UNITED STATES PATENT

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[54] INK FOUNTAIN KEY CONTROL SYSTEM

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[57] ABSTRACT

Unitary electrical control for several individually adjustable fountain keys which control the rate at which ink is withdrawn from an ink fountain on a printing unit at different locations across the sheet or web being printed upon. The settings of the keys are sensed electrically and each key can be adjusted only a limited amount with respect to the neighboring keys.

14 Claims, 4 Drawing Figures
INK FOUNTAIN KEY CONTROL SYSTEM

This is a continuation of application Ser. No. 829,916, now abandoned, filed June 3, 1969.

This invention relates to a control for the fountain keys controlling the rate at which ink is withdrawn from an ink fountain in a printing unit.

A principal object of this invention is to provide a novel and improved unitary electrical control for fountain keys in an inker for a printing unit which enables the user to selectively adjust each fountain key individually in a convenient manner, preferably from a remote location.

Another object of this invention is to provide such a control in which the position of each key is sensed and the key being adjusted is limited in the extent to which it can be displaced with respect to one or more neighboring keys.

Further objects and advantages of this invention will be apparent from the following detailed description of a presently preferred embodiment thereof, which is illustrated schematically in the accompanying drawings.

In the drawings:

FIG. 1 is a schematic end elevational view of a printing unit provided with an inker having the present fountain key control;

FIG. 2 is a fragmentary and schematic perspective view showing two neighboring fountain keys and the adjusting mechanism therefor in accordance with the present invention;

FIG. 3 is an enlarged end elevational view showing one fountain key and its adjusting mechanism in greater detail; and

FIG. 4 is a schematic electrical circuit diagram showing the control circuitry associated with four of the fountain keys in the present system, as illustrative of the complete control circuit for all of the fountain keys.

Referring to FIG. 1, the present fountain key control system may be associated with the inker 1 of a lithographic printing unit of known design which has a plate cylinder 10, a blanket cylinder 11, and an impression cylinder 12. The inker 1 has an ink fountain or reservoir 13, a fountain roll 14 for transferring ink from the fountain roll 13, an adjustable ducting mechanism including a duct roll 15 for receiving ink from the fountain roll, and a plurality of ink transfer and vibrating rolls 16 for transferring ink from the duct roll to the plate cylinder 10 in a known manner.

The duct roll 15 is cyclically reciprocated angularly between a position in which it engages the fountain roll 14 and a position in which it engages the first vibrating roll 16a. During the portion of a cycle when the duct roll 15 engages the fountain roll 14, the fountain roll 14 is rotated an angular amount determined by the operation of a pawl and ratchet drive 17 of known design. The amount of angular rotation of the fountain roll 14 while engaged by the duct roll 15 determines, for a given thickness of the ink film on the fountain roll, the amount of ink transferred from the fountain roll to the duct roll and, therefore, the amount of ink transferred through the inker to the plate cylinder 10.

As best seen in FIG. 2 the fountain roll 14 constitutes one side of the ink fountain or reservoir 13, and the opposite side of this reservoir is provided by a generally flat fountain blade 18, which is inclined downwardly and inwardly toward the surface of the fountain roll 14 to define therewith the bottom of the ink reservoir. The spacing between the bottom edge of the fountain blade 18 and the adjacent surface of the fountain roll determines the thickness of the ink film withdrawn by the fountain roll from the reservoir or fountain 13.

The fountain blade 18 extends along the length of the fountain roll, and a plurality of adjusting keys K (only two of which are shown in FIG. 2) bear against the outside of blade 18 close to its bottom edge at locations spaced apart along the length of the fountain roll. The adjustment of each key K determines the thickness of the ink film withdrawn from the fountain in the vicinity of that key. The adjustments of the several keys K may be different from one another because the printer may want to provide different ink film thicknesses along the length of the fountain roll, depending upon the requirements of the particular job. The present invention is directed to a novel control for making the individual adjustments of the fountain keys K.

As best seen in FIG. 3, each fountain key K has a screw-threaded portion 20 which threadedly engages a complementary screw-threaded opening 21 in a vertical wall 22 of a support housing H, which is fixedly positioned on the opposite side of the fountain blade 18 from the fountain roll 14. The inner end of the key K has a control point 23 which bears against the outside of the fountain blade 18 near the latter's bottom edge. Obviously, the longitudinal adjustment of the key toward or away from the fountain roll (which is made by turning the key in the opening 21) determines the thickness of the ink film which is withdrawn by the fountain roll 14 at that key. This adjustment may be performed manually, and for this purpose each key has a knob 24 on its outer end (away from the fountain blade 18). As shown in FIG. 3, each key has a smooth cylindrical shank portion 25 between its screw-threaded portion 20 and its knob 24, and this smooth shank portion is rotatably supported by a suitable antifriction bearing 26 carried by a vertical wall 27 of housing H which is spaced outwardly from the housing wall 22 which threadedly passes the key.

Between the housing walls 22 and 27 each key carries a spur gear 28 driven by a pinion shaft 30 which is rotatably supported by antifriction bearings 31 and 32 carried by the respective housing walls 22 and 27. Each pinion shaft 30 is coupled to the output side or driven half of a respective electromagnetic clutch 33 of conventional design. The input side or driving half of each clutch is connected to a respective small helical gear 34 which meshes with a screw shaft 35 extending longitudinally of the fountain roll 14 and driven by an electrically energized stepping motor 36, as best seen in FIG. 2. When motor 36 is energized, the screw shaft 35 drives the input side or driving half of every one of the clutches 33 for the respective keys K but, as described hereinafter, only one clutch can be energized at a time and therefore this drive can be imparted to only one selected key K at a time.

The spur gear 28 connected to each key drives a respective pinion 37 attached to the rotary input shaft 38 of a respective potentiometer P, whose casing is attached to the housing wall 27, as shown in FIG. 3. With this arrangement, the effective resistance of each potentiometer P corresponds to the adjusted rotational position of the respective fountain key K. Each potentiometer is a position sensor for the respective key.

Referring now to FIG. 4, the respective potentiometers for the first four keys, starting from the left end
of the fountain blade 18 in FIG. 2, are designated as \( P_a \), \( P_b \), \( P_c \), and \( P_d \) respectively. As already indicated, the position of the adjustable contact of each potentiometer is proportional to the position of the respective fountain key \( K \) toward or away from the fountain roll 14.

The potentiometer resistances are connected in parallel with each other, with one end of each connected through a resistor 39 to a 15 volt D.C. positive power supply terminal 40 and with the opposite end of each connected through a resistor 41 to minus 15 volt D.C. negative power supply terminal 42.

Three sets of normally open relay contacts \( a_1, a_2 \) and \( a_3 \) are connected to the adjustable contact of potentiometer \( P_a \). These sets of contacts are controlled individually by respective relay coils \( A_1, A_2 \) and \( A_3 \) (shown at the bottom of FIG. 4), such that when relay coil \( A_1 \) is energized it will close contacts \( a_1 \), and when relay coil \( A_2 \) is energized it will close contacts \( a_2 \), etc.

Similarly, three sets of normally open relay contacts \( b_1, b_2 \) and \( b_3 \) are connected to the adjustable contact of potentiometer \( P_b \) and are arranged to be closed individually by the energization of the corresponding relay coils \( B_1, B_2 \) and \( B_3 \); three sets of normally open relay contacts \( c_1, c_2 \) and \( c_3 \) are connected to the adjustable contact of potentiometer \( P_c \), and are arranged to be closed individually by the energization of the respective relay coils \( C_1, C_2 \) and \( C_3 \). Three sets of normally open relay contacts \( d_1, d_2 \) and \( d_3 \) are connected to the adjustable contact of potentiometer \( P_d \). Contacts \( d_1 \) and \( d_2 \) are arranged to be closed individually in response to the energization of respective relay coils \( D_1 \) and \( D_2 \). Contacts \( d_3 \) are arranged to be closed individually by the energization of a corresponding relay coil which does not appear in FIG. 4, but would appear in the next group of relay coils to the right if FIG. 4 were extended.

All of the relay contacts with the subscript “1” (i.e., contacts \( a_1 \), \( b_1 \), \( c_1 \), \( d_1 \), etc.) are connected through a resistor 43 to one input terminal of a first differential amplifier 44. All of the relay contacts with the subscript “2” (i.e., contacts \( a_2 \), \( b_2 \), \( c_2 \), \( d_2 \), etc.) are connected through a resistor 45 to the second input terminal of the differential amplifier 44.

Also, all of the relay contacts with the subscript “2” are connected through a resistor 46 to one input terminal of a second differential amplifier 47. All of the relay contacts with the subscript “3” (i.e., contacts \( a_3 \), \( b_3 \), \( c_3 \), \( d_3 \), etc.) are connected through a resistor 48 to the second input terminal of differential amplifier 47.

To illustrate the operation of the portion of the control circuit already described, let it be assumed that the operator wants to adjust the “B” fountain key (the next key to the right from the left end key in FIG. 2). To do so, he manually closes a normally open switch \( B \), which has its movable contact connected directly to the positive power supply terminal 40.

If he desires to increase the ink film thickness provided by the “B” fountain key, he moves the adjustable contact of switch \( B \) into engagement with the left-hand fixed contact 49 of this switch, thereby completing an energization path for a relay coil \( X \) from the positive power supply terminal 40, through switch \( B \), a rectifier diode 50 and relay coil \( X \) to the negative power supply terminal 42. Relay coil \( X \) controls the energization of motor 36 such that when relay coil \( X \) is energized it causes the motor 36 to be energized in a direction effective to drive the shaft 35 in a direction for retracting away from the fountain roll whichever fountain key (in this case, the “B” key) is then coupled to shaft 35 through the respective clutch 33.

Conversely, if the user desires to decrease the ink film thickness at the “B” fountain key, he moves the adjustable contact of switch \( B \) into engagement with the right-hand fixed contact 51 of this switch, thereby completing an energization circuit for a relay coil \( Y \) as follows: from the positive power supply terminal 40, through switch \( B \), rectifier diode 52 and relay coil \( Y \) to the negative power supply terminal 42. When energized, relay coil \( Y \) causes the motor to be energized in the opposite direction from the direction of its energization by relay coil \( X \), so that shaft 35 is driven in a direction for advancing toward the fountain roll 14 whichever fountain key (in this case, the “B” key) is then coupled to shaft 35 through the respective clutch 33.

The particular clutch 33 associated with the “B” fountain key is controlled by a relay coil \( B_3 \) such that this clutch will be engaged when \( B_3 \) is energized. Relay coil \( B_3 \) is energized in response to the closing of switch \( B \) in either direction. Thus, when switch \( B \) is closed to the left in FIG. 4, relay coil \( B_3 \) is energized from the positive power supply terminal 40 through switch \( B \), rectifier diode 53 and coil \( B_3 \) to the negative power supply terminal 42. Alternatively, when switch \( B \) is closed to the right in FIG. 4, relay coil \( B_3 \) is connected across the power supply terminals 40, 42 by way of switch \( B \) and rectifier diode 54.

Relay coils \( A_1, B_2 \) and \( C_2 \) are connected in parallel with relay coil \( B_3 \) to be energized whenever \( B_3 \) is energized.

Accordingly, when switch \( B \) is closed, the “B” fountain key will be driven from the motor 36 through the respective clutch 33, being either advanced inwardly or retracted, depending upon the direction in which switch \( B \) is closed. While this condition exists, the relay contacts \( a_1, b_2 \) and \( c_2 \) will be closed due to the energization of the respective relay coils \( A_1, B_2 \) and \( C_2 \). As long as the user holds switch \( B \) closed, the adjustable contact on potentiometer \( P_b \) will be moving continuously in accordance with the inward or outward movement of the “B” fountain key. The respective neighboring keys on either side of the “B” key (namely, the “A” key and the “C” key) will be stationary because their respective clutches 33 are not energized, and therefore the settings of the respective potentiometers \( P_a \) and \( P_c \) will remain unchanged.

The first differential amplifier 44 will receive two input signals, through the now-closed relay contacts \( a_1 \) and \( b_2 \), respectively. The input signal through contacts \( a_1 \) is determined by the setting of potentiometer \( P_a \) and is proportional to the position of the “A” fountain key. The input signal through contacts \( b_2 \) is determined by the instantaneous adjustment of potentiometer \( P_b \) and is proportional to the instantaneous position of the “B” fountain key. Amplifier 44 subtracts these two input signals, so that its output signal is continuously proportional to the difference between the now-fixed position of the “A” fountain key and the instantaneous position of the moving “B” fountain key.

The second differential amplifier 47 receives one input signal from potentiometer \( P_c \) through the now-closed relay contacts \( b_3 \). Amplifier 47 receives a second input signal through the now-closed relay contacts \( c_3 \) from the potentiometer \( P_c \), and this signal is propor-
tional to the now-fixed position of the “C” fountain key. Amplifier 47 subtracts these two input signals and continuously provides an output signal which is proportional to the difference between the now-fixed position of the “C” fountain key and the instantaneous position of the moving “B” fountain key.

Thus, the position of the fountain key (in this case, the “B” key) which is being adjusted is compared continuously against the positions of the next keys (in this case, the “A” and “C” keys) on either side.

From an inspection of FIG. 4, it will be evident that the same arrangement is provided for each of the other fountain keys (except the end keys) so that any key which is being adjusted has its instantaneous position compared against the positions of the neighboring keys on opposite sides of it.

In the case of an end key, such as the “A” key, it has only one neighboring key to be compared against. Thus, as will be evident from FIG. 4, the circuitry for the “A” key enables it to be compared against the “B” key only by the respective input signals applied to differential amplifier 47.

As shown in FIG. 1, the stepping motor 36 which drives shaft 35 to adjust the selected key K is energized through a translator 50, which is energized by an oscillator 51 through a respective gate 52 or 53. Gate 52 is open and gate 53 is closed when shaft 35 is driven clockwise, which is the direction for increasing the gap between the bottom edge of the fountain blade 18 and the fountain roll 14 at the selected key. Conversely, gate 53 is open and gate 52 is closed when shaft 35 is to be driven counterclockwise, which is the direction for decreasing the gap between the bottom edge of the fountain blade 18 and the fountain roll 14 at the selected key.

The clockwise gate 52 has one terminal normally connected to ground through a set of normally closed relay contacts $x_1$. However, when relay coil X is energized, as described, it opens contacts $x_1$ and thereby enables gate 52 to pass the signal from oscillator 51 to the translator 50.

The clockwise gate 52 has two additional terminals which are connected respectively to the outputs of voltage comparators 54 and 55, respectively.

Voltage comparator 54 receives a first input signal via resistor 56 from the output of the first differential amplifier 44. The second input terminal of voltage comparator 54 is connected by a resistor 57 to a negative D.C. signal from the adjustable contact of a potentiometer 58 connected in series with a fixed resistor 59 between the negative power supply terminal 42 and ground. As already indicated, differential amplifier 44 provides a comparison between a signal representing the instantaneous position of the selected key and the position of the next key to the left in FIG. 2. When the difference between these positions of these two keys reaches a predetermined limit value, as determined by the setting of the adjustable contact on potentiometer 58, the signal applied to one input terminal of the voltage comparator 54 from the output of differential amplifier 44 will exceed the signal on the other input terminal on voltage comparator 54 from the adjustable contact on potentiometer 58. The signal on the line 60 connecting the output of the voltage comparator amplifier 54 to the clockwise gate 52 now assumes a polarity effective to close this gate, so that the oscillator signal is no longer applied to the translator 50. As long as the difference between the positions of the two keys compared by differential amplifier 44 is less than this predetermined limit value, the signal on line 60 will have a polarity effective to permit gate 52 to pass the output of oscillator 51 to the translator 50.

The voltage comparator amplifier 55 similarly limits the extent to which the selected key can be displaced with respect to the next key to the right in FIG. 2. Corresponding circuit elements associated with voltage comparator 55 have the same reference numerals as those associated with comparator 54, but with a “prime” suffix added, and the description of these corresponding circuit elements will not be repeated in detail. As long as the difference between the respective positions of the key being adjusted and the next key to the right is less than the predetermined limit, which is determined by the adjustment of potentiometer 58', the output signal from differential amplifier 47 will be less than the signal from potentiometer 58' and therefore the signal on the output line 60' from comparator 55 will have a polarity effective to permit gate 52 to pass the oscillator output to translator 50. However, when the difference between the positions of these two keys exceeds the predetermined limit, the comparator 55 will produce a signal on its output line 60' of a polarity effective to close gate 52.

In this manner, the operation of gate 52 is such that the key being retracted can be displaced only a predetermined amount relative to the next key to the left (as determined by the setting of potentiometer 58) or a predetermined amount relative to the next key to the right (as determined by the setting of potentiometer 58'), whichever limit is lower.

Similarly, the counterclockwise gate 53 is under the control of limiting circuitry composed of circuit elements which are numbered the same as their respective counterparts in the limit circuits for gate 52, but with a “z” suffix added. In this manner, the key being adjusted inward toward the fountain roll 14 can be displaced only a predetermined amount relative to the next key to the left (as determined by the setting of potentiometer 58z) or a predetermined amount relative to the next key to the right (as determined by the setting of potentiometer 58z'), whichever limit is lower.

A set of normally closed relay contacts $y_1$ is connected between a terminal of the counterclockwise gate 53 and ground. These $y_1$ contacts are opened in response to the energization of relay coil $Y_1$, as already described in detail.

Usually the settings of potentiometers 58, 58', 58z and 58z' will be the same so that the key being adjusted can be displaced only so far with respect to either the neighboring key to the left or the neighboring key to the right.

From the foregoing, it will be evident that the selection of a particular switch A, B, C, etc., determines which fountain key is to be adjusted individually by the drive from motor 36, and the direction in which this switch is operated determines whether the selected key will be adjusted toward or away from the fountain roll 14. The inward or outward movement of the selected key is effected by the energization of the stepping motor 36 from the translator 50 and oscillator 51 through the respective gate 52 or 53. Either gate 52 or gate 53 will be opened, depending upon whether relay coil X or relay coil Y is energized, which, as described, depends upon which direction the selected switch is op-
erated. The selected gate will remain open to continue the energization of motor 36 only until the selected key reaches a predetermined displacement with respect to one or both of the neighboring keys on either side of it, at which time the respective gate 52 or 53 will close and the motor 36 will stop.

If desired the respective key selection switches A, B, C, etc., may be interlocked, either mechanically or electrically, so that only one switch at a time may be closed.

Also, it is to be understood that the several individual relay coils which are energized by the closing of a particular key switch (e.g., the coils A', B', C', and B') may actually be only one or two relay coils operating the corresponding designated relay contacts.

From the foregoing description it will be evident that the illustrated embodiment of the present control circuit uses the same few differential amplifiers and voltage comparators for all of the key adjustments because the circuit arrangement inherently enables any selected key to be compared against its neighboring key or keys.

While a presently preferred embodiment of this invention has been described in detail with reference to the accompanying drawings, it is to be understood that various modifications, omissions and adaptations which differ from the disclosed embodiment may be adopted without departing from the scope of the present invention.

Having described my invention, I claim:
1. In combination with an inker for a printing unit having a fountain roll and a fountain blade extending inward toward the fountain roll along the latter's length to control the thickness of an ink film withdrawn by the fountain roll past the fountain blade, and a plurality of fountain keys spaced apart in succession along the fountain blade and engaging the outside of the latter to control its spacing from the fountain roll, a control for said fountain keys comprising:
   electrically operable drive means for adjusting the fountain keys toward or away from the fountain roll;
   a plurality of switches individual to the respective fountain keys;
   a plurality of key position sensors individual to the respective fountain keys and arranged to produce signals corresponding to the positions of the respective keys;
   signal comparing means operable to produce an output signal proportional to the difference between two input signals;
   means responsive to the operation of a selected switch for connecting the position sensor for the key selected for adjustment and the position sensor for a neighboring key to the input of said signal comparing means to enable the latter to produce an output signal proportional to the difference between the respective positions of said last-mentioned keys;
   a comparator for comparing the output of said signal comparing means against a reference signal corresponding to the maximum permissible displacement of said selected key with respect to said neighboring key;
   and means operable by said comparator means for stopping the adjustment of said selected key when its displacement with respect to said neighboring key reaches said maximum permissible value,

whereby to limit the flexing of said fountain blade thereat.

2. The combination of claim 1, wherein said signal comparing means comprises two differential amplifiers, and said means responsive to the operation of a selected switch, except the switches for the end keys, connects the position sensor for the selected key to the inputs of both differential amplifiers and connects the position sensor for the neighboring key at one side of the selected key to the input of one differential amplifier and connects the position sensor for the neighboring key at the other side of the selected key to the input of the other differential amplifier.

3. The combination of claim 2, wherein there are provided two pairs of comparators with each pair connected to the output of a respective differential amplifier, means for applying to one comparator of each pair a respective reference signal of one polarity, and means for applying to the other comparator of each pair a respective reference signal of the opposite polarity.

4. The combination of claim 3, and further comprising means for energizing said drive means for the fountain keys, a pair of gates connected between said energizing means and said drive means to control the energization of the latter in opposite directions respectively, means for connecting to one of said gates to control the same the respective outputs of said one comparator of both pairs, and means for connecting to the other of said gates to control the same the outputs of said other comparator of both pairs.

5. A control for the fountain keys of an inker for a printing unit, said control comprising means for selectively adjusting the positions of the fountain keys individually, and means for limiting the individual adjustments of one or more keys with respect to the positions of one or more neighboring keys, said last-mentioned means comprising means for sensing the individual positions of the fountain keys and providing electrical signals indicative thereof, means operable to receive said electrical signals from said sensing means and for comparing the instantaneous position of a key which is being adjusted against the position of one or more neighboring keys, and means responsive to said comparing means for preventing the key which is being adjusted from being displaced more than a predetermined amount relative to said one or more neighboring keys.

6. A control according to claim 5, wherein said means for adjusting the fountain keys comprises a drive motor and a plurality of clutches driven by said motor and coupled individually to the respective fountain keys, and further comprising a plurality of switches individual to the respective fountain keys, and means controlled by said switches for engaging the clutch which is coupled to the fountain key selected for adjustment to impart the drive from said motor to said selected key and for connecting to said comparing means the means for sensing the position of said selected key and the means for sensing the position of one or more neighboring keys.

7. A control according to claim 6, and further comprising oscillator means for energizing the drive motor, gate means connected between said oscillator means and the motor, and means for closing said gate means to disconnect the motor from said oscillator means when the selected key which is being adjusted becomes displaced said predetermined amount relative to one or more neighboring keys.
8. A control according to claim 6, wherein said means for sensing the key positions comprises a plurality of key position sensors which produce signals representative of the individual positions of the respective keys, and said comparing means comprises differential amplifier means, and means operable by each switch for connecting the input of said differential amplifier means to the position sensor for the selected key and to the position sensor for a neighboring key to compare the signals therefrom.

9. A control according to claim 8, and further comprising signal comparator means connected to the output of said differential amplifier means, and means for applying to said comparator means a signal representing the limit of the adjustment of the selected key with respect to the neighboring key for comparison against the output of said differential amplifier means.

10. A control according to claim 9, and further comprising means for energizing the drive motor, gate means connected between said energizing means and the motor, and means connecting the output of said comparator means to said gate means to close the latter so as to disconnect said energizing means from the motor when the selected key reaches the limit of its adjustment relative to the neighboring key.

11. A control according to claim 8, wherein said differential amplifier means comprises two differential amplifiers, and means operable by each of said switches except those for the end fountain keys to connect the position sensor for the selected key to the input of both differential amplifiers and to connect the position sensor for the neighboring key on one side of the selected key to the input of one of the differential amplifiers and to connect the position sensor for the neighboring key on the opposite side of the selected key to the input of the other of said differential amplifiers.

12. A control according to claim 11, wherein said last-mentioned means comprises respective relay coil means operable by each switch, and relay contacts operable by the respective relay coil means to connect said position sensors to the respective differential amplifiers.

13. A control for the fountain keys of an inker for a printing unit, said control comprising means for selectively adjusting the positions of the fountain keys individually through a predetermined range of adjustment, means for providing a first signal indicative of the position of a selected one of said keys which is to be adjusted, means for providing a second signal indicative of the position of a neighboring key disposed adjacent to said selected one of said keys, comparator means for comparing the position of said one key as it is adjusted relative to the position of said neighboring key, said comparator means including means for comparing said first and second signals and for providing a third signal which varies with variations in the position of said one key relative to said neighboring key, and means responsive to said comparator means for limiting the adjustment of said one key relative to said neighboring key to a relatively small portion of said predetermined range of adjustment which is determined by the position of said neighboring key relative to said one key, said means for limiting adjustment of said one key including means responsive to said third signal for preventing said one key which is being adjusted from being displaced through more than the relatively small portion of the predetermined range of adjustment relative to said neighboring key.

14. A control for an inker of a printing unit having a plurality of ink control devices spaced longitudinally along the inker to control the deflection of an ink control blade for controlling the flow of ink from the inker, said control comprising first means for adjusting the positions of the ink control devices individually and means for electrically limiting the position of each ink control device with respect to the positions of any adjacent device comprising means for producing electrical signals each indicative of the position of a corresponding one of said ink control devices, said signals each having a characteristic whose magnitude indicates the position of the corresponding device, and means for receiving said electrical signals and for controlling said first means to limit the difference between said electrical signals for adjacent ink control devices to a predetermined maximum on adjustment of an ink control device.