

- [54] **PEN HAVING VERTICAL MOVEMENT CONTROL**
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318/640, 687, 686, 128; 250/231 R, 231 P,  
229; 310/27, 13; 33/18 R

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[57] **ABSTRACT**

A mechanism to propel the vertical movement of an automatic drawing pen or apparatus in such a manner to maintain a constant writing pressure. The mechanism includes a movable coil mounted in a magnetic field responsive to a drive current. The pen moves with respect to the coil movement. Inherent with the mechanism is a control device to induce precise vertical movement of the pen by compensating for various parameters associated with the vertical movement of the pen to produce a constant velocity of the pen when it contacts a writing surface to eliminate possible bouncing of the pen.

**16 Claims, 7 Drawing Figures**

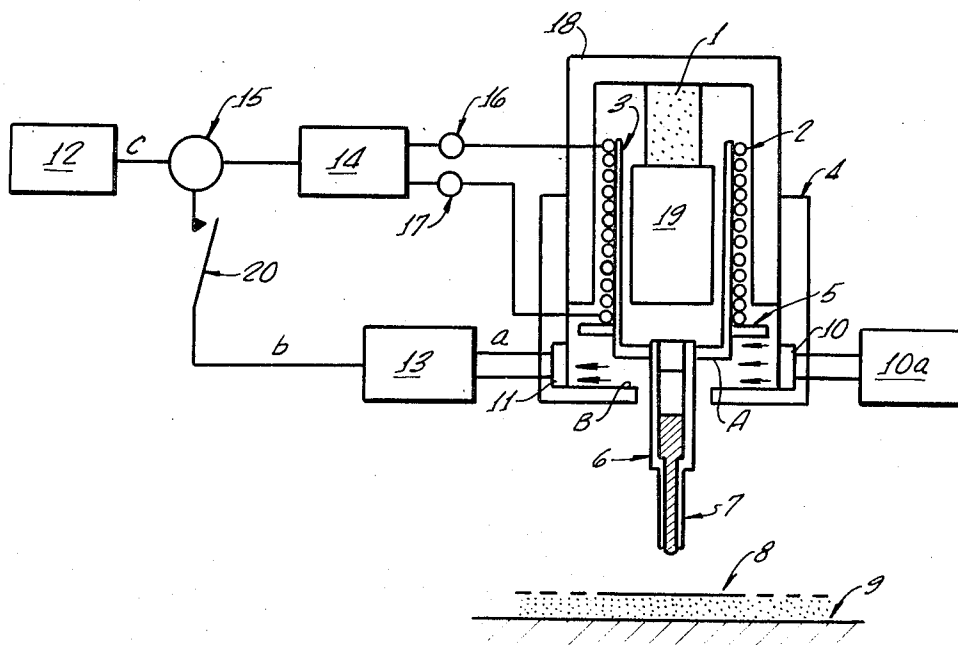


FIG. 1.

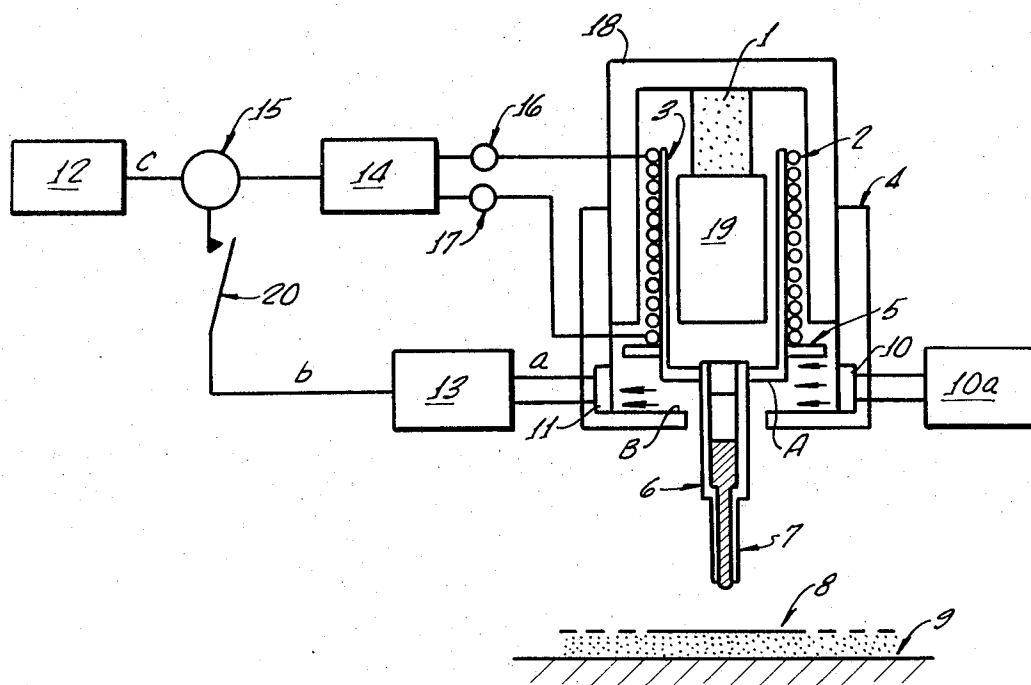
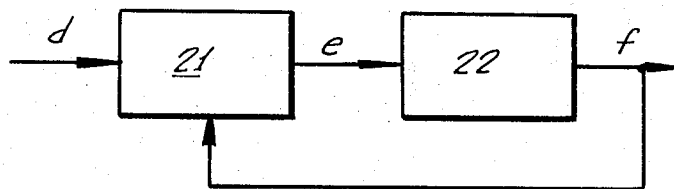


FIG. 3.



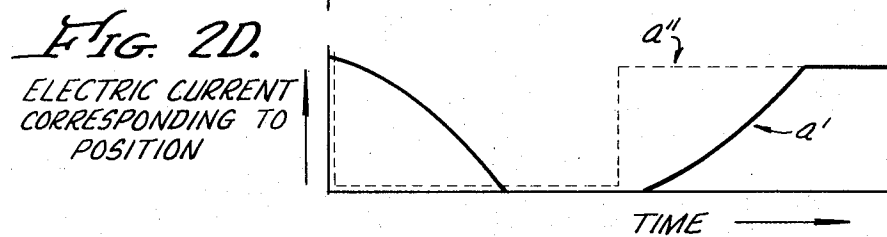
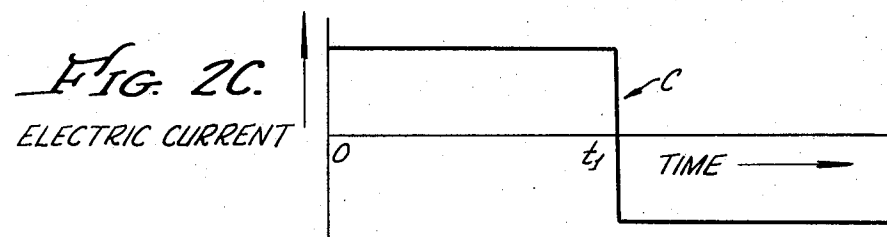
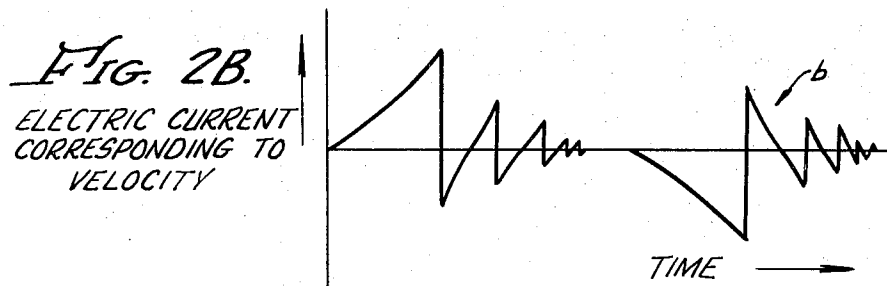
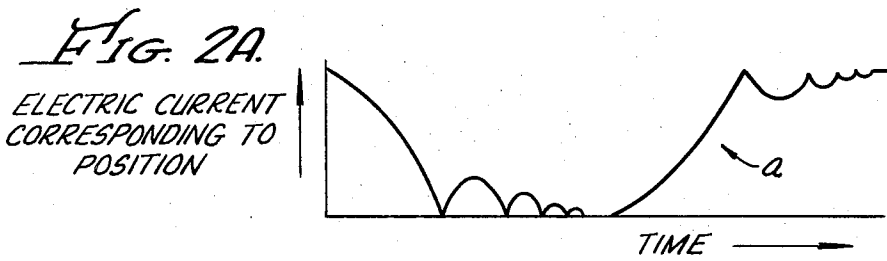
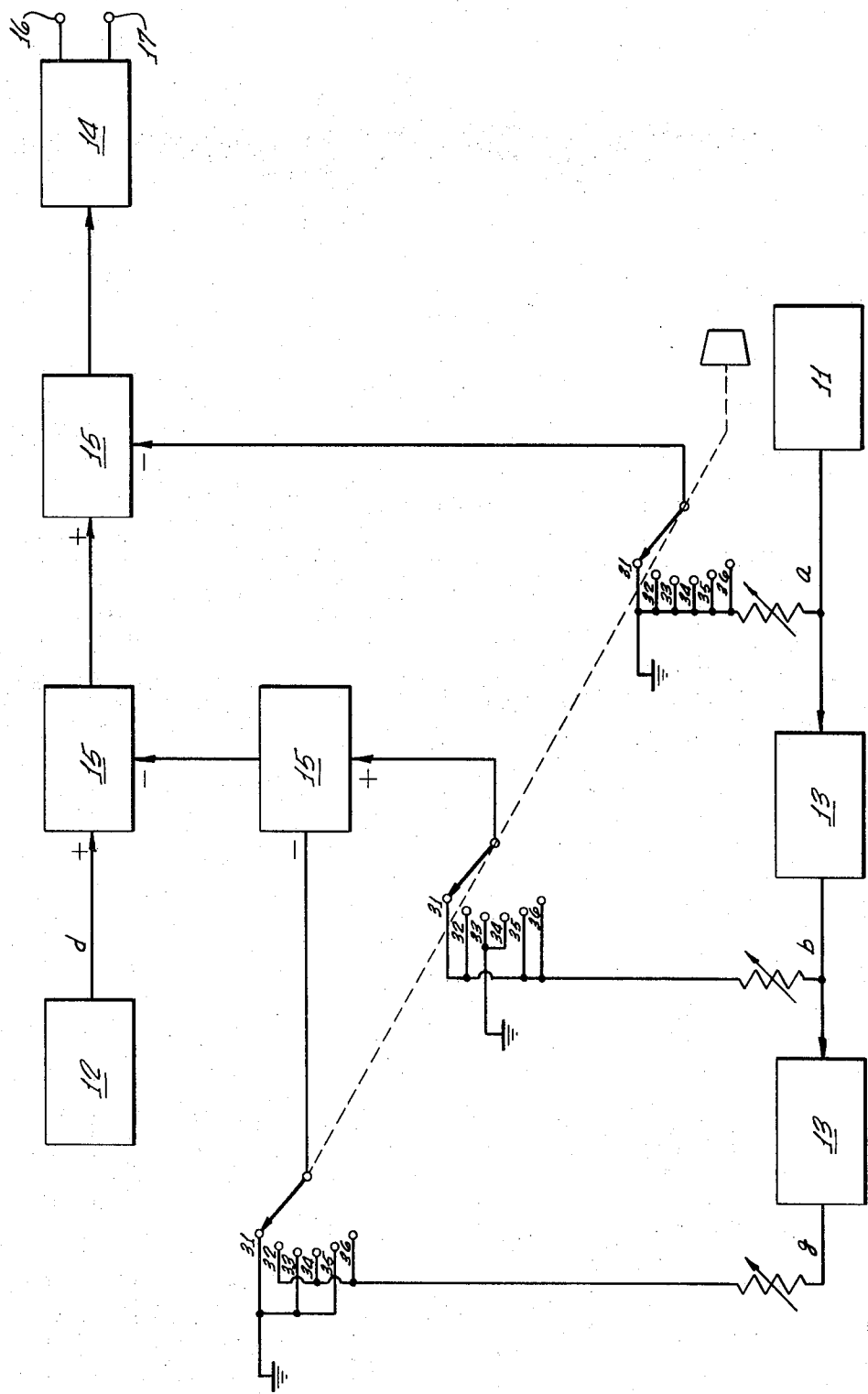


FIG. 4.



## PEN HAVING VERTICAL MOVEMENT CONTROL

## BACKGROUND OF THE INVENTION

The present invention relates to an improved device for propelling and precisely controlling vertical movement of a pen at a high velocity in automatic drawing apparatus or the like.

The prior art devices for vertical movement of the pen include the use of an attractive force between a movable iron piece associated with the pen and a magnet and the use of a torque provided by a rotary solenoid. The means of the prior art using these manners of driving have been attended with various disadvantages such as an undesirable variation of the writing pressure of the pen depending upon the thickness of drawing paper and a movable stroke of the pen inconveniently limited by such a variable writing pressure. Also the prior art has been unable to properly control the velocity at which the pens moves.

The velocity at which the pen moves downward is accelerated as the pen moves on toward a plane of paper and the velocity reaches the maximum at the moment when the pen strikes against paper surface. As a result, collision of the pen with paper surface is followed by bounces of the pen which may cause quality of writing to be deteriorated or the pen may stick in paper surface. Ball pen or hollow ink pen has usually been used as the pen and, particularly when the hollow ink pen is used, ink may scatter on paper surface at the collision of the pen with paper surface. There has already been suggested and employed an improvement such that, to overcome the drawback as mentioned above, there is provided an element such as a spring to control the velocity of downward movement of the pen and to absorb said bounce. However, even with this approach, it has been difficult to eliminate the bounce of the pen on paper surface caused by factors such as low surface precision of the drawing board, unevenness of paper thickness and deterioration of the used spring when the pen is moved at high velocity. It has been difficult also to eliminate the bounce taking place at the upper limited position of the pen when the pen has been moved upward and it has usually been impossible to move the pen downward again before this bounce disappears. If the pen starts to be moved downward while the bounce of the pen occurring at the uppermost position thereof is still present, the initial condition of the downward movement of the pen might be altered by said bounce and accordingly the normal collision of the pen with paper surface might be affected, causing the pen to be violently bounced on the paper surface. Thus, an effective improvement of vertical movement velocity of the pen and consequently of writing velocity has conventionally been limited.

## SUMMARY OF THE INVENTION

The principal object of the present invention is to provide a new device to overcome the drawbacks of the means of prior art by utilizing improved means for control of the vertical movement of the pen in an automatic drawing apparatus or the like to assure vertical movement of the pen at high velocity with high accuracy and to maintain the writing pressure of the pen constant regardless of the surface precision of a particular drawing board and the thickness of used paper as well as to enlarge the movable stroke of the pen. The

present invention uses a movable coil mounted around a frame to which the pen is attached. This coil is located in a magnetic field and will move vertically according to the direction and amount of current induced through it. In order to determine the proper amount of current to be introduced through the coil at specified times, a control device, forming a part of the invention, will precisely vary the current according to feedback of various parameters associated with the movement of the pen which affect the velocity of the pen.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of the present invention;

FIG. 2A is a graphic representation of the signal *a* showing pen position with respect to time;

FIG. 2B is a graphic representation of the signal *b* showing the electric current corresponding to the velocity of the pen with respect to time;

FIG. 2C is a graphic representation of the signal *c* showing the electric current with respect to time;

FIG. 2D is a graphic representation of the comparison between optimal movement of the pen and the time delay movement of the pen;

FIG. 3 is a schematic view showing a general feedback control system; and

FIG. 4 is a detailed schematic view of a feedback control system showing the various switch settings for the various vertical movement parameters.

## DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1, a movable coil 2 is wound on a cylindrical winding frame 3 in a magnetic field which is produced by a cylindrical permanent magnet 1 across pole pieces 18 and 19. The coil 2 is supplied from a constant current source 14 with a drive current, causing the pen holder 6 and the pen 7 mounted on the cylindrical winding frame 3 to be subjected to a force upward or downward with respect to a plane of paper 8 placed on the drawing board 9 according to the Fleming's left hand law. Depending upon whether the drive current flows from terminal 16 or 17 the pen will move up or down as will be explained later. The upper limited position in the movable range of the pen 7 is defined by relative positions of lower end of the pole piece 18 and a stopper 5 while the lower limited position is defined by relative positions of lower end of the cylindrical winding frame 3 and an outer frame 4. The pen 7 is always subjected to a constant force upward or downward so far as winding width of the movable coil 2 is larger or smaller than the longitudinal width of the pole piece 19 and the number of magnetic flux intersecting said movable coil 2 within the movable range remains constant. This means that the force produced in the pen 7 remains constant so far as the movable stroke of the pen 7 corresponds to a difference between the longitudinal effective width of the pole piece 19 and the winding width of the movable coil 2. Thus, it is possible, as a principle, to provide the pen 7 with relatively large stroke of vertical movement. Accordingly, the pen 7 is pressed against paper 8 at a constant writing pressure regardless of the thickness of paper 8 and the surface precision of the drawing board 9. Although a permanent magnet is used in this embodiment, it will be obviously understood that this may be effectively replaced by an electromagnet.

With reference to the switch 20 in FIG. 1 no feedback occurs when it is open and the movable coil 2 is

subjected to a force in any one of opposite directions depending upon whether the drive current flows from the terminal 16 through the movable coil 2 to the terminal 16, or inversely from the terminal 17 through the movable coil 2 to the terminal 16. The movable coil 2 or the pen 7 may be vertically moved by changing over the direction in which the drive current flows through the movable coil 2. Vertical movement instruction signal *c* applied from a signal source 12 has its polarity reversed as mentioned later as the movement of the pen is reversed from upward to downward or vice versa. Accordingly, the drive current may be applied from the current source 14 to the movable coil 2 in proportion to the vertical movement instruction signal *c* to obtain vertical movement of the pen 7 in accordance with said vertical movement instruction signal *c*.

There are provided a luminous element 10 to be lit by a power source 10a and a light receiving element 11 between the A-surface of the cylindrical winding frame 3 and the B-surface of the outer frame 4 so that said light receiving element 11 is exposed to light emitted from said luminous element 10. These luminous and light receiving elements 10 and 11 are so arranged in a space defined between the A- and B- surfaces that an amount of the part of light emitted from the luminous element 10 that is intercepted varies according to the position of said A-surface which is vertically moved and consequently an amount of light to which said light receiving element 11 is exposed varies also in accordance with said position of the A-surface. A signal *a* corresponding to said amount of light to which said light receiving element 11 is exposed thus corresponds to a movement quantity of the pen 7. As seen in FIG. 1, the amount of light emitted from the luminous element 10 which is represented by three arrows is reduced to the amount represented by two arrows when received by the light receiving element 11. This reduction in the amount of light corresponds to the movement quantity of the pen 7. The signal *a* may be differentiated by a differentiator 13 to obtain a signal *b* corresponding to a velocity of the pen 7. The differentiator 13 is differentiating circuit which will produce as output a signal proportional to the derivative of the input signal. A simple exemplary embodiment of such a circuit is the combination of a series capacitor and shunt resistor where the RC time constant is kept very short.

Waveforms of said signals *a*, *b* and *c* are shown by FIGS. 2A, 2B and 2C, respectively. In FIG. 2A showing said signal *a*, the abscissa indicates the time and the ordinate indicates the electric current corresponding to the position of the pen 7. A series of peaks seen in FIG. 2A comprises the first half which indicates bounces of the pen 7 on paper 8 occurring in movement downward and the second half which indicates bounces of the pen 7 occurring at the uppermost position at the end of movement upward of said pen 7. FIG. 2B shows the signal *b* corresponding to the velocity at which the pen 7 is vertically moved. This signal *b* takes the positive polarity when the pen 7 is moved downward and the negative polarity when the pen 7 is moved upward. In FIG. 2B, the abscissa indicates the time and the ordinate indicates the electric current corresponding to the velocity of the pen 7. FIG. 2C shows the vertical movement instruction signal *c* comprising the signal for downward movement of the pen 7 while said signal *c* takes the positive polarity over the time from 0 to  $t_1$  and the signal for upward movement of the pen 7 while said signal

*c* takes the negative polarity over the time beyond  $t_1$ . In FIG. 2C, the abscissa indicates the time and the ordinate indicates the electric current.

When the switch 20 as shown in FIG. 1 is closed from the state shown by FIG. 2C, the signal ( $c-b$ ) is applied by a subtracter 15, which may be for example a second differential amplifier, and the output corresponds to a difference between the signal *c* from the signal source 12 and the signal *b* from the differentiator 13 to the current source 14 which may be an amplifier producing a current output that is proportional to the output of the subtracter 15. Now, the case will be considered where the vertical movement instruction signal *c* is positive or the pen 7 is moved downward. When the vertical movement instruction signal *c* (c.f., FIG. 2C) has the positive polarity (corresponding to the signal for downward movement of the pen 7), the drive current (of operating amount in automatic control engineering) is applied from the current source 14 to the movable coil 2. The drive current for the movable coil 2 (the electric current proportional to the signal ( $c-b$ )) decreases as the velocity of the pen 7 increases, since the signal *b* (c.f., FIG. 2B) corresponds to the velocity of the pen 7. The velocity of the pen 7 is maintained therefore substantially constant before the pen 7 strikes the paper surface 8. This velocity of the pen 7 decreases as the operating amount increases and, as a result, a shock of the pen 7 against paper surface is correspondingly reduced.

The velocity of the pen 7 should be preferably high so far as there is no bounce of the pen 7 on paper 8, since it is preferable for the pen 7 to take a short time from the uppermost position to the surface of paper 8. The operating amount is selected to keep the velocity. Then, in the case of the vertical movement instruction signal *c* of negative polarity of upward movement of the pen 7, the signal *b* also has the negative polarity and, in consequence, bounce of the pen 7 occurring at the uppermost position when the pen 7 is moved upward is removed just as the bounce of the pen 7 occurring on paper 8.

As shown by a broken line  $a''$  in FIG. 2D, the pen 7 presents an optimal movement when the vertical movement instruction signal *c* shown by FIG. 2C is followed without any time delay. In practice, however, the pen 7 is moved as shown by a solid line  $a'$  due to a time delay occurring under influence of a mass of movable elements. In FIG. 2D, the abscissa indicates the time and the ordinate indicates the electric current corresponding to the position of the pen 7.

FIG. 3 is a block diagram showing a general feedback control system corresponding to the embodiment shown by FIG. 1. Block 22 designates a movable element or an object to be controlled and 21 designates a control device (consisting of the differentiator 13 and the subtracter 15 in FIG. 1) adapted to supply said controlled object 22 with said opening amount *e* (i.e., the drive current for the movable coil 2). In the embodiment as previously described, the operating amount *e* corresponds to (reference input *d*-output response *f*) where said reference input *d* corresponds to said instruction signal *c* for vertical movement of the pen 7 (c.f., FIG. 2C) and said output response *f* corresponds to the electric current in accordance with the amount of vertical movement of the pen 7. As to the operating amount *e* to control movement of the pen 7, an additional five factors as following may be considered.

- i. Operating amount  $e = (\text{reference input } d) - (\text{electric current corresponding to velocity}) + (\text{electric current corresponding to acceleration})$  (1)

The electric current corresponding to the velocity in the formula (1) may be obtained by time-differentiating the output response  $f$  and the electric current corresponding to the acceleration in the same formula (1) may be obtained by time-differentiating said electric current corresponding to the velocity. Addition of the electric current corresponding to the acceleration to the operating amount  $e$  is effective in that the mass of the movable element included in the means for vertical movement of the pen may be equivalently reduced. As a result, the means for vertical movement of the pen which may improve the response characteristic of the pen in vertical movement can be provided.

- ii. Operating amount  $e = (\text{reference input } d) - (\text{electric current corresponding to movement amount})$  (2)

The electric current corresponding to movement amount of the pen in the above formula (2) is subjected to regulation such that said electric current has the positive polarity when the pen 7 is downward moved and the negative polarity when upward moved. The output response  $f$  should be always subjected to such a regulation when the electric current corresponding to movement amount of the pen is considered into the operating amount  $e$ . Said electric current corresponding to the movement amount of the pen 7, in such a case, increases as the pen 7 comes near to paper 8. This means that the operating amount  $e$  decreases and the velocity of the pen 7 accordingly decreases as the pen 7 comes near to paper 8. As a result, shock of the pen 7 against paper 8 and bounce of the pen 7 on paper 8 is reduced with respect to the case according to the embodiment shown by FIG. 1 and the formula (1). Also when the pen 7 is moved upward, the velocity is reduced as the pen 7 is moved upward and the bounce thereof occurring at the uppermost position is accordingly reduced. When the electric current corresponding to the movement amount is thus fed back to the control device 21, a writing pressure of the pen 7 is maintained constant so far as said movement amount of the pen 7 is constant. However, it may be impossible for said writing pressure to be maintained constant when the movement amount of the pen 7 varies in accordance with a variation in thickness of paper 8 and deterioration of the surface precision of the drawing board. To overcome this inconvenience, the electric current corresponding to the movement amount may be interrupted from being fed back to the control device 21 at the moment when the pen 7 reaches upper surface of paper 8 and the writing pressure of the pen 7 may be maintained only by the reference input  $d$  constant.

- iii. Operating amount  $e = (\text{reference input } d) - (\text{electric current corresponding to movement amount}) + (\text{electric current corresponding to acceleration})$  (3)

This is the case in which the electric current corresponding to the acceleration is added to the operating amount  $e$  in the previous case (ii). The electric current corresponding to the acceleration is effective to equivalently reduce a mass of the movable element included in the means just as in the case of (i). Therefore, the pen 7 moves in the same manner as in the case (ii) and the means for vertical movement of the pen in which

the pen 7 has a high response characteristic for vertical movement may be offered.

- iv. Operating amount  $e = (\text{reference input } d) - (\text{electric current corresponding to velocity}) - (\text{electric current corresponding to movement amount})$  (4)

This case is attended with the advantage and the disadvantage as mentioned in connection with the embodiment of FIG. 1 and the case (ii). However, shock of the pen 7 against paper 8 is further reduced with respect to the embodiment shown by FIG. 1. Also in this case, there arises the problem of writing pressure as in the case (ii), so that the same consideration as in the case (ii) is necessary.

- v. Operating amount  $e = (\text{reference input } d) - (\text{electric current corresponding to velocity}) - (\text{electric current corresponding to movement amount}) + (\text{electric current corresponding to acceleration})$  (5)

This is the case in which the electric current corresponding to the acceleration is added to the operating amount in the case (iv). The electric current corresponding to the acceleration is effective to equivalently reduce a mass of the movable element included in the means just as in the case (i). Therefore, the pen 7 moves in the same manner as in the case (iv) and the means for vertical movement of the pen in which the pen 7 has a higher response characteristic for vertical movement relative to the case (iv) may be offered. Also in this case, there arises the problem of writing pressure as in the case (ii), so that the same consideration as in the case (ii) is necessary.

Depicted in FIG. 4 is a detailed schematic of a feedback control system with the capability to selectively establish the feedback conditions exemplified by the arrangement shown in FIG. 1 and the five equations discussed above for determining the proper operating amount  $e$ .

When the switch of the circuit in FIG. 4 is positioned at 31 the control system operates just as shown in FIG. 1 where the receiving element 11 produces an output signal  $a$  proportional to the movement of the pen 7 to the differentiator 13 which in turn produces an output signal  $b$  proportional to the velocity of the pen 7. This signal  $b$  is received in the subtracter 15 as feedback to determine the proper instructional signal  $c$  to be sent to the current source 14. This feedback compensates for the increasing velocity of the pen 7 for example in the downward direction by decreasing the signal  $c$  as the pen 7 approaches the paper 8 and, therefore, helps to eliminate the shock of the pen 7 against the paper.

With the switch in position 32 on FIG. 4, the movement of the pen 7 can be made more responsively controlled by compensating not only for the velocity, but also for the acceleration of the pen. The signal  $b$  is received in a differentiator 13 which produces an output signal  $g$  proportional to the acceleration of the pen 7. This signal  $g$  is also received in a subtracter 15 along with the signal  $b$  in order to properly compensate for the proper operating amount by determining the proper reference input  $d$ . This operation is exhibited by equation (1) above.

Referring to position 33 of the switch in FIG. 4, the resulting circuit operation reflects the equation (2) discussed above where the signal  $a$  corresponding to the movement amount or position of pen 7 is sent to a subtracter 15 to compensate for the variation of the thick-

ness in the paper 8 or deterioration of the surface 9 in order to promote a constant pen pressure.

The switch position 34 in FIG. 4 corresponds to equation (3) above to offer a higher response to the movement characteristic, signal  $a$ , in addition to the acceleration characteristic, signal  $g$ , in the control operation.

The remaining two switch positions, 35 and 36, in FIG. 4 reflect the conditions explained previously regarding respective equations (4) and (5).

There is established an equation of motion, in connection with the case (i), of the movable element included in the means as follows:

$$m(dv/dt) = F_0 - [\alpha V - \beta(dv/dt)] \quad (6)$$

where  $m$  represents a mass of the movable element included in the means,  $v$  represents a velocity of the pen 7 and  $F_0$  represents a force exerted by the drive system on said movable element (i.e., a force developed in said movable element according to the reference input  $d$ ). In this equation (6),  $m(dv/dt)$  represents a force finally exerted on the movable element included in the means after feedback,  $\alpha V$  represents a force exerted by the electric current corresponding to the velocity on the movable element and  $\beta(dv/dt)$  represents a force exerted by the electric current corresponding to the acceleration on said movable element.  $\alpha$  and  $\beta$  depend upon the amount of the electric current corresponding to the velocity and the electric current corresponding to the acceleration fed back to the control device 21, respectively. Although an influence of gravity acceleration  $g$  is neglected on the assumption that this gravity acceleration is substantially smaller than  $F_0$  in the equation (6),  $F_0$  may be replaced by  $(F_0 + mg)$  when the acceleration of gravity is taken into account. The velocity  $v_A$  of the pen 7 before collision thereof with paper surface may be obtained by resolving the equation (6) as follows:

$$v_A = (F_0/\alpha) \{ 1 + [(\alpha/F_0)v_1 - 1] e^{-\infty(m-\beta)/\alpha} \} \quad (7)$$

where  $v_1$  represents the initial velocity of the pen 7.

It will be apparent from the equation (7) that, when the electric current corresponding to the acceleration is fed back to the control device 21 under the condition of  $m > \beta$ , the velocity  $v_A$  of the pen 7 will finally be a constant velocity  $(F_0/\alpha)$  regardless of the initial velocity  $v_1$ . Larger the value of  $\alpha/(m-\beta)$ , shorter the time taken before the velocity of the pen 7 reaches a substantially constant value. Assumed that the velocity at which the pen 7 strikes paper surface without any bounce is determined as  $v_A$ ,  $F_0$  and  $\alpha$  are necessarily determined. It is preferable, therefore, to select  $\beta$  substantially equal to  $m$  to obtain a larger  $\alpha/(m-\beta)$ . The time taken before  $v_A$  attains the constant velocity  $(F_0/\alpha)$  may be considered substantially as zero since this time is free from any influence of the mass  $m$  of the movable element. The velocity at which the pen 7 strikes paper 8 represented by  $(F_0/\alpha)$  therefore, may be controlled so that there takes place almost no bounce of the pen 7 on paper 8.

According to the present invention, as seen from the foregoing description, bounce of the pen 7 may be eliminated regardless of the surface precision of the drawing board and the thickness of paper 8 and the pen 7 may be moved at a constant velocity independently of the initial velocity thereof, resulting in that, even when the pen 7 is forcibly moved downward from the

state where the pen 7 is being upward moved or is bouncing at the uppermost position, it is possible for the pen 7 to be brought into collision with paper 8 at the constant velocity causing no bounce of the pen 7 on paper 8. The means for vertical movement of the pen according to the present invention is, accordingly, remarkably effectively particularly in application in which extremely high frequency of vertical movement of the pen is required to draw figures such as point- or letter-figuring.

Although the particular embodiment of the present invention has been described hereinbefore wherein a movement amount of the pen 7 is directly detected in optical manner, it will be obviously understood that the physical quantity corresponding to said movement amount of the pen 7 may be detected by electrostatic, magnetic or mechanic means for the same effect or the physical quantity corresponding to a velocity of the pen 7 may be directly detected for the same effect so far as a suitable processing is carried out after detection. For direct detection of the physical quantity corresponding to the velocity of the pen, for example, the principle that an electromotive force develops in an electric circuit which moves in a permanently constant magnetic field may be utilized. This electromotive force corresponds to the physical quantity in accordance with the velocity.

The present invention thus provides improved drive means for the drawing pen which is excellent in its response characteristic with respect to vertical movement.

What is claimed is:

1. A device for producing the vertical movement of a pen in a scribing apparatus comprising:
  - a frame member;
  - a movable coil mounted on said frame member;
  - means attached to said frame member for holding said pen;
  - means electrically connected to said movable coil for supplying a drive current to move said coil;
  - a first magnetic pole piece located within said frame member;
  - a second magnetic pole piece located outside of said frame member, said coil having a winding width greater than the longitudinal width of said first pole piece, so that the writing pressure of said pen is constant within the movable range of said coil; and
  - a feedback control device for controlling said drive current to said movable coil to insure that said pen makes a proper stroke with no bounce thereof on a work surface.
2. A device as claimed in claim 1, wherein said frame member is a cylindrical winding frame upon which said movable coil is wound.
3. A device as defined in claim 1, wherein said movable range of said coil can be varied by changing the respective difference in said longitudinal width of said first magnetic pole piece and said winding width of said coil.
4. A device as defined in claim 1, wherein said means for supplying a current source includes means for reversing the direction of the flow of the current to reverse said vertical movement of said pen.
5. A device as defined in claim 1 and additionally comprising means for limiting the upward travel of said pen.



6. A device as defined in claim 1 and additionally comprising means for limiting the downward travel of said pen.

7. A device as defined in claim 1 wherein said feedback control device comprises a detector to detect the signals of a movement amount, velocity and acceleration of said pen which are used to prevent bounce of said pen at the collision thereof with said writing surface, said feedback control device responding to any or a combination of any of said detected signals to varying said drive current.

8. A device as defined in claim 7 wherein said detector comprises a photoelectric sensing means for sensing a movement amount of said pen.

9. A device as defined in claim 8 wherein said detector additionally comprises a differentiator to receive velocity and acceleration signals from said movement amount signals of said pen.

10. A device as defined in claim 7 wherein said feedback control device additionally comprises a subtractor to control said drive current to said movable coil in response to said detected signals.

11. A device as defined in claim 1 wherein said feedback control device comprises:

- a photoelectric sensing means for sensing a movement amount of said pen;
- a differentiator to receive velocity and acceleration signals from said movement amount; and
- a subtractor to control said supplying means and said drive current to said movable coil in response to said movement amount and said signals, said drive current being equal to a reference current input minus current corresponding to said velocity signal.

12. A device as defined in claim 1 wherein said feedback control device comprises:

- a photoelectric sensing means for sensing a movement amount of said pen;
- a differentiator to receive velocity and acceleration signals from said movement amount; and
- a subtractor to control said supplying means and said drive current to said movable coil in response to said movement amount and said signals, said drive current being equal to a reference current input plus current corresponding to said acceleration signal minus a current corresponding to said velocity signal.

13. A device as defined in claim 1 wherein said feedback control device comprises:

a photoelectric sensing means for sensing a movement amount of said pen;

a differentiator to receive velocity and acceleration signals from said movement amount; and

a subtractor to control said supplying means and said drive current to said movable coil in response to said movement amount and said signals, said drive current equal to a reference current input minus a current corresponding to said movement amount.

14. A device as defined in claim 1 wherein said feedback control device comprises:

a photoelectric sensing means for sensing a movement amount of said pen;

a differentiator to receive velocity and acceleration signals from said movement amount; and

a subtractor to control said supplying means and said drive current to said movable coil in response to said movement amount and said signals, said drive current equal to a reference current input plus a current corresponding to said acceleration signal minus a current corresponding to said movement amount.

15. A device as defined in claim 1 wherein said feedback control device comprises:

a photoelectric sensing means for sensing a movement amount of said pen;

a differentiator to receive velocity and acceleration signals from said movement amount; and

a subtractor to control said supplying means and said drive current to said movable coil in response to said movement amount and said signals, said drive current equal to a reference current input minus a current corresponding to said velocity signal minus a current corresponding to said movement amount.

16. A device as defined in claim 1 wherein said feedback control device comprises:

a photoelectric sensing means for sensing a movement amount of said pen;

a differentiator to receive velocity and acceleration signals from said movement amount; and

a subtractor to control said supplying means and said drive current to said movable coil in response to said movement amount and said signals, said drive current equal to a reference current input plus a current corresponding to said acceleration signal minus a current corresponding to said velocity signal minus a current corresponding to said movement amount.

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