter is checked, for example, by an optical or capacitance sensors. Any rod that fails either of these tests is rejected and ejected off the inspection drum. As an optional additional test dilution tests may be made to test the effectiveness of the attached filter to allow air to be drawn through its side perforations. After the inspection drum, cigarettes that have not been rejected are passed downstream to a tray filler or other processing unit which does not form a part of the present invention.

[0090] Conventional rod makers and tippers are driven from a single drive from which are taken a variety of secondary drives through appropriate reduction gearing. This is very bulky and inflexible. The combined rod maker and tipper embodying the present invention dispenses with that arrangement and uses a number of separate drives which are interconnected and controlled by a dedicated motion controller. The rod maker and tipper are controlled by the same PLC controller.

[0091] Figures 27, 28 and 29 show, respectively, the location of the principal motors in the rod maker and the tipper respectively. Tables 1 and 2 below show, respectively, the listing and function of each motor in the rod maker and the tipper.
It should be appreciated that although the system has been described in terms of servo motors, non-servo motors could be used as some degree of control can still be achieved using a conventional variable speed motor with a speed control signal. Alternatively, motors using embedded intelligence may be used to provide synchronisation.

Referring now to figure 29 the positioning of the motors referred to in Table 2 can be appreciated. The main drive motor can be a synchronous servo motor. The other motors on the tipper are standard fixed speed motors. Figures 27 and 28 show the equivalent situation for the rod maker although some of the motors are omitted for clarity.

A preferred embodiment of the control system comprises the following main elements:

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**Table 1:**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2</td>
<td>Large Fan Motor</td>
</tr>
<tr>
<td>M3</td>
<td>Small Fan Motor</td>
</tr>
<tr>
<td>M4</td>
<td>Oil Pump Motor</td>
</tr>
<tr>
<td>M6</td>
<td>Hopper Motor</td>
</tr>
<tr>
<td>M8</td>
<td>Tobacco Return (vibrating tray) motor</td>
</tr>
<tr>
<td>M9</td>
<td>Cut-off cooling fan</td>
</tr>
<tr>
<td>M10</td>
<td>Cut-off cooling fan</td>
</tr>
<tr>
<td>M10.1</td>
<td>Cut-off cooling fan</td>
</tr>
<tr>
<td>M11</td>
<td>Control cabinet cooling fan</td>
</tr>
<tr>
<td>M12</td>
<td>Hopper Tangential Feeder motor</td>
</tr>
<tr>
<td>M14</td>
<td>Hopper Tobacco Delivery Roller motor</td>
</tr>
<tr>
<td>M15</td>
<td>Bobbin changer Capstan motor</td>
</tr>
<tr>
<td>M17</td>
<td>Weight control motor</td>
</tr>
<tr>
<td>M19</td>
<td>Tipper dust extractor</td>
</tr>
<tr>
<td>M21</td>
<td>Cut off motor (master for motion control) - drives cut-off knife drum</td>
</tr>
<tr>
<td>M22</td>
<td>Ecreuteur motor (position synchronised) - drives dense end cam and ecreuteur discs</td>
</tr>
<tr>
<td>M23</td>
<td>Printer motor (position synchronised) - drives print die wheel</td>
</tr>
<tr>
<td>M24</td>
<td>Tape drum motor (velocity synchronised) - drives garniture tape drum</td>
</tr>
<tr>
<td>M25</td>
<td>Suction chamber motor (velocity synchronised) - drives suction tape</td>
</tr>
<tr>
<td>M26</td>
<td>Hopper motor (velocity synchronised) - drives hopper carded drums</td>
</tr>
</tbody>
</table>

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**Table 2:**

<table>
<thead>
<tr>
<th>Electrical Reference</th>
<th>Motor Description</th>
<th>Motor Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tipper main drive motor (TMDM)</td>
<td>Position Synchronised to Cut off motor Bobbin Swivel</td>
<td>Drives complete tipper gear train Swivels the bobbin plate Provides drive for glue rollers</td>
</tr>
<tr>
<td>M3</td>
<td>Glue Stirrer</td>
<td>Glue Feed</td>
</tr>
<tr>
<td>M4</td>
<td>Glue Pump</td>
<td>Provides Suction for tipping drum</td>
</tr>
<tr>
<td>M7*1</td>
<td>Fan</td>
<td>Drives knife 1 (filter)</td>
</tr>
<tr>
<td>M9*1</td>
<td>Vacuum Pump</td>
<td>Drives knife 2 (tobacco rod)</td>
</tr>
<tr>
<td>M9*2</td>
<td>Knife 2</td>
<td></td>
</tr>
</tbody>
</table>

---

[0092] It should be appreciated that although the system has been described in terms of servo motors, non-servo motors could be used as some degree of control can still be achieved using a conventional variable speed motor with a speed control signal. Alternatively, motors using embedded intelligence may be used to provide synchronisation.

[0093] Referring now to figure 29 the positioning of the motors referred to in Table 2 can be appreciated. The main drive motor can be a synchronous servo motor. The other motors on the tipper are standard fixed speed motors. Figures 27 and 28 show the equivalent situation for the rod maker although some of the motors are omitted for clarity.

[0094] A preferred embodiment of the control system comprises the following main elements:
1. The machine controller;
2. The motion controller and servo motors;
3. The fieldbus connecting sensors, pneumatic valves and some motor drives to the machine controller;
4. The HMI; and
5. Inspection and rejection.

[0095] The machine controller comprises two PCS running the Windows NT (TM) operating system and configured such that one is a server and the other a client. Other operating systems such as WIN CE may be used. The PCs communicate via TCP/IP and Ethernet. The controller software controls both the maker and the tipper using standard PLC functions but without a PLC. The PCs communicate with the machine devices via the fieldbus.

[0096] The motion controller and servo motors provide synchronised control of servo motors on multiple axes by an advanced motion controller. Each axis is programmable for motor characteristics, speed, position and phase relationships. Synchronisation between motors relies on high speed communications between each axis controller which is independent of the fieldbus.

[0097] The fieldbus connects devices and I/O terminals to the machine controller via a single cable. Sensors attach either directly to the fieldbus cable or to connector blocks on the cable. Pneumatic valves may be attached to the fieldbus via their own interface in their valve island block and other motor drives and the motion controllers connect directly to the cable.

[0098] The HMI provides an easy to use, graphical interface for the operation, maintenance and configuration of the machine. In a preferred embodiment it uses a touch screen for operator command entry. The HMI provides on screen buttons, sliders, keyboards etc. for input of data and commands to the machine, as well as on-screen messages, gauges, digital displays, graphs, reports etc. to provide information to the operator. It also includes a database for multilanguage messages and for historical records.

[0099] Inspection and rejection systems are controlled by an independent, dedicated programmable controller which interfaces to the machine controller and HMI for parameter settings and performance display.

[0100] The motion control, fieldbus and HMIs aspects of the control system will now be described in greater detail.

[0101] Motion Control. It will be appreciated that the synchronised servomotors are all synchronised to the cut off motor M2 which is the master for motion control. Alternatively, synchronisation may be to a virtual axis. The relationship between garniture belt speed and the cut-off motor speed determines the length of the cut tobacco rod. The ecreteur and printer motors are speed and position synchronised with the cut-off motor and the tipper main drive motor is position synchronised with the cut-off motor. The Tape drum motor, the suction chamber motor and the hopper motor are speed synchronised with the cut-off motor.

[0102] In conventional making machines, these motors have been fixed by complex arrangements of gear boxes, shafts, drive belts etc. to support the various main functions controlling the product. By using a motion control system, the one main drive motor and associated drive system may be eliminated. Instead, a number of drives axes are used as the optimum solution between a totally mechanical and totally electrical system. It will be appreciated from tables 1 and 2 that the preferred embodiment has 7 axes, 6 in the maker and 1 in the tipper. Of course, other numbers are possible and other motors may be introduced on separate axes. Use of motion control has the obvious advantage of eliminating some costly gearboxes, but also reduces maintenance, reduces build time and reduces noise. This is especially important in the context of increasing production speeds. Furthermore, motion control allows the phase relationship between the various axes to be used as an alternative to mechanical settings to give much more accurate results in much less time. It allows almost infinite tuning of the relationship between the axes. For example, the mechanical relationship of the tipper catching drum to the cigarette maker is greatly simplified. Moreover, the relationships between the various axes can be varied dynamically. Thus in the example given above, the phase relationship of the catcher drum could be varied according to the machine speed to ensure optimum transfer. A further advantage is the ability to change rod length without changing parts. Usually a change in rod length would signify a change to production of a different brand. This requires a different label to be printed onto each rod. The print label could be changed electronically using ink jet printing techniques and the relative position on the rod as well as the rod length can both be adjust by varying the relationships between the axes under motion control.

[0103] The motion control comprises the seven motors identified earlier each with a motor controller mounted on a backplate with a dedicated processor. The control could alternatively be embedded in the motor. The processor is programmed to synchronise and phase control the motors via their individual controllers and information on phase and speed is fed to the motion processor via a dedicated high speed transmission line. As will be explained, the motion controller may also be connected to the field bus so that it can receive control signal such as stop, start, jog etc. and parameter signals such as speed, phase, etc. and can send status signals to the system. The other motors which do not form a part of the motion control system are connected to the fieldbus either via their controllers or via their direct on-line starters.

[0104] Fieldbus. The fieldbus consists of a cable routed around the maker and the tipper to form the backbone of
the control system. The controllers and the controlled elements connect to this cable. The flow of signals is controlled by a software protocol. The presently preferred protocols are DeviceNet (TM) and Profibus (TM). This protocol controls signal flow between elements connected to the fieldbus to enable specific signal to be routed to and from specific devices. In the DeviceNet protocol, each signal is a packet containing 8 bytes of data. The packet is preceded by a header which contains information about the content of the message and its priority. Other devices on the fieldbus will be programmed to certain message contents and so will accept or not the message depending on the content of the header. The priority content ensures that only one device transmits at a time. In this way the control system may be configured such that a central controller, typically a PLC or a PC may control all functions or may be configured such that no central controller exists and intelligent devices communicate with other intelligent devices using peer to peer communications; these devices then perform the control functions related to their own applications.

[0105] The devices connected to the fieldbus may be similar to conventional devices with the addition of a processor whose function is to code information for transmission and to decode message the device needs to receive. Thus, for example, a switch would need to transmit information as to whether it is operated or not and possibly diagnostic information such as whether its operating surface is dirty, whether it is overheating, is receiving too much vibration etc. On the other hand, a motor could transmit information such as speed, torque, direction of rotation, power temperature etc. The motor may also receive information such as start, stop, jog, change speed or direction etc. Devices that do not have the necessary processor embedded may still be connected to the fieldbus but will require an interface which will handle coding and decoding. Of course in that case, the device cannot produce diagnostic information.

[0106] Figure 30 shows an overview of a first embodiment of the control system. A field bus 500, connects six main system blocks: the maker 502, the maker cabinet 504, the tipper 506, the tipper cabinet 508, the inspection unit 510 and the control system 512. The maker cabinet includes the maker HMI 514, a number of blocks of sensors, here shown as sensor blocks 516, 518 and 520, and a block of pneumatic valves 522. Each of the sensor blocks, the valve blocks and the HMI are connected to the fieldbus 500. The maker cabinet 504 has a number of variable speed drives and a maker machine controller each attached to the fieldbus. In the figure, variable speed drives 524-530 are shown for the picker/winner, large and small fans and tobacco return. In the tipper, the tipper HMI 532 is connected directly to the fieldbus as are drives block sensors 534, glue area sensors 536, pneumatic valve clutches 538 and pneumatic auto cleaning valves 540. In the tipper cabinet, the tipper machine controller 542 is connected to the fieldbus 500. In the inspection unit, a DeviceNet scanner 544 is connected to the fieldbus. Connected to the Scanner 544, which acts as an interface, is an inspection and rejection controller 546.

[0107] A DeviceNet manager 548 is also connected to the fieldbus. Of course, this manager is chosen according to the fieldbus protocol being used. Finally a central controller 550 is also connected to the fieldbus. This central controller 550 has overall control over all machine functions over the fieldbus. The central controller 550 has VGA, keyboard and mouse inputs 551, which are also attached to a further PC 552 for programming input and to a data capture device 554 which is connected to the DeviceNet manager 548 via a local Ethernet 556.

[0108] The synchronous motor motion controller 557 is connected to the central controller 550 via a remote I/O link 558. It will be appreciated that the motion controller is not connected to the fieldbus. Thus, for example, operating parameters input via the HMIs, which themselves may be accessed remotely are received first by the central controller which can send them to the motion controller if appropriate. Control of speed and phase of the synchronised motors is therefore separate from the HMI functions.

[0109] Figure 31 illustrates an alternative control arrangement. In this figure the two HMIs, shown as operator control touch screens 560, 562 are connected by a graphics cable link to the central machine controller 564 and are kept remote from the fieldbus or control network 566. Although one of the HMIs 560 is shown dissociated from the maker cabinet, there is still one HMI for the maker and one for the tipper. The machine controller is connected to management supervisory systems 568 and to the factory network 570 via an Ethernet link. In the maker and tipper cabinets, the valves and various I/O devices are all connected to the control network before. However, in addition, the motion controller 572 is also connected to the control network. It will be appreciated that the HMIs are still separated from the motion control by the overall machine controller 564. In figure 31, a representative selection of maker functions are shown connected to the control network. This is not exhaustive.

[0110] HMI. Two HMIs are required providing different functions, one for the tipper and one for the rod maker. This gives rise to the need for two PCS. The PCS are configured such that the database and one HMI process reside on the server PC and the other is configured as a client.

[0111] The HMI software, in addition to displaying machine control and message functions allows the integration of other PC applications for historical data analysis, performance reports to networked PCS or systems and on line diagnostic and help facilities such as parts catalogues, operator manuals, expert systems and operator training videos.

[0112] The HMI uses open technologies to allow maximum connectivity and use of technologies such as the Internet and Object based programming. This may be utilised to connect to other applications within the factory for maintenance tracking and to a central parts supplier for predictive maintenance and parts ordering. Other applications are, of course possible and will occur to those skilled in the art.
A separate HMI is provided on both the tipper and the rod maker although a single HMI could be used. The HMIs are each controlled by a PC which may be connected through a TCP/IP link for example to a remote LAN. This gives rise to the possibility of accessing the controllers of the tipper and the rod maker from a remote location possibly not even in the factory. The HMIs provide the system supervisor with a software interface to the cigarette making machine. The HMI displays comprise a configurable selection of function buttons, which may be displayed on, for example, a touch sensitive display screen. An operator can input a password from a keypad which will give access to one of a hierarchical set of control levels. For example a master password gives complete access to the system whereas a more restricted access may only allow the user access to certain control functions. As an alternative to a keypad, passwords or user identifiers may be stored on swipe cards or other identification devices and the HMI provided with a suitable card reader. The HMI may be implemented as a PC with a suitable interface to the machine controller.

Figures 32 to 36 show examples of HMI screens which are presented to the operator. Many of the user selectable features are represented as push buttons. These are areas of the screen which perform a function equivalent to a push button when selected by the operator. As can be seen from the shading of the buttons shown in the figures, different types of function may be displayed as different coloured buttons. For example, each of the following functions may be represented by a different colour: change to another screen; stop a function that is presently running; start a non-running function; inching (very slow movement of a component such as a motor); fault reset; and miscellaneous. At any given time, the HMI will only display to the operator a fraction of the available information, or the available controls. Figure 37 shows the relationship between various different screens which could be presented to an operator with the appropriate level of clearance. It will be clear to those skilled in the art that figure 37 only shows a few of the screens which could be displayed.

The screen shown in figure 32 is the main menu. The information is presented on four rows. The first row 420 is for message display. In figure 32 this informs the operator that the machine is stopped having detected a fault in the roll block heater which is outside its preset operating range. The message row would also display the machine speed in cigarettes per minute if the machine was running.

The second row has only a FAULT RESET button 422 by which the operator resets the machine after a fault has been cleared. The third row has a STOP button 424, selection of which causes the machine to come to a controlled stop; and a SUCTION CHAMBER GUARD 426.

The fourth row has, from left to right, the following buttons:
- PREPARE MAKER 428
- PARAMETER ADJUST SCREEN 430
- PHASE SHIFT SCREEN 432
- MAINTENANCE MODE SCREEN 434
- ADVANCED DIAGNOSTICS SCREEN 436
- GO TO CONFIG SCREEN 438

The PREPARE MAKER button 428 selects the prepare maker screen shown in figure 33. The PARAMETER ADJUST SCREEN button 430 selects the parameter adjust screen shown in figure 34. Selecting the PHASE SHIFT SCREEN button 432 takes the operator to a phase shift screen shown in figure 35. Selecting the MAINTENANCE MODE SCREEN button 434 takes the operator to a maintenance mode screen and selection of the ADVANCED DIAGNOSTICS SCREEN and GO TO CONFIG SCREEN buttons 436, 438 takes the operator to advanced diagnostics and go to configuration screens respectively.

Turning to figure 33, the first row of the prepare maker screen is similar to that of the main menu but additionally includes a display of the present heater temperature. On the second row, in addition to the FAULT RESET button are MAKER FANS, TOBACCO FEED, HOPPER and GARNITURE TAPE buttons 440, 442, 444 and 446. Each of these four buttons turns the respective item on or off when selected. The third row of the screen has, in addition to the suction chamber guard button displayed on the main screen, ROD HEATER ON, HEATER DOWN, MANUAL GLUE and SUCTION CHAMBER TENSION buttons, 448,450,452 and 454. The ROD HEATER on button switches on the rod heater and the HEATER DOWN button brings the heater down allowing lap and heater settings to be checked. The MANUAL GLUE button switches the glue supply on and off and the SUCTION CHAMBER TENSION button allows the suction tape tensioner to be switched on and off. When off, the tape can be removed and changed. The SUCTION CHAMBER GUARD button turns the suction chamber guard on and off.

The fourth row of the prepare maker screen has a MAIN MENU button 456 which returns to the main menu, and buttons 458, 460 RUN MAKER IN MANUAL and RUN MAKER IN AUTO which take the operator to manual/automatic running screens (not shown). The RUN MAKER IN MANUAL button will only operate if the software detects that the MAKER FANS button 440 is on, and the RUN MAKER IN AUTO function will only operate if the MAKER FANS, TOBACCO FEED and HOPPER buttons are in an on position.

The PARAMETER ADJUST screen in shown in figure 34. This allows the operator to adjust certain parameters of the rod maker from the HMI simply by pressing the relevant areas on the screen. The information on the PARAMETER ADJUST screen is divided into five rows. On the first row are buttons INCH SPEED, MAKER HEATER and CIGARETTE
LENGTH 462, 464, and 466, for adjusting the inch speed, the temperature of the maker heater and the cigarette length respectively. On the second row are buttons LOW SPEED, HEATER MAKER STOP HIGH LIMIT and MAKER HOPPER SPEED 468, 470 and 472 for setting low running speed (in cigarettes per minute), for automatically stopping the maker heater when the temperature reaches the set level, and for setting the hopper speed. On the third row are buttons 474, 476 PRODUCTION SPEED and MAKER HEATER STOP LOWER LIMIT for setting production speed and the lower limit of the maker heater. The sole button 478 on the fourth row MAINTENANCE SPEED sets the machine speed for running during maintenance operations. On the fifth row, the sole button 480 PREVIOUS SCREEN returns the user to the previous screen.

[0121] Figure 35 shows the phase shift screen. This display has four rows of buttons, the first two of which perform self explanatory functions. On the first row are PRINTER ADVANCE, ECRETEUR ADVANCE and TIPPER ADVANCE buttons 482, 484 and 486. On the second row are PRINTER RETARD, ECRETEUR RETARD AND TIPPER RETARD buttons 488, 490 and 492. On the third row is a PHASE ADJUST button 494 which allows the operator to select the amount by which the selected axis from one of the first two rows is adjusted. Typically the adjustments will be in increments of 0.1mm. The fourth row has PREVIOUS SCREEN and STOP buttons 496 and 498.

[0122] The screens illustrated are all examples of maker HMI screens. It will be understood that the tipper HMI displays similar screens as appropriate to the tipper functions. The PREPARE TIPPER screen is shown at figure 36.

[0123] Figure 38 is a flow chart which explains the major control steps of the controller. The controller, which is separate from the HMI may typically be a PC using control software applications running under Microsoft Windows NT, or a display panel.

[0124] On initialisation, once the controller has established that the machine is ready to start (at 700), the controller performs a start up routine at 702 and then actively monitors the cigarette production speed at 704. The production speed may be input through the HMI with other production data such as tobacco rod length, tobacco density and print position. In practice, most of these variable are fixed for a given brand of cigarettes and the operator can simply enter through the HMI the brand of cigarette to be manufactured. The combined tipper and rod maker described can operate at speeds of up to 8000 cigarettes per minute (cpm).

[0125] At any time during production, the operator can stop the machine. At step 706, the controller looks for an indication of a manual stop and if one is detected stops production and causes that information to be sent to the HMI for display. The controller then keeps looking for a reset command which, when received causes the controller to return to the beginning of the control process. At Step 708 the controller monitors the data on the fieldbus for an emergency stop signal which may be received from one of the devices on the fieldbus, for example in the event of an actual, or impending catastrophic failure of a component. At step 710 the controller monitors the data on the fieldbus for an indication of a fault condition. In either steps 712 or 714 the controller will cause production to be halted and look for a reset command in the same manner as with a manual stop.

[0126] The smart devices plugged into the fieldbus may be capable of distinguishing between a condition which requires the production line to be halted, and a fault which requires fixing when convenient. At step 716, the controller looks for warning signals put on the fieldbus by any of the devices and relays this warning to the HMI, for example to be displayed, printed or otherwise drawn to the operator's attention. At step 718, having failed to find any reason that requires the production to be stopped, and after any warning messages have been sent to the HMI, the controller at steps 720 and 722 looks for information from sensors located at the wrapper paper bobbin and the tipping paper bobbin to determine whether either of the bobbins need to be changed. If one does, the controller checks to see that a fresh bobbin is present and then, at step 724 or 726, runs the appropriate splice routine which will involve controlling the speed of the bobbin to gradually bring it up to the manufacturing speed while monitoring the condition of the paper reservoir.

[0127] At step 728, the controller looks to see whether there is data on the bus from the HMI and, if so, acts on it and communicates that fact to the HMI. At step 730 the controller sends data on the fieldbus to the HMI that does not fall into the categories described above and which might be required, for example operating data such as running speeds, output rates, reservoir levels, temperatures etc.

[0128] Figures 39, 40 and 41 are flow charts of the start up process and help to understand how the HMIs and the control PCS interact. When the operator begins the start up routine at step 900, the software first checks at step 902 that all emergency stops on the system are unlocked. Then at step 904, it checks that all guards and covers on the tipper and the maker are closed. At step 906 it checks that the compressed air supply is on and at step 908 and 910 it checks that the appropriate maintenance and cleaning schedules have been followed. Finally at step 912 the main isolators are checked and if on, the software enters the tipper start procedure at which point the operator selects the prepare tipper screen of figure 31. The tipper start procedure commences by checking, at 914 and 916, that the glue supply and tipper paper are in order. If they are, the operator selects from the HMI screen, at steps 918, 920, 922, 924, 926 and 928, the ROLL BLOCK, TIPPER FANS, GLUE ROLLER, KNIVES MOTOR, AUTO/MANUAL and INCH to turn each function on and select between automatic and manual operation. The INCH function will advance the tipper until it is determined, at 930, 932, that the tipper paper feed is in the correct position and the filter plugs are on the feed
At that point the software can proceed to the maker start routine illustrated in figure 35. The operator initially selects the display language at the HMI, at 934 and then presses, at 936, the prepare maker screen from the main display. On the prepare maker screen, the operator then switches on the maker fans, the tobacco feed, and the hopper at steps 938, 940 and 944. At 946, the operator loads the bobbin with paper and threads the paper through the printer and then, at 948, selects INCH from the HMI display whereupon the drives are slowly moved round until the software detects that tobacco is available at 950 at which point paper is fed along the garniture and the print lever engaged at 952. When it is found that all materials are feeding correctly, at 954, the operator can select at 956 the RUN MAKER IN AUTO button from the prepare maker screen and the run automatically from the AUTO RUN screen.

The cigarette rod maker and tipper described, and the method of control have a number of advantages over prior art systems. The use of synchronous drive motors eliminates the need for noisy inefficient gearboxes running off a central motor facilitating an increased running speed. Moreover parameters such as print position, and dense end position can be moved as a control operation related to the printer or cam phase. This means that these parameters can be adjusted with reduced production stoppage time. This results in an improvement in quality which can reduce production costs. As well as giving higher operating speeds, the use of synchronous servo motors is much less noisy which contributes to a more benign working environment. In addition the energy requirements are much lower. A further advantage of the system is that by dispensing with a greater part of the mechanical linkages, the mean time between failures is increased. The use of a PC based HMI and smart sensors and other devices also reduces the mean time to repair as diagnostics information is available at the HMI. The HMI can also identify the particular component which requires replacing by use of an on-line catalogue. This in turn can reduce the size of inventory that has to be carried.

As the HMI can be connected by a TCP/IP link to an Intranet or LAN, remote diagnostics are possible as well as remote repairs and upgrades. In addition, factory data can be downloaded from a central source to one or a number of machines. This, may include information such as master clock, shift times, brand data etc. Furthermore, the HMI can be programmed to carry instructional information which can used to inform operators, for example, about aspects of the machine control which they would rarely encounter, or to run interactive training programs, for example on CD-ROM or training videos for new operators.

Claims

1. A cigarette manufacturing apparatus comprising:

   a tobacco rod maker for making double length tobacco rods;
   a tipper (400) for applying filters to tobacco rods to form filter tipped cigarettes;
   a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper;

   wherein the tipper and the rod maker comprises a plurality of devices for monitoring and a plurality of devices for affecting parameters of the rod maker, the tipper or the cigarettes being manufactured, and wherein one or more of said monitoring devices and said parameter affecting devices both monitors and affects parameters;

   the apparatus being characterised by a controller (550) for controlling the plurality of devices on the tipper and the rod maker, including varying one or more parameters of the rod maker, the tipper or the cigarettes being manufactured, in response to conditions monitored by one or more of said devices; and

   a field bus (500), the plurality of devices and the controller each being connected to the field bus.

2. Apparatus according to claim 1, further comprising a plurality of synchronous motors controlled by a motion controller (557).

3. Apparatus according to claim 2, wherein the motion controller is connected to the controller.

4. Apparatus according to claim 2 or 3, wherein the motion controller is connected to the field bus.

5. Apparatus according to claim 2, 3 or 4, wherein the plurality of motors includes a cut-off motor (M21) for driving a device (124) for cutting individual tobacco rods, a suction chamber motor (M25) for driving a suction belt, a garniture belt drive motor (M24), and a hopper motor (M6) for controlling the rate at which tobacco is drawn from a hopper.

6. Apparatus according to claim 5, wherein the rotational speed of the suction chamber motor, the garniture belt drive motor and the hopper motor are synchronised to the rotational speed of the cut-off motor.

7. Apparatus according to claim 5, wherein the rotational speed of the cut-off motor, the suction chamber motor, the garniture belt drive motor and the hopper motor are synchronised to a virtual axis.
8. Apparatus according to claim 5, 6 or 7, wherein the plurality of motors further includes an ecreteur motor (M22) for driving a dense end cam and a pair of ecreteur discs, a capstan motor, and a printer motor for driving a printer to print onto the cigarette wrapping paper.

9. Apparatus according to claim 8, wherein the ecreteur motor and the printer motor (M23) are speed and position synchronised to the cut-off motor or the virtual axis.

10. Apparatus according to claim 5, 6 or 7, wherein the plurality of motors further includes a tipper motor for driving a tipper drum train, wherein the tipper motor is synchronised to the position of the cut-off motor or to the virtual axis.

11. Apparatus according to any preceding claim further comprising at least one human-machine interface (HMI) connected to the field bus.

12. Apparatus according to claim 11, wherein the at least one HMI comprises a rod maker HMI and a tipper HMI, each of the rod maker HMI and the tipper HMI being connected to the controller via the fieldbus.

13. Apparatus according to any of claims 1 to 10, comprising at least one human-machine interface (HMI,560) connected to the controller.

14. Apparatus according to claim 13, wherein the at least one HMI comprises a rod maker HMI and a tipper HMI, each of the rod maker HMI and the tipper maker HMI being connected to the controller.

15. Apparatus according to any of claims 11 to 14, wherein the at least one HMI is connected to a communications network.

16. Apparatus according to any preceding claim, wherein at least one of the plurality of devices is connected to the field bus via an interface.

17. Apparatus according to any of claims 1 to 15, wherein at least one of the devices is a field device.

18. Apparatus according to any of claims 1 to 15, wherein at least of the plurality of devices transmits data including diagnostic data to the controller over the field bus.

19. A cigarette manufacturing apparatus comprising:

   a tobacco rod maker for making double length tobacco rods;
   a tipper (450) for applying filters to tobacco rods to form filter tipped cigarettes;
   a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper;
   wherein each of the tipper and the rod maker comprises a plurality of devices for monitoring and a plurality of devices for affecting parameters of the rod maker, the tipper or the cigarette being manufactured, and wherein one or more of said monitoring devices and said parameter affecting devices both monitors and affects parameters;
   the apparatus being characterised by a first controller (550) for controlling the plurality of devices on the tipper and the rod maker, including varying parameters of the rod maker, the tipper or the cigarettes being manufactured, in response to conditions monitored by one or more of said devices; and
   a second controller (564) for providing tipper, rod maker and cigarette information to an operator and for communicating input data from the user to one or both of the first and second controllers.

20. Apparatus according to claim 19, wherein the second controller includes at least one Human/Machine Interface (HMI) and communicates with the first controller, for communicating tipper, rod maker and cigarette data to an operator and for communicating input data to the first controller.

21. Apparatus according to claim 19, wherein the second controller comprises a tipper controller communicating with a tipper HMI and a rod maker controller communicating with a rod maker HMI.

22. Apparatus according to claim 21, wherein the tipper controller and the rod maker controller each comprises a PC or similar device.
23. Apparatus according to claim 21 or 22, wherein the tipper controller and the rod maker controller each comprise an HMI.

24. Apparatus according to claim 21, 22 or 23, wherein the tipper controller and the rod maker controller are interconnected.

25. Apparatus according to any of claims 19 to 24, wherein the first controller and at least some of the rod maker and tipper devices are connected to a fieldbus (500).

26. Apparatus according to claim 25, wherein the second controller is connected to the fieldbus.

27. Apparatus according to any of claims 19 to 26, wherein the second controller is connected to an external communications network.

28. Apparatus according to any of claims 19 to 27, further comprising a motion controller controlled by the first controller for synchronising a plurality of motors on one or both of the rod maker and the tipper.

29. Apparatus according to claim 28, wherein the plurality of motors includes a cut-off motor for driving a device for cutting individual tobacco rods and the remainder of the plurality of motors is synchronised to the cut-off motor.

30. Apparatus according to claim 28, wherein the plurality of motors is synchronised to a virtual axis.

31. Apparatus according to claim 26, 27 or 28, wherein the motion controller is connected to the field bus.

32. Apparatus according to any of claims 11 to 15 or 20 to 24, wherein the HMI is configured to display to the operator one of a hierarchical set of display screens.

33. Apparatus according to claim 32, wherein at least one of the set of screens includes rows areas representing buttons for controlling rod maker or tipper functions.

34. Apparatus according to claim 32 or 33, wherein the HMI is configured to display diagnostic information from tipper or rod maker components.

35. A method of controlling the manufacture of cigarettes by an apparatus comprising a tobacco rod maker and tipper interconnected by a rod transfer apparatus, the method characterised by the steps of:

providing a field bus and a machine controller connected to the field bus;
connecting a plurality of devices to the field bus for monitoring and a plurality of devices for affecting parameters of the rod maker, the tipper or the cigarettes being manufactured, one or more of said monitoring devices and said parameter affecting devices both monitoring and affecting parameters;
monitoring the field bus from the controller for data from the devices; and
automatically adjusting one or more parameters of the tipper or rod maker in accordance with the information content of the data received.

36. A method according to claim 35, further comprising providing a second controller to interface with the machine controller, wherein the machine controller receives data from and sends data to the second controller.

37. A method according to claim 35 or 36, wherein the machine controller looks for a signal on the field bus indicating a machine stop command input from the second controller and, if the machine stop signal is present, sends a stop signal to the field devices.

38. A method according to claim 35, 36 or 37, wherein the machine controller looks for a signal on the field bus indicating an emergency stop condition or indicating that a protective guard on the rod maker or tipper is not in place and, if the signal is present, sends a stop signal to the field device.

39. A method according to any of claims 35 to 38, wherein the machine controller looks for a signal on the field bus indicating a fault condition at one of the field devices and, if the fault condition signal is present, sends a stop signal to the field device.
40. A method according to any of claims 35 to 37, wherein the machine controller also communicates the stop signal to the second controller together with information identifying the cause of the stop signal.

41. A method according to claim 40, wherein the information sent to the second controller includes diagnostic information and component identification information.

42. A method according to any of claims 35 to 41, wherein the machine controller looks for a signal on the field bus warning of a non-ideal condition at one of the field devices and, if the warning signal is present, sends a warning signal to the second controller.

43. A method according to any of claims 35 to 42, wherein the field of devices include a cut-off motor which controls the cutting of cigarette rods from a continuous length of wrapped tobacco produced by the rod maker and a plurality of further motors synchronised to the cut-off motor.

44. A method according to any of claims 35 to 42, wherein the field devices include a cut-off motor which controls the cutting of cigarette rods from a continuous length of wrapped tobacco produced by the rod maker and a plurality of further motors, the further motors and the cut-off motor being synchronised to a virtual axis.

45. A method according to claim 43 or 44, wherein the synchronised motors include motors synchronised by speed and motors synchronised by position.

46. A method according to any of claims 35 to 45, wherein the machine controller looks for a signal on the field bus indicating that a wrapping paper bobbin or a tipping paper bobbin is nearly exhausted and, if the signal is detected, initiates a routine to splice a fresh paper bobbin onto the present paper bobbin.

47. A cigarette manufacturing apparatus comprising:

   a tobacco rod maker for making double length tobacco rods;
   a tipper for applying filters to tobacco rods to form filter tipped cigarettes;
   a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper;
   a plurality of synchronised motors each for driving a respective operation in the tipper or the rod maker;

   characterised in that each of the tipper and the rod maker further includes a plurality of devices for monitoring and a plurality of devices for affecting parameters of the rod maker, the tipper or the cigarettes being manufactured, and wherein one or more of said monitoring devices and said parameter affecting devices both monitors and affects parameters;
   a motion control device for controlling the plurality of synchronised motors;
   the apparatus characterised by a system for controlling the plurality of devices on the tipper and the rod maker, including varying one or more parameters of the rod maker, the tipper or the cigarettes to be manufactured, in response to conditions monitored by one or more of said devices, the motion control devices being connected to the system controller; and
   a field bus, the plurality of devices and the controller each being connected to the communications network.

48. A cigarette manufacturing apparatus comprising:

   a tobacco rod maker for making double length tobacco rods;
   a tipper for applying filters to tobacco rods to form filter tipped cigarettes;
   a transfer apparatus for transferring double length tobacco rods from the rod maker to the tipper;
   wherein each of the tipper and the rod maker comprises a plurality of devices for monitoring and a plurality of devices for affecting parameters of the rod maker, the tipper or the cigarettes being manufactured, and wherein one or more of said monitoring devices and said parameter affecting devices both monitors and affects parameters;
   the apparatus characterised by a control network, the plurality of devices being coupled to the control network;
   a first controller connected to the control network for controlling the plurality of devices on the tipper and rod maker, including varying one or more parameters of the rod maker, the tipper or the cigarette to be manufactured, in response to the conditions monitored by one or more of said devices;
   a second controller coupled to the first controller and including at least one HMI for providing tipper, rod maker and cigarette information to an operator and for communicating input data from the user to the first controller.
Patentansprüche

1. Zigarettenherstellungsvorrichtung, umfassend:
   eine Tabakstockherstellungseinheit zum Herstellen doppeltlanger Tabakstücke,
   einen Filteransetzer (400) zum Ansetzen von Filtern an Tabakstücke zum Bilden von Filterzigaretten,
   eine Übergabevorrichtung zum Transferieren doppeltlanger Tabakstücke von der Tabakstockherstellungseinheit zum Filteransetzer,
   bei der der Filteransetzer und die Tabakstockherstellungseinheit eine Mehrzahl von Vorrichtungen zum Überwachen und eine Mehrzahl von Vorrichtungen zum Beeinflussen von Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der hergestellten Zigaretten aufweist und bei der eine oder mehrere der genannten Überwachungsvorrichtungen und der genannten Parameter beinflussenden Vorrichtungen Parameter sowohl überwachen als auch beeinflussen,
   wobei die Vorrichtung gekennzeichnet ist durch einen Controller (550) zum Steuern der Mehrzahl von Vorrichtungen am Filteransetzer und an der Tabakstockherstellungseinheit, einschließlich Varieren von einem oder mehr Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der hergestellten Zigaretten in Reaktion auf Bedingungen, die von einer oder mehreren der genannten Vorrichtungen überwacht werden, und einen Feldbus (500), wobei die Mehrzahl von Vorrichtungen und der Controller jeweils mit dem Feldbus verbunden sind.

2. Vorrichtung nach Anspruch 1, ferner umfassend eine Mehrzahl synchroner Motoren, die von einem Bewegungscontroller (557) gesteuert werden.

3. Vorrichtung nach Anspruch 2, bei der der Bewegungscontroller mit dem Controller verbunden ist.

4. Vorrichtung nach Anspruch 2 oder 3, bei der der Bewegungscontroller mit dem Feldbus verbunden ist.

5. Vorrichtung nach Anspruch 2, 3 oder 4, bei der die Mehrzahl von Motoren einen Abschneidmotor (M21) zum Antreiben einer Vorrichtung (124) zum Schneiden einzelner Tabakstücke, einen Saugkammermotor (M25) zum Antreiben eines Saugbands, einen Formatbandantriebsmotor (M24) und einen Trichtermotor (M5) zum Regeln der Geschwindigkeit, mit der Tabak aus einem Trichter gezogen wird.


8. Vorrichtung nach Anspruch 5, 6 oder 7, bei der die Mehrzahl der Motoren ferner einen Begrenzermotor (M22) zum Antreiben eines Nockens für das verdichtete Ende und eines Begrenzerscheibenpaares, einen Capstan-Motor und einen Druckermotor zum Antreiben eines Druckers zum Bedrucken des Zigarettenumhüllungspapiers hat.

9. Vorrichtung nach Anspruch 8, bei der der Begrenzermotor und der Druckermotor (M23) mit dem Abschneidmotor oder der virtuellen Achse geschwindigkeits- und positionssynchronisiert sind.

10. Vorrichtung nach Anspruch 5, 6 oder 7, bei der die Mehrzahl von Motoren ferner einen Filteransetzermotor zum Antreiben eines Filteransetzer trommelsatzes hat, bei der der Filteransetzermotor mit der Position des Abschneidmotors oder der virtuellen Achse synchronisiert ist.

11. Vorrichtung nach einem der vorhergehenden Ansprüche, ferner umfassend wenigstens eine mit dem Feldbus verbundene Mensch-Maschine-Schnittstelle (HMI).

12. Vorrichtung nach Anspruch 11, bei der die wenigstens eine HMI eine Tabakstockherstellungseinheit-HMI und eine Filteransetzter-HMI umfasst, wobei die Tabakstockherstellungseinheit-HMI und die Filteransetzter-HMI jeweils über den Feldbus mit dem Controller verbunden sind.

13. Vorrichtung nach einem der Ansprüche 1 bis 10, umfassend wenigstens eine mit dem Controller verbundene
Mensch-Maschine-Schnittstelle (HMI, 560).

14. Vorrichtung nach Anspruch 13, bei der die wenigstens eine HMI eine Tabakstockherstellungseinheit-HMI und eine Filteransetzer-HMI umfasst, wobei die Tabakstockherstellungseinheit-HMI und die Filteransetzer-HMI jeweils mit dem Controller verbunden sind.

15. Vorrichtung nach einem der Ansprüche 11 bis 14, bei der die wenigstens eine HMI mit einem Kommunikationsnetz verbunden ist.

16. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der wenigstens eine der Mehrzahl von Vorrichtungen über eine Schnittstelle mit dem Feldbus verbunden ist.

17. Vorrichtung nach einem der Ansprüche 1 bis 15, bei der wenigstens eine der Vorrichtungen eine Feldvorrichtung ist.

18. Vorrichtung nach einem der Ansprüche 1 bis 15, bei der wenigstens eine der Mehrzahl von Vorrichtungen Daten einschließlich Diagnosedaten über den Feldbus zum Controller überträgt.

19. Zigarettenherstellungsvorrichtung, umfassend:

   eine Tabakstockherstellungseinheit zum Herstellen doppeltlanger Tabakstöcke,
   einen Filteransetzer (450) zum Ansetzen von Filtern an Tabakstöcke zum Bilden von Filterzigaretten,
   eine Übergabevorrichtung zum Transferieren doppeltlanger Tabakstöcke von der Tabakstockherstellungseinheit zum Filteransetzer,
   bei der der Filteransetzer und die Tabakstockherstellungseinheit jeweils eine Mehrzahl von Vorrichtungen zum Überwachen und eine Mehrzahl von Vorrichtungen zum Beeinflussen von Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der hergestellten Zigarette aufweist und bei der eine oder mehrere der genannten Überwachungsvorrichtungen und der genannten Parameter einflussenden Vorrichtungen Parameter sowohl überwachen als auch beeinflussen,

wobei die Vorrichtung **gekennzeichnet ist durch** einen ersten Controller (550) zum Steuern der Mehrzahl von Vorrichtungen am Filteransetzer und an der Tabakstockherstellungseinheit, einschließlich Variieren von Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der hergestellten Zigaretten in Reaktion auf Bedingungen, die von einer oder mehreren der genannten Vorrichtungen überwacht werden, und einen zweiten Controller (564) zum Übermitteln von Filteransetzer-, Tabakstockherstellungseinheit- und Zigaretteninformationen an eine Bedienkraft und zum Übertragen von Eingabedaten vom Benutzer zum ersten oder zweiten Controller oder zu beiden.


22. Vorrichtung nach Anspruch 21, bei der der Filteransetzer-Controller und der Tabakstockherstellungseinheit-Controller jeweils einen PC oder eine ähnliche Vorrichtung umfassen.

23. Vorrichtung nach Anspruch 21 oder 22, bei der der Filteransetzer-Controller und der Tabakstockherstellungseinheit-Controller jeweils eine HMI haben.

24. Vorrichtung nach Anspruch 21, 22 oder 23, bei der der Filteransetzer-Controller und der Tabakstockherstellungseinheit-Controller miteinander verbunden sind.

25. Vorrichtung nach einem der Ansprüche 19 bis 24, bei der der erste Controller und wenigstens einige der Tabakstockherstellungseinheit- und Filteransetzervorrichtungen mit einem Feldbus (500) verbunden sind.

26. Vorrichtung nach Anspruch 25, bei der der zweite Controller mit dem Feldbus verbunden ist.
27. Vorrichtung nach einem der Ansprüche 19 bis 26, bei der der zweite Controller mit einem externen Kommunikationsnetz verbunden ist.

28. Vorrichtung nach einem der Ansprüche 19 bis 27, ferner umfassend einen vom ersten Controller gesteuerten Bewegungscontroller zum Synchronisieren einer Mehrzahl von Motoren an der Tabakstockherstellungseinheit oder dem Filteransetzer oder an beiden.

29. Vorrichtung nach Anspruch 28, bei der die Mehrzahl von Motoren einen Abschneidmotor zum Antrieben einer Vorrichtung zum Schneiden einzelner Tabakstücke aufweist und der Rest der Mehrzahl von Motoren mit dem Abschneidmotor synchronisiert ist.

30. Vorrichtung nach Anspruch 28, bei der die Mehrzahl von Motoren mit einer virtuellen Achse synchronisiert ist.

31. Vorrichtung nach Anspruch 26, 27 oder 28, bei der der Bewegungscontroller mit dem Feldbus verbunden ist.

32. Vorrichtung nach einem der Ansprüche 11 bis 15 oder 20 bis 24, bei der die HMI konfiguriert ist, um der Bedienkraft einen aus einem hierarchischen Satz von Bildschirmen anzuzeigen.


34. Vorrichtung nach Anspruch 32 oder 33, bei der die HMI zum Anzeigen von Diagnoseinformationen vom Filteransetzer oder von der Tabakstockherstellungseinheit konfiguriert ist.

35. Verfahren zum Steuern der Herstellung von Zigaretten mit einer Vorrichtung, umfassend eine Tabakstockherstellungseinheit und einen Filteransetzer, die durch eine Tabakstockübergabevorrichtung miteinander verbunden sind, wobei das Verfahren durch die folgenden Schritte gekennzeichnet ist:

Bereitstellen eines Feldbusses und eines mit dem Feldbus verbundenen Maschinencontrollers,


37. Verfahren nach Anspruch 35 oder 36, bei dem der Maschinencontroller den Feldbus auf ein Signal kontrolliert, das einen Maschinenstoppbefehleingang vom zweiten Controller anzeigt und, wenn das Maschinenstoppsignal vorliegt, ein Stoppsignal an die Feldvorrichtungen sendet.

38. Verfahren nach Anspruch 35, 36 oder 37, bei dem der Maschinencontroller den Feldbus auf ein Signal kontrolliert, das eine Not-Aus-Bedingung anzeigt oder anzeigt, dass eine Schutzvorrichtung an der Tabakstockherstellungs einheit oder dem Filteransetzer nicht angebracht ist, und, wenn das Stoppsignal vorliegt, ein Stoppsignal an die Feldvorrichtung sendet.

39. Verfahren nach einem der Ansprüche 35 bis 38, bei dem der Maschinencontroller den Feldbus auf ein Signal kontrolliert, das eine Fehlerbedingung an einer der Feldvorrichtungen anzeigt und, wenn das Fehlerbedingungs signal vorliegt, ein Stoppsignal an die Feldvorrichtung sendet.

40. Verfahren nach einem der Ansprüche 35 bis 37, bei dem der Maschinencontroller das Stoppsignal zusammen mit die Ursache des Stoppsignals identifizierenden Informationen auch an den zweiten Controller übermittelt.

41. Verfahren nach Anspruch 40, bei dem die an den zweiten Controller gesendeten Informationen Diagnoseinforma-
Verfahren nach einem der Ansprüche 35 bis 41, bei dem der Maschinencontroller den Feldbus auf ein Signal kontrolliert, das auf eine nicht ideale Bedingung an einer der Feldvorrichtungen hinweist, und, wenn das Warnsignal vorliegt, ein Warnsignal an den zweiten Controller sendet.


Verfahren nach einem der Ansprüche 35 bis 42, bei dem die Feldvorrichtungen einen Abschneidmotor, der das Schneiden von Zigaretten-Tabakstücken von einem von der Tabakstockherstellungseinheit produzierten kontinuierlichen Strang umwickelten Tabaks steuert, und eine Mehrzahl weiterer Motoren aufweisen, wobei die weiteren Motoren und der Abschneidmotor mit einer virtuellen Achse synchronisiert sind.

Verfahren nach Anspruch 43 oder 44, bei dem die synchronisierten Motoren geschwindigkeitssynchronisierte Motoren und positionssynchronisierte Motoren beinhalten.

Verfahren nach einem der Ansprüche 35 bis 45, bei dem der Maschinencontroller den Feldbus auf ein Signal kontrolliert, das anzeigt, dass eine Ummüllungspapierbobine oder eine Belagpapierbobine fast aufgebraucht ist und, wenn das Signal erfasst wird, eine Routine zum Ankleben einer neuen Papierbobine an der vorhandenen Papierbobine einleitet.

Zigarettenherstellungsvorrichtung, umfassend:

- eine Tabakstockherstellungseinheit zum Herstellen doppeltlanger Tabakstücke,
- einen Filteransetzer zum Ansetzen von Filtern an Tabakstücke zum Bilden von Filterzigaretten,
- eine Übergabevorrichtung zum Transferieren doppeltlanger Tabakstücke von der Tabakstockherstellungseinheit zum Filteransetzer,
- eine Mehrzahl von synchronisierten Motoren, jeweils zum Antreiben eines betreffenden Vorgangs im Filteransetzer oder in der Tabakstockherstellungseinheit,

dadurch gekennzeichnet, dass der Filteransetzer und die Tabakstockherstellungseinheit jeweils eine Mehrzahl von Vorrichtungen zum Überwachen und eine Mehrzahl von Vorrichtungen zum Beeinflussen von Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der hergestellten Zigaretten aufweist, und bei der eine oder mehrere der genannten Überwachungsvorrichtungen und der genannten Parameter beinflussenden Vorrichtungen Parameter sowohl überwachen als auch beeinflussen,

- eine Bewegungssteuervorrichtung zum Steuern der Mehrzahl synchronisierter Motoren, wobei die Vorrichtung gekennzeichnet ist durch ein System zum Steuern der Mehrzahl von Vorrichtungen am Filteransetzer und an der Tabakstockherstellungseinheit, einschließlich Varieren von einem oder mehr Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der herzustellenden Zigaretten in Reaktion auf Bedingungen, die von einer oder mehreren der genannten Vorrichtungen überwacht werden, wobei die Bewegungssteuervorrichtungen mit dem Systemcontroller verbunden sind, und
- einen Feldbus, wobei die Mehrzahl von Vorrichtungen und der Controller jeweils mit dem Kommunikationsnetz verbunden sind.

Zigarettenherstellungsvorrichtung, umfassend:

- eine Tabakstockherstellungseinheit zum Herstellen doppeltlanger Tabakstücke,
- einen Filteransetzer zum Ansetzen von Filtern an Tabakstücke zum Bilden von Filterzigaretten,
- eine Übergabevorrichtung zum Transferieren doppeltlanger Tabakstücke von der Tabakstockherstellungseinheit zum Filteransetzer,

wobei der Filteransetzer und die Tabakstockherstellungseinheit jeweils eine Mehrzahl von Vorrichtungen zum Überwachen und eine Mehrzahl von Vorrichtungen zum Beeinflussen von Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der hergestellten Zigaretten aufweist, und bei der eine oder mehrere der genannten Überwachungsvorrichtungen und der genannten Parameter beinflussenden Vorrichtungen Parameter
sowohl überwachen als auch beeinflussen,

wobei die Vorrichtung gekennzeichnet ist durch ein Steuernetzwerk, wobei die Mehrzahl von Vorrichtungen mit dem Steuernetzwerk gekoppelt sind,

einen ersten mit dem Steuernetzwerk verbundenen Controller zum Steuern der Mehrzahl von Vorrichtungen am Filteransetzer und an der Tabakstockherstellungseinheit, einschließlich Varieren von einem oder mehr Parametern der Tabakstockherstellungseinheit, des Filteransetzers oder der herzustellenden Zigaretten in Reaktion auf Bedingungen, die von einer oder mehreren der genannten Vorrichtungen überwacht werden,

einen zweiten Controller, der mit dem ersten Controller gekoppelt ist und wenigstens eine HMI zum Übermitteln von Filteransetzer-, Tabakstockherstellungseinheit- und Zigaretteninformationen an eine Bedienkraft und zum Übertragen von Eingabedaten vom Benutzer zum ersten Controller hat.

**Revendications**

1. Appareil de fabrication de cigarettes comprenant:

   un dispositif de fabrication de bâtonnets de tabac pour fabriquer des bâtonnets de tabac de double longueur;
   un dispositif de pose de bouts-filtres (400) pour appliquer des filtres aux bâtonnets de tabac afin de former des cigarettes à bout-filtre;
   un appareil de transfert pour transférer les bâtonnets de tabac de double longueur depuis le dispositif de fabrication de bâtonnets jusqu’au dispositif de pose de bouts-filtres;

   dans lequel le dispositif de pose de bouts-filtres et le dispositif de fabrication de bâtonnets comprennent une pluralité de dispositifs de surveillance et une pluralité de dispositifs de modification de paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, et dans lequel un ou plusieurs desdits dispositifs de surveillance et desdits dispositifs de modification de paramètres surveillent et modifient des paramètres;

   le dispositif étant caractérisé par un contrôleur (550) pour commander la pluralité de dispositifs sur le dispositif de pose de bouts-filtres et le dispositif de fabrication de bâtonnets, y compris faire varier l’un ou plusieurs des paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, en réponse à des conditions surveillées par un ou plusieurs desdits dispositifs; et

   un bus local (500), la pluralité de dispositifs et le contrôleur étant chacun connectés au bus local.

2. Appareil selon la revendication 1, comprenant en outre une pluralité de moteurs synchrones commandés par un contrôleur de mouvement (557).

3. Appareil selon la revendication 2, dans lequel le contrôleur de mouvement est connecté au contrôleur.

4. Appareil selon la revendication 2 ou 3, dans lequel le contrôleur de mouvement est connecté au bus local.

5. Appareil selon la revendication 2, 3 ou 4, dans lequel la pluralité de moteurs comporte un moteur de coupure (M21) pour commander un dispositif (124) servant à couper des bâtonnets de tabac individuels, un moteur de chambre d’aspiration (M25) pour commander une courroie d’aspiration, un moteur de commande de courroie de garniture (M24) et un moteur de trémie (M6) pour commander le débit auquel le tabac est aspiré depuis la trémie.

6. Appareil selon la revendication 5, dans lequel les vitesses de rotation du moteur de chambre d’aspiration, du moteur de commande de courroie de garniture et du moteur de trémie sont synchronisées sur la vitesse de rotation du moteur de coupure.

7. Appareil selon la revendication 5, dans lequel les vitesses de rotation du moteur de coupure, du moteur de chambre d’aspiration, du moteur de commande de courroie de garniture et du moteur de trémie sont synchronisées sur un axe virtuel.

8. Appareil selon la revendication 5, 6 ou 7, dans lequel la pluralité de moteurs comporte en outre un moteur écrêteur (M22) pour commander une came de bout dense et une paire de disques écrêteurs, un moteur de cabestan, et un moteur d’imprimante pour commander une imprimante afin d’imprimer sur le papier enveloppant les cigarettes.

9. Appareil selon la revendication 8, dans lequel le moteur écrêteur et le moteur d’imprimante (M23) sont synchronisés.
en vitesse et en position sur le moteur de coupure ou l'axe virtuel.

10. Appareil selon la revendication 5, 6 ou 7, dans lequel la pluralité de moteurs comporte en outre un moteur de dispositif de pose de bouts-filtres pour entraîner un train de tambours de dispositif de pose de bouts-filtres, dans lequel le moteur de. dispositif de pose de bouts-filtres est synchronisé sur la position du moteur de coupure ou l'axe virtuel.

11. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre au moins une interface homme-machine (HMI) connectée au bus local.

12. Appareil selon la revendication 11, dans lequel la au moins une HMI comprend une HMI de dispositif de fabrication de bâtonnets et une HMI de dispositif de pose de bouts-filtres, chacune des HMI de dispositif de fabrication de bâtonnets et HMI de dispositif de pose de bouts-filtres étant connectée au contrôleur par l'intermédiaire du bus local.


14. Appareil selon la revendication 13, dans lequel la au moins une HMI comprend une HMI de dispositif de fabrication de bâtonnets et une HMI de dispositif de pose de bouts-filtres, chacune des HMI de dispositif de fabrication de bâtonnets et HMI de dispositif de pose de bouts-filtres étant connectée au contrôleur.

15. Appareil selon l'une quelconque des revendications 11 à 14, dans lequel la au moins une HMI est connectée à un réseau de communications.

16. Appareil selon l'une quelconque des revendications précédentes, dans lequel la au moins un de la pluralité de dispositifs est connecté au bus local par l'intermédiaire d'une interface.

17. Appareil selon l'une quelconque des revendications 1 à 15, dans lequel la au moins un des dispositifs est un dispositif local.

18. Appareil selon l'une quelconque des revendications 1 à 15, dans lequel au moins un de la pluralité de dispositifs transmet des données y compris des données de diagnostic au contrôleur sur le bus local.

19. Appareil de fabrication de cigarettes comprenant:

   un dispositif de fabrication de bâtonnets de tabac pour fabriquer des bâtonnets de tabac de double longueur ;
   un dispositif de pose de bouts-filtres (450) pour appliquer des filtres aux bâtonnets de tabac afin de former des cigarettes à bout-filtre ;
   un appareil de transfert pour transférer les bâtonnets de tabac de double longueur depuis le dispositif de fabrication de bâtonnets de tabac jusqu'au dispositif de pose de bouts-filtres ;
   dans lequel chacun du dispositif de pose de bouts-filtres et du dispositif de fabrication de bâtonnets comprend une pluralité de dispositifs de surveillance et une pluralité de dispositifs de modification de paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, et dans lequel un ou plusieurs desdits dispositifs de surveillance et desdits dispositifs de modification de paramètres à la fois surveillent et modifient des paramètres ;
   l'appareil étant caractérisé par un premier contrôleur (550) pour commander la pluralité de dispositifs sur le dispositif de pose de bouts-filtres et le dispositif de fabrication de bâtonnets, y compris faire varier des paramètres du dispositif de fabrication de bâtonnets, du dispositif de bouts-filtres ou des cigarettes en cours de fabrication, en réponse à des conditions surveillées par un ou plusieurs desdits dispositifs de surveillance et modifient des paramètres ; et
   un deuxième contrôleur (564) pour fournir des informations concernant le dispositif de pose de bouts-filtres, le dispositif de fabrication de bâtonnets et les cigarettes à un opérateur et pour communiquer des données d'entrée depuis l'utilisateur à un des premier et deuxième contrôleurs ou aux deux.

20. Appareil selon la revendication 19, dans lequel le deuxième contrôleur comporte au moins une Interface Homme/Machine (HMI) et communique avec le premier contrôleur, pour communiquer des données concernant le dispositif de pose de bouts-filtres, le dispositif de fabrication de bâtonnets et les cigarettes à un opérateur et pour communiquer des données d'entrée au premier contrôleur.
21. Appareil selon la revendication 19, dans lequel le deuxième contrôleur comprend un contrôleur de dispositif de pose de bouts-filtres communiquant avec une HMI de dispositif de pose de bouts-filtres et un contrôleur de dispositif de fabrication de bâtonnets communiquant avec une HMI de dispositif de fabrication de bâtonnets.

22. Appareil selon la revendication 21, dans lequel le contrôleur de dispositif de pose de bouts-filtres et le contrôleur de dispositif de fabrication de bâtonnets comprennent chacun un PC ou dispositif semblable.

23. Appareil selon la revendication 21 ou 22, dans lequel le contrôleur de dispositif de pose de bouts-filtres et le contrôleur de dispositif de fabrication de bâtonnets comprennent chacun une HMI.

24. Appareil selon la revendication 21, 22 ou 23, dans lequel le contrôleur de dispositif de pose de bouts-filtres et le contrôleur de dispositif de fabrication de bâtonnets sont interconnectés.

25. Appareil selon l'une quelconque des revendications 19 à 24, dans lequel le premier contrôleur et au moins certains des dispositifs du dispositif de fabrication de bâtonnets et du dispositif de pose de bouts-filtres sont connectés à un bus local (500).

26. Appareil selon la revendication 25, dans lequel le deuxième contrôleur est connecté au bus local.

27. Appareil selon l'une quelconque des revendications 19 à 26, dans lequel le deuxième contrôleur est connecté à un réseau de communications externe.

28. Appareil selon l'une quelconque des revendications 19 à 27, comprenant en outre un contrôleur de mouvement commandé par le premier contrôleur pour synchroniser une pluralité de moteurs sur l'un du dispositif de fabrication de bâtonnets et du dispositif de pose de bouts-filtres ou les deux.

29. Appareil selon la revendication 28, dans lequel la pluralité de moteurs comporte un moteur de coupure pour commander un dispositif servant à couper des bâtonnets de tabac individuels et le reste de la pluralité de moteurs est synchronisé sur le moteur de coupure.

30. Appareil selon la revendication 28, dans lequel la pluralité de moteurs est synchronisée sur un axe virtuel.

31. Appareil selon la revendication 26, 27 ou 28, dans lequel le contrôleur de mouvement est connecté au bus local.

32. Appareil selon l'une quelconque des revendications 11 à 15 ou 20 à 24, dans lequel la HMI est configurée pour afficher à l'opérateur un écran d'un ensemble hiérarchique d'écrans d'affichage.

33. Appareil selon la revendication 32, dans lequel au moins un de l'ensemble d'écrans comporte des zones de rangées représentant des boutons pour commander des fonctions de dispositif de fabrication de bâtonnets ou de dispositif de pose de bouts-filtres.

34. Appareil selon la revendication 32 ou 33, dans lequel la HMI est configurée pour afficher des informations de diagnostic provenant des composants du dispositif de pose de bouts-filtres ou du dispositif de fabrication de bâtonnets.

35. Procédé de commande de la fabrication de cigarettes par un appareil comprenant un dispositif de fabrication de bâtonnets de tabac et un dispositif de pose de bouts-filtres interconnectés par un dispositif de transfert de bâtonnets, le procédé étant caractérisé par les étapes de :

- fourniture d'un bus local et d'un contrôleur de machines connecté au bus local ;
- connexion au bus local d'une pluralité de dispositifs de surveillance et d'une pluralité de dispositifs de modification de paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, un ou plusieurs desdits dispositifs de surveillance et desdits dispositifs de modification de paramètres à la fois surveillant et modifiant des paramètres ;
- surveillance du bus local par le contrôleur à la recherche de données provenant des dispositifs ; et
- réglage automatique d'un ou de plusieurs paramètres du dispositif de pose de bouts-filtres ou du dispositif de fabrication de bâtonnets conformément au contenu d'informations des données reçues.
Procédé selon la revendication 35, comprenant en outre la fourniture d'un deuxième contrôleur destiné à s'interfacer avec le contrôleur de machines, dans lequel le contrôleur de machines reçoit des données depuis et envoie des données vers le deuxième contrôleur.

Procédé selon la revendication 35 ou 36, dans lequel le contrôleur de machines recherche un signal sur le bus local indiquant une entrée de commande d'arrêt de machine en provenance du deuxième contrôleur et, si le signal d'arrêt de machine est présent, envoie un signal d'arrêt aux dispositifs locaux.

Procédé selon la revendication 35, 36 ou 37, dans lequel le contrôleur de machines recherche un signal sur le bus local indiquant une condition d'arrêt d'urgence ou indiquant qu'un écran de protection sur le dispositif de fabrication de bâtonnets ou le dispositif de pose de bouts-filtres n'est pas en place et, si le signal est présent, envoie un signal d'arrêt aux dispositifs locaux.

Procédé selon l'une quelconque des revendications 35 à 38, dans lequel le contrôleur de machines recherche un signal sur le bus local indiquant une condition de panne au niveau de l'un des dispositifs locaux et, si le signal de condition de panne est présent, envoie un signal d'arrêt au dispositif local.

Procédé selon l'une quelconque des revendications 35 à 37, dans lequel le contrôleur de machines communique aussi le signal d'arrêt au deuxième contrôleur avec des informations identifiant la cause du signal d'arrêt.

Procédé selon la revendication 40, dans lequel les informations envoyées au deuxième contrôleur incluent des informations de diagnostic et des informations d'identification de composants.

Procédé selon l'une quelconque des revendications 35 à 41, dans lequel le contrôleur de machines recherche un signal sur le bus local avertissant d'une condition non idéale au niveau de l'un des dispositifs locaux et, si le signal d'avertissement est présent, envoie un signal d'avertissement au deuxième contrôleur.

Procédé selon l'une quelconque des revendications 35 à 42, dans lequel les dispositifs locaux comportent un moteur de coupure qui commande la coupe de bâtonnets de cigarettes à partir d'une longueur continue de tabac enroulée produite par le dispositif de fabrication de bâtonnets et une pluralité d'autres moteurs synchronisés sur le moteur de coupure.

Procédé selon l'une quelconque des revendications 35 à 42, dans lequel les dispositifs locaux comportent un moteur de coupure qui commande la coupe de bâtonnets de cigarettes à partir d'une longueur continue de tabac enroulée produite par le dispositif de fabrication de bâtonnets et une pluralité d'autres moteurs, les autres moteurs et le moteur de coupure étant synchronisés sur un axe virtuel.

Procédé selon la revendication 43 ou 44, dans lequel les moteurs synchronisés comportent des moteurs synchronisés par vitesse et des moteurs synchronisés par position.

Procédé selon l'une quelconque des revendications 35 à 45, dans lequel le contrôleur de machines recherche un signal sur le bus local indiquant qu'une bobine de papier d'enveloppement ou une bobine de papier de bout-filtre est presque épuisée et, si le signal est détecté, lance un sous-programme pour joindre par épissurage une bobine de papier pleine à la bobine de papier en cours.

Appareil de fabrication de cigarettes comprenant:

un dispositif de fabrication de bâtonnets de tabac pour fabriquer des bâtonnets de tabac de double longueur ;
un dispositif de pose de bouts-filtres (400) pour appliquer des filtres aux bâtonnets de tabac afin de former des cigarettes à bout-filtre ;
un appareil de transfert pour transférer les bâtonnets de tabac de double longueur depuis le dispositif de fabrication de bâtonnets de tabac jusqu'au dispositif de pose de bouts-filtres ;
une pluralité de moteurs synchronisés pour commander chacun une opération respective dans le dispositif de pose de bouts-filtres ou le dispositif de fabrication de bâtonnets ;

caractérisé en ce que chacun du dispositif de pose de bouts-filtres et du dispositif de fabrication de bâtonnets comporte une pluralité de dispositifs de surveillance et une pluralité de dispositifs de modification de paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours.
de fabrication, et dans lequel un ou plusieurs desdits dispositifs de surveillance et desdits dispositifs de modification de paramètres à la fois surveillent et modifient des paramètres ;

un dispositif de commande de mouvement pour commander la pluralité de moteurs synchronisés ;

l'appareil étant caractérisé par un système pour commander la pluralité de dispositifs sur le dispositif de pose de bouts-filtres et le dispositif de fabrication de bâtonnets, y compris faire varier un ou plusieurs paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, en réponse aux conditions surveillées par un ou plusieurs desdits dispositifs, les dispositifs de commande de mouvement étant connectés au contrôleur de système ; et

un bus local, la pluralité de dispositifs et le contrôleur étant chacun connectés au réseau de communications.

48. Appareil de fabrication de cigarettes comprenant:

un dispositif de fabrication de bâtonnets de tabac pour fabriquer des bâtonnets de tabac de double longueur ;

un dispositif de pose de bouts-filtres (400) pour appliquer des filtres aux bâtonnets de tabac afin de former des cigarettes à bout-filtre ;

un appareil de transfert pour transférer les bâtonnets de tabac de double longueur depuis le dispositif de fabrication de bâtonnets de tabac jusqu'au dispositif de pose de bouts-filtres ;

dans lequel chacun du dispositif de pose de bouts-filtres et du dispositif de fabrication de bâtonnets comprend une pluralité de dispositifs de surveillance et une pluralité de dispositifs de modification de paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, et dans lequel un ou plusieurs desdits dispositifs de surveillance et desdits dispositifs de modification de paramètres à la fois surveillent et modifient des paramètres ;

l'appareil étant caractérisé par un réseau de commande, la pluralité de dispositifs étant couplée au réseau de commande ;

un premier contrôleur connecté au réseau de commande pour commander la pluralité de dispositifs sur le dispositif de pose de bouts-filtres et le dispositif de fabrication de bâtonnets, y compris faire varier un ou plusieurs paramètres du dispositif de fabrication de bâtonnets, du dispositif de pose de bouts-filtres ou des cigarettes en cours de fabrication, en réponse aux conditions surveillées par un ou plusieurs desdits dispositifs ;

un deuxième contrôleur couplé au premier contrôleur et comportant au moins une HMI pour fournir des informations concernant le dispositif de pose de bouts-filtres, le dispositif de fabrication de bâtonnets et les cigarettes à un opérateur et pour communiquer des données d'entrée de l'utilisateur au premier contrôleur.
FIG. 3
FIG. 30 CONT'D
FIG. 33
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>INCH SPEED (CIGS/MIN)</td>
<td>462</td>
</tr>
<tr>
<td>MAKER HEATER (CELSIUS)</td>
<td>464</td>
</tr>
<tr>
<td>CIGARETTE LENGTH (MM)</td>
<td>466</td>
</tr>
<tr>
<td>LOW SPEED (CIGS/MIN)</td>
<td>468</td>
</tr>
<tr>
<td>MAKER HEATER STOP HIGH LIMIT (CELSIUS)</td>
<td>470</td>
</tr>
<tr>
<td>MAKER HOPPER STOP (RPM)</td>
<td>472</td>
</tr>
<tr>
<td>PRODUCTION SPEED (CIGS/MIN)</td>
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</tr>
<tr>
<td>MAKER HEATER STOP LOW LIMIT (CELSIUS)</td>
<td>476</td>
</tr>
<tr>
<td>MAINTENANCE SPEED (CIGS/MIN)</td>
<td>478</td>
</tr>
</tbody>
</table>

**FIG. 34**
FIG. 36
FIG. 39

GO TO TIPPER START PROCEDURE

MAIN ISOLATORS ON?

Y

N

CLEANING SCHEDULE FOLLOWED?

Y

N

MAINTENANCE SCHEDULES FOLLOWED?

Y

N

COMPRESSED AIR ON?

Y

N

MAKER / TIPPER GUARDS CLOSED

Y

N

EMERGENCY STOPS UNLOCKED?

Y

N

900
FIG. 40

914
GLUE SUPPLY PREPARED?

916
TIPPER PAPER LOADED & PREPARED?

Y

918
SELECT ROLL BLOCK FROM HMI

920
SELECT TIPPER FANS FROM HMI

922
SELECT GLUE ROLLER FROM HMI

924
SELECT KNIVES MOTOR FROM HMI

926
SELECT AUTO OR MANUAL

928
SELECT INCH FROM HMI

930
TIPPER PAPER FED?

932
PLUGS ON FEED DRUM?

GO TO MAKER START
SELECT LANGUAGE AT HMI

SELECT 'PREPARE MAKER' AT HMI

SELECT 'MAKER FANS' AT HMI

SELECT 'TOBACCO FEED' AT HMI

SELECT 'HOPPER' AT HMI

LOAD BOBBIN AND THREAD PAPER

SELECT 'RUN MAKER IN MANUAL' AT HMI

SELECT 'INCH' AT HMI

TOBACCO AVAILABLE?

Y

ENGAGE PRINT LEVER

N

ALL MATERIALS FEEDING CORRECTLY?

Y

SELECT 'AUTO RUN' MODE AT HMI

N

FIG. 41