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APPARATUS FOR THE AUTOMATIC CONTROL OF MACHINERY

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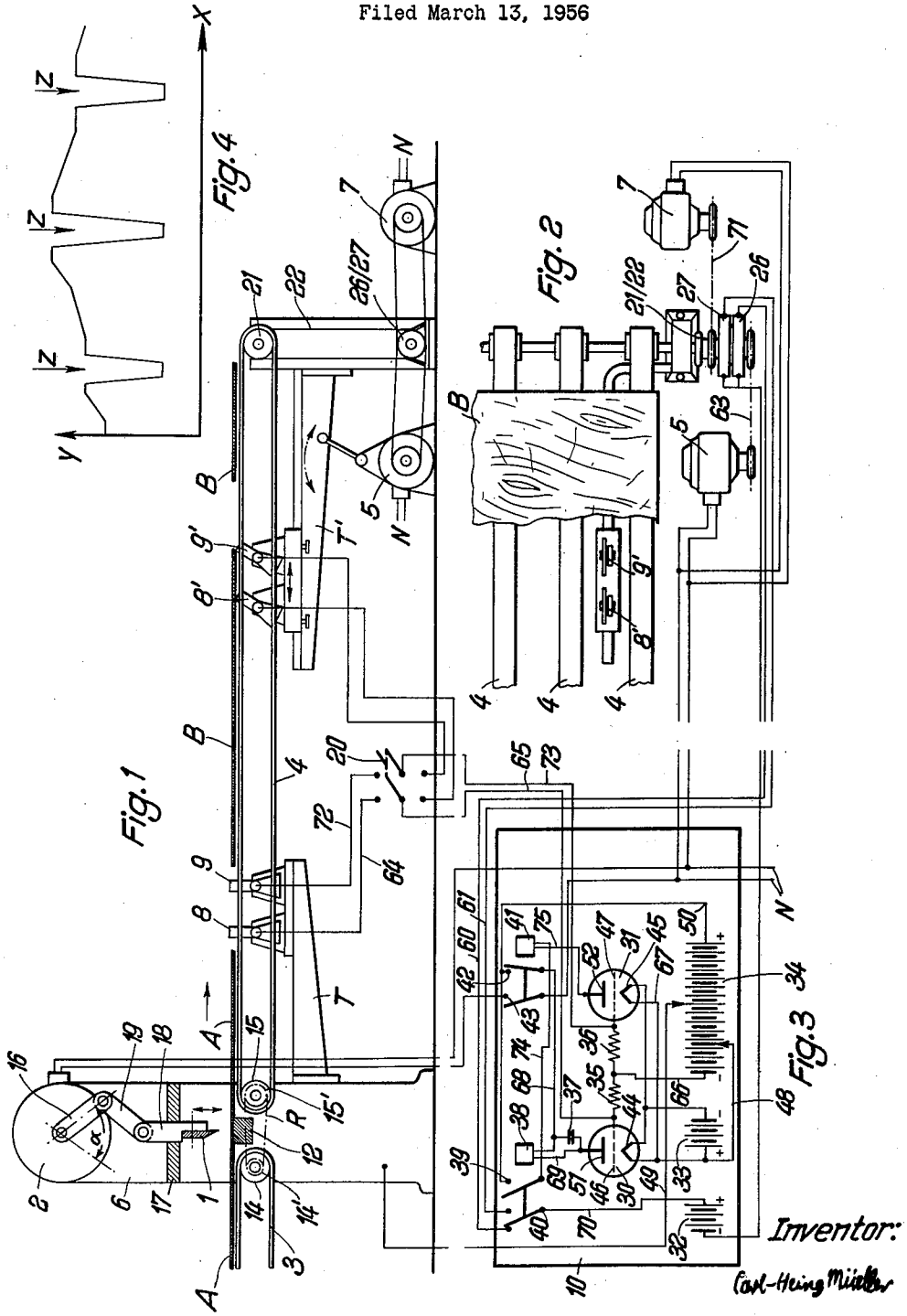

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APPARATUS FOR THE AUTOMATIC CONTROL OF MACHINERY

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The present invention relates to a method and apparatus for the automatic control of machinery and in particular of electrically driven machinery, such as veneer cutting machinery.

It is one object of the present invention to permit the repeated engagement of a work tool with a work piece at accurately determined spaced positions on the work piece, while the work piece is rapidly advanced by a transport, the accuracy of the tool-engaging location on the work piece being independent of the speed of the transport. In a particular instance, this permits the automatic severance of veneer pieces from a veneer band, advanced by a conveyer belt, at accurately measured distances on the band, which accuracy is independent of the speed of the conveyer belt between the cutting operations. Thus predetermined lengths of the veneer band may be cut off with an accuracy practically independent of the speed of operation of the machine.

According to the invention, the rapid advance of the work piece is automatically slowed down for a comparatively short period of time during which the engagement of the tool and the work piece take place. After completion of whatever operation the tool is to perform on the work piece, the speed of advance of the work piece is automatically increased.

In the case of the veneer cutter, the invention provides a control circuit which is operated automatically as soon as the work piece (veneer band) extends by a desired and predetermined length past the tool e.g. cutters. This control circuit is operated by any suitable device and preferably by the front edge of the work piece when it reaches a desired distance from the tool, whereby the length of the piece to be cut is measured. The control circuit not only actuates the tool for one operation thereof, but also reduces the speed with which the work piece such as a veneer band travels through the machine to a relatively slow speed at least for the duration of the operation, for instance a cutting operation; this slow speed may be the same during each operation.

The invention further suggests a device for the speed control of the conveyor band drive which advances the veneer band and the severed veneers through the machine and under the cutter.

This control is effected by means of contacts arranged in the path of the conveyor band and at a desired distance behind the cutter. The conveyor band is made of insulating material; it may be an endless rubber band. The contacts are intended to meet the front edge of the humid veneer band, which advances with the conveyor band, thereby closing a control circuit containing the humid veneer band, which control circuit initiates the cutting operation by means of a relay circuit.

The contacts are tiltably arranged and maintained vertical by gravity or the like. By the passage of the veneer on the conveyor band, these contacts are tilted into a position in which they will not obstruct the further advancement of the veneer. When the veneer has passed the contacts, they will again resume their operative vertical position under the effect of gravity.

The severance of a veneer piece from the veneer band and the advance of the veneer piece interrupts the electric circuit which the veneer band established between the cutter and the contact.

It will be understood that the distance of the contact from the cutter determines the length of the veneer piece to be cut from the veneer band, and thus constitutes a measured distance.

This measured distance, and hence the length of the veneer piece to be cut from the band, can be adjusted, if the contacts are slidably mounted on a support. The contacts may be moved into position within the path of the conveyor band and then secured in position. Alternatively, a plurality of such tiltable contacts may be spacedly arranged, each having a different desired distance from the cutter. Insertion of a selected one of these contacts into the electric control circuit will serve to automatically cut veneers of different lengths depending on the measured distance of the selected contact. Both embodiments of a variable measured distance may be simultaneously used.

In modern high efficiency veneer cutting machines, the cutter is moved so rapidly down and back up (see my copending U.S. patent application, Ser. No. 455,995, filed Aug. 24, 1954), now abandoned, that the veneer band need not be at rest but may advance during the cutting operation. Since this advancement is rapid in the known machines, and the instance of cutting occurs after the signal, due to the contact meeting the front edge of the veneer band, has passed the control circuit and actuated the cutter drive, the veneer band has advanced somewhat past the contact, tilted by its passage, at the time the cutting operation takes place. Consequently the actual length of the veneer piece cut off from the veneer band deviates somewhat from the distances of the contact from the cutter. Further the rate of advance of the veneer band under the cutter cannot be maintained constant, because the cutting out of defective pieces, the quality of the veneer band, or the like, make it necessary to increase or decrease the normally high rate of advance by means of a manually operated known switch on the driving motor.

Experience has shown that in modern high-efficiency veneer cutting machines with a cutting frequency of about 1000 cuts a minute, a time delay occurs between the meeting of the contacts with the veneer band and the actual cutter operation, even though electronic control is used for the cutter drive (see the copending U.S. patent application, Ser. No. 457,150, filed Sept. 20, 1954, now Patent 2,918,971 issued Dec. 29, 1959 to Bertram, assigned to Carl-Heinz Müeller). Since all control and drive mechanisms exhibit a certain variation in their timing, which may for instance be due to the frequency of the alternating current, the mentioned delay is not constant and can, therefore, not be taken into account when the measuring distance is set. This repeatedly resulted in undesirable deviations in the length of the cut veneer pieces.

It is the object of the present invention to overcome this drawback; essentially the invention is based on the two following discoveries: At the instant of each cutting operation the veneer band must move with a certain velocity, which should be the same for all cutting operations; and this velocity must be so low that the effect, of the variations of the unavoidable time delay between the meeting of the contact with the veneer band and the cutting operation on the length of the veneer piece cut from the veneer band, is maintained within admissible limits. A velocity of between 6 to 10 meters/min. for the advance of the veneer band during the cutting operation appears to be satisfactory. It was thus the problem to draw the practical conclusions from this knowledge without sacrificing the advantages resulting from the normal average speed of approximately 60 meter/min. of the veneer band advance and the associated high efficiency of the veneer cutting machine.

According to the invention, this problem is solved, e.g. by arranging the contact feelers, which meet the veneer band after passing the cutter and the spacing of which from the cutter constitutes the measured distance for the veneer to be cut, as pairs of feelers, and by providing two alternately engageable drives for the conveyor band transporting the veneer band through the veneer cutting machine, one of the drives advancing the conveyor band with a high average velocity, and the other drive advancing the conveyor belt for the veneer band with the slow velocity intended for the cutting operation. The two drives are alternately connected to advance the conveyor belt in the following manner: When the veneer band meets the first contact feeler of a pair positioned closer to the cutter, the high-velocity drive is disconnected from the conveyor band and the low-velocity drive is connected instead; when the veneer band meets the second contact feeler of the same pair further removed from the cutter—which second contact feeler determines the measured distance—the drive for the cutter is actuated for one cutting operation and, after a suitable time-delay, the conveyor belt for the veneer is disconnected from the low-velocity drive and connected to the high-velocity drive.

The invention will be best understood from the following detailed description taken in connection with the accompanying drawings, forming a part of this specification and in which an embodiment of the invention has been shown by way of example. However, it should be understood that the invention is not limited to any strict conformity with the showing of the drawings, but may be changed or modified, as long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

FIG. 1 is a side elevation of a veneer cutting machine with two pairs of contact feelers behind the cutter;

FIG. 2 is a top view of a portion of FIG. 1;

FIG. 3 is a diagram of the electronic control circuit; and

FIG. 4 is a graph of the veneer velocity vs. time curve in an automatic machine as shown in FIG. 1.

As illustrated in FIG. 1, a frame **6** supports a cutter **1** having a driving motor **2** and a cutter plate **12**. The frame also carries reversal rollers **14** and **15** for the conveyor bands **3** and **4**. The transmission of motion from the conveyor bands **4** to the conveyor bands **3** is effected by a chain or belt drive R, over rollers **14'** and **15'** which are of different diameter, whereby the bands **4** advance faster, by a predetermined amount, than the bands **3**. The driving motor **2** may be an electrically controlled hydraulic wing motor which carries out a reciprocating movement, such as described in my co-pending U.S. patent application Ser. No. 455,995. This motor **2** is connected by way of links **16**, **19**, to a holder **18** for the cutter, which holder may move up and down in a guide **17**. Link **16** is mounted for reciprocating movement through an angle α. The conveyor bands **3** transport veneer band A, taken, e.g., from a roll (not shown) to the cutter **1**, as described in the above mentioned co-pending U.S. patent application Ser. No. 457,150.

The veneer band A travels from the conveyor band **3** to the conveyor **4**, which consists of a plurality of adjacent endless bands of insulating material, e.g. of rubber. The conveyor bands **3** and **4** are alternately driven by a known continuously-variable speed motor **5** (FIGS. 1 and 2) for the high adjustable average velocity of the veneer band A, and by a motor **7** with constant low velocity suitable for the cutting operation, by means of a double-action electromagnetic clutch **26**, **27**. The contact feelers arranged behind the cutter **1** in the path of the veneer band and between the conveyor bands **4** are, according to the invention, double contacts **8**, **9** and **8'**, **9'**, respectively. The contacts **9** and **9'**, respectively, determine the measured distance for the desired length of the veneer piece B to be cut; they also actuate the switches for the motor **2** of the cutter. The other contact feelers **8**, **8'** of each double contact serve to switch by means of the magnetic clutch **26**, **27** the drive of the conveyor bands **3**, **4**, carrying the veneer band A, from the motor **5** of high average velocity to the motor **7** of constant low velocity for the cutting operation. This will be described below.

The distance between the contacts **8** and **9**, and that between **8'** and **9'**, is so chosen that the veneer band A finds time on its way from the contact **8** (**8'**) to the contact **9** (**9'**) to reduce its velocity from its high value to the low value equal for all cutting operations of the cutter **1**.

The electric control of the magnetic clutch **26**, **27** as well as that of the motor **2** for the cutter **1** is effected by the electronic control circuit (FIG. 3), responsive to the contacts **8**, **9** (**8'**, **9'**).

It will be understood that if only one stationary contact pair is arranged behind the cutter **1**, only one measured distance will be available. However, assuming a sufficient length of the conveyor band **4**, a considerable number of such pairs of contacts may be arranged at varying distances from the cutter **1**; as many measured distances as there are pairs of contacts will be available.

In the embodiment of the invention illustrated in the drawing, the two contact pairs **8**, **9** (**8'**, **9'**) are arranged behind the cutter and at different desired distances from the cutter **1**. The contact pair **8**, **9** is stationary mounted on a fixed support T, while the contacts **8'**, **9'** are slidable on a fixed support T' of the machine frame and can be secured in position. It follows that the measured distance determined by the contact feelers **8**, **9** is fixed, while the distance between the pair of contacts **8'**, **9'** and the cutter **1**, and thereby the associated measured distance, can be varied by shifting of these contacts. Of course, the measured distance formed by the contact feelers **8**, **9** could be adjustable if these feelers were made slidable on their fixed support T.

Depending on which measured distance is to be used, either the contact pair **8**, **9** or **8'**, **9'** is inserted into the control circuit by means of a schematically shown selector switch **20**.

The control of the transport and cutting operations is accomplished by the electronic control circuit **10** (FIG. 3). This control circuit comprises triodes **30** and **31**, batteries **32**, **33** and **34**, resistances **35** and **36**, a capacitor **37**, a relay **38** with contacts **39** and **40**, and a relay **41** with contacts **42** and **43**. Cathodes **44** and **45** of the triodes **30** and **31** are heated by battery **33** over wire **67**. The grid **46** of the triode **30** receives a negative bias from battery **34** via a wire **66** and a resistor **35**. The triode **31** receives a grid bias for its grid **47** also from battery **34** via the wire **66** and a resistor **36**.

The positive terminal of the battery **33** is connected by a wire **48** to a tap on the battery **34**. A further tap on the battery **34** is connected by a wire **49** to the frame **6** of the cutter **1**. The positive terminal of the battery **34** is connected by wire **50** to the contact **42** of the relay **41** and to contact **39** of the relay **38**. The capacitor **37** is connected in parallel to the winding of the relay **38**.

Let us assume that, in the illustrated embodiment, the contact pair **8**, **9** be connected by the selector switch **20** and contact pair **8'**, **9'** thus inoperative. Under normal working conditions, both motors **5** and **7** are running.

At the beginning of an operating cycle, the clutch **26** (FIG. 2) receives its operating voltage from battery **32** through a wire **70**, the contact **40** of the relay **38** and a wire **60**. The motor **5**, coupled to the clutch **26** by the belt or chain drive **63**, in turn drives the driving roller **21** for the conveyor bands **4** and **3** through a driving belt **22**, whereby the conveyor bands **4** and **3** are driven at the speed of motor **5**.

When the front edge of the veneer band A meets at this velocity the contact feeler **8**, a current flows from

the battery 34 through the wire 49, the frame 6, the cutter plate 12, the veneer band A, the contact feeler 8, the wire 64, the selector switch 20 connected to wire 64, a wire 65 to the grid 46 of the triode 30, and thus changes the negative bias supplied over resistance 35 and wire 66 by battery 34. This starts triode 30 to conduct, whereby a current flows from the battery 34 through the wire 50, the contact 42 of the relay 41, the wire 68, the winding of the relay 38 and the wire 69, the plate 51, the cathode 44 of the triode 30, the wire 48 and back to battery 34. This causes the relay 38 to attract, switching contact 40, thereby interrupting the magnetic clutch 26 and connecting the magnetic clutch 27 to the battery 32 through wire 70, contact 40 and wire 61. The magnetic clutch 27 now connects the motor 7, connected to the clutch 27 by the chain or belt drive 71, to the driving roller 21 of the conveyor bands 4 and 3, so that these are now driven by the constant low velocity of the motor 7. The veneer band A now tilts the contact feeler 8 downwards into a position where it does not interfere with its advance and its front edge meets contact feeler 9 while progressing with this low velocity.

Meeting of the contact feeler 9 and the front edge of the veneer band A establishes a circuit from the battery 34 through the wire 49, the frame 6, the cutter plate 12, the veneer band A, the contact 9, the wire 72, the selector switch 20 and the wire 73 to the grid 47 of the triode 31. The negative grid potential supplied through the resistor 36 and the wire 66 from the battery 34 is thus changed to cause the triode 31 to carry current. The plate current flows from the positive terminal of the battery 34 through wire 50, contact 39 of the relay 38, wire 74, the winding of the relay 41, wire 75, plate 52, cathode 45 of the triode 31 and wires 67 and 48 to the battery 34. The relay 41 will now attract, closing contact 43 which supplies power from the supply N to the motor 2 of the vgeneer cutter 1 which now cuts the veneer band. Operation of relay 41 also opens the contact 42, cutting off the plate voltage for the plate 51 of the triode 30; the triode stops conducting. However, the capacitor 37, charged by the closing of the above circuit, prevents the relay 38 from releasing until discharged, so that the contacts 39 and 40 return to their initial position, as shown in FIG. 3, only after the discharge time of the capacitor has elapsed.

Until the release of the relay 38 into its initial condition, the motor 7 drives the conveyor bands 4 and 3 of the veneer band A through the magnetic clutch 27 in the manner described above. Since the conveyor band 4 travels faster than the conveyor band 3, an air gap occurs between the front edge of the veneer band A and the veneer piece B cuts therefrom. This air gap interrupts the currents flowing until then from the battery 34, the wire 49, the frame 6, the cutter 1, the veneer band A, the contacts 8 and 9, the wires 64 and 72, the selector switch 20, the wires 65 and 73 to the grids 46 and 47 of the triodes 30 and 31, respectively, returning the circuits to their initial condition and disconnecting the motor 2 from the power supply. Now the relay 38, held by the capacitor 37, releases.

Release of the relay 38 operates contact 40 and thereby switches the battery 32 from the magnetic clutch 27 to the magnetic clutch 26 so that the drive of the conveyor bands 4, 3 is again taken over by motor 5 and the system operated as at the onset of the cycle of operation.

The veneer band A now travels with the high velocity of the motor 5 until the front edge thereof again meets the contact feeler 8 and the operation cycle is repeated.

The veneer piece B, thus severed from the veneer band A, travel past the disconnected pair of contacts 8', 9' without any effect by tilting these contacts. The contact feelers 8, 9 (8', 9') reassume their upright position by the action of gravity, or by a spring action, or the like.

Since the cycle of operation initiated by the pair of contacts 8', 9' is the same as that initiated by the pair of contacts 8, 9, a repetition of the description of this operation appears to be dispensable.

FIG. 4 is a curve showing the velocity of the veneer band before, during and after each cutting operation of the cutter 1. The arrows z indicate the instants of cutting, the abscissa x represents time, and the ordinate y represents the speed of advance of the veneer band so that the relationship between time, the velocity of advance of the veneer band, and the cutting operation, can be seen from the graph.

What I claim is:

1. In an apparatus for automatically cutting veneer from a veneer band while the band is in motion and having conveying means for moving the veneer band along a predetermined path and a cutter movable up and down with respect to said veneer band; and having first driving means for said conveying means comprising a manually controlled device of variable speed and a drive for constant speed; second driving means for said cutter, switching means actuating said second driving means; clutch means for connecting said conveying means with said manually controlled drive and with the drive of constant speed, respectively; a control device being responsive to electric feeler means arranged in the path of the moving veneer band in a preselected distance behind the cutter; said control device being adapted and connected so as to actuate said clutch means upon a signal from said feeler means for disconnecting said manually controlled speed drive from said conveyor means, and for connecting the constant speed drive with said conveying means and for subsequently closing said switching means for one cut of said cutter and then reconnecting said manually controlled drive with said conveying means; the improvement wherein said control device comprises a first electron tube and a second electron tube; a battery connected to provide cathode current, cut-off grid bias and plate voltage to both tubes; a first relay connected into the plate circuit of said first tube, a double switch and a single switch operated by said first relay, said double switch controlling the speed of said first drive, said single switch being connected in the plate voltage supply for the second tube; a time-delay capacitor, connected in parallel to the winding of said first relay; a second relay connected into the plate circuit of said second tube and operating said switching means, said switching means being normally set for high-speed operation of said first drive; a normally closed switch, also operated by said second relay and being connected into the plate supply for said first tube; two contacts spacedly arranged two predetermined distances from said cutter; said first contact being connected to the control grid of said first tube; said second contact being connected to the control grid of said second tube; automatic means supplying a potential to each contact at predetermined positions of the work piece; said potential being of a value to overcome the negative grid bias of each tube; and means for re-establishing the initial negative grid bias after each operation of said cutter.

2. In an apparatus as claimed in claim 1, the further improvement comprising two pairs of contacts and a double-pole double-throw switch, the two pairs of contacts being arranged at different distances from said cutter, the center terminals of said switch being connected to the grids of said tubes, respectively, each pair of outside terminals being individually connected to one pair of said contacts.

3. In an apparatus as claimed in claim 1, wherein said first drive comprises a first motor running at said comparatively high speed, a second motor running at said comparatively low speed, a rotatably supported shaft, and a double-action electromagnetic clutch mounted on said shaft and having a first driven roller associated with a first clutching mechanism and a second driven roller associated with a second clutching mechanism, each of said clutching mechanisms when energized clasping said shaft, said shaft being connected to drive said conveying

means, said first motor being connected to drive said first driven roller, said second motor being connected to drive said second driven roller, said switching means alternately supplying energizing current to said clutching mechanism and supplying said first clutching mechanism when the relay is in its rest position.

4. In an apparatus as claimed in claim 3, wherein at least one of said motors is a variable-speed motor, and a manual control for setting the speed.

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