June 22, 1965 A. VACCARO 3,190,956

FACSIMILE APPARATUS HAVING A MAGNETICALLY BIASED MARKING STYLUS

Filed Sept. 9, 1959 4 Sheets-Sheet 1

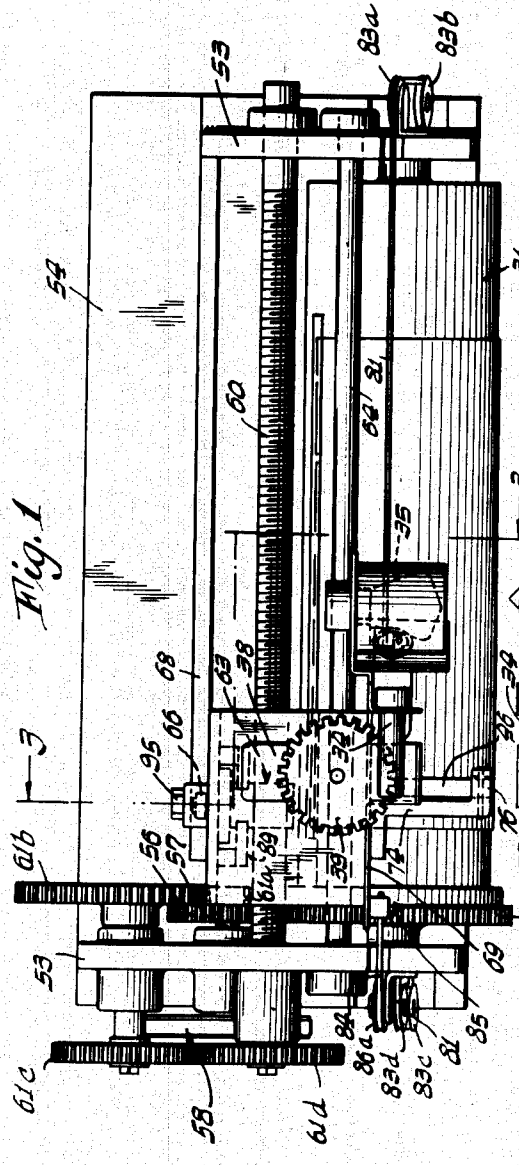

Fig. 1

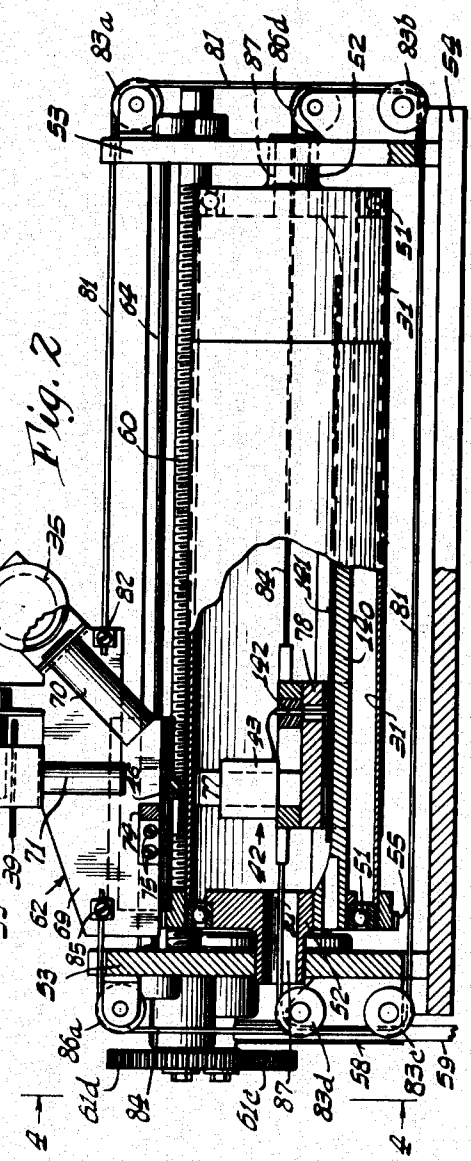

Fig. 2

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Fig. 3

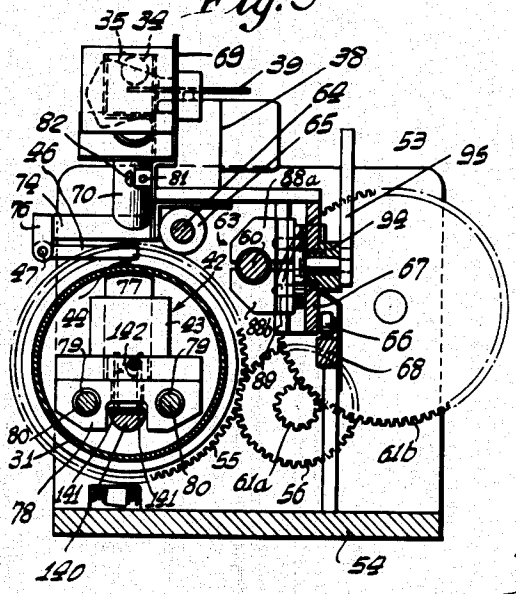

Fig. 4

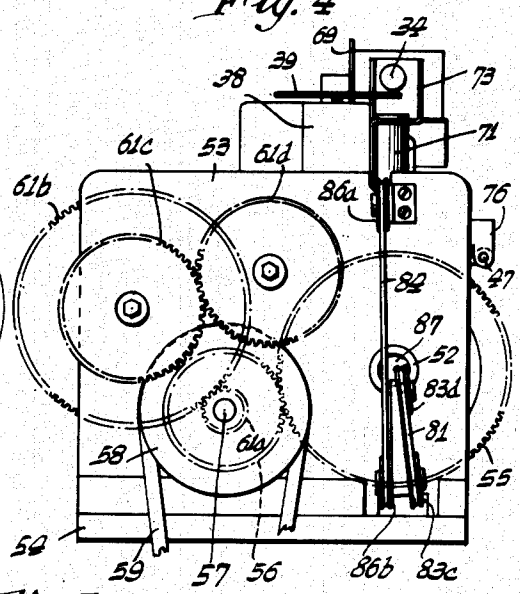

Fig. 5

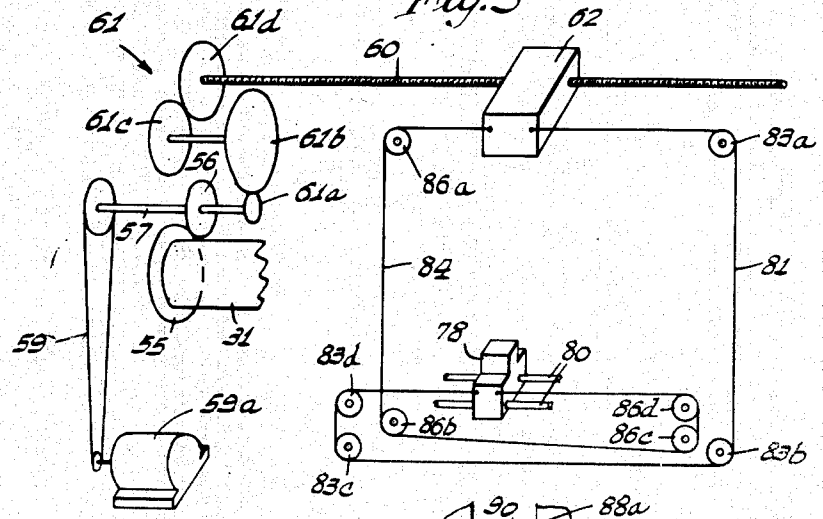

Fig. 8

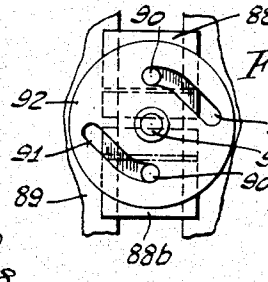

Fig. 9

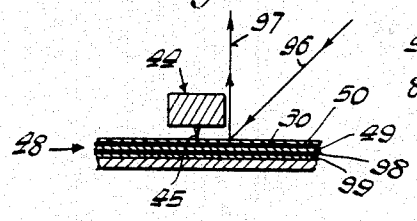

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Fig. 6

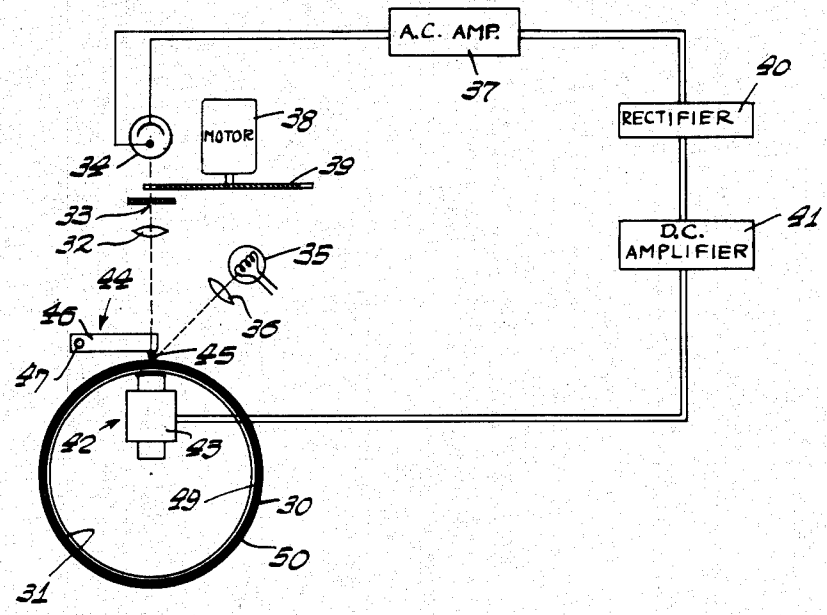


Fig. 7

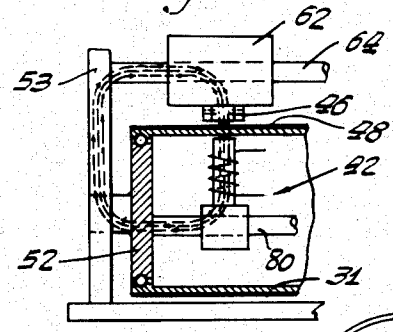


Fig. 7b

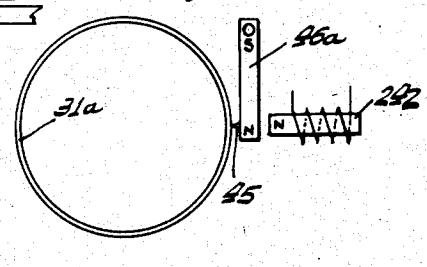
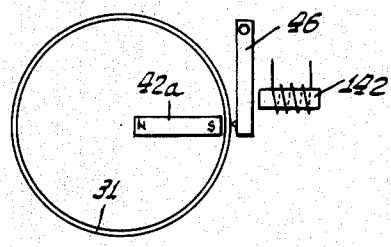


Fig. 7a



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FACSIMILE APPARATUS HAVING A MAGNETICALLY BIASED MARKING STYLUS

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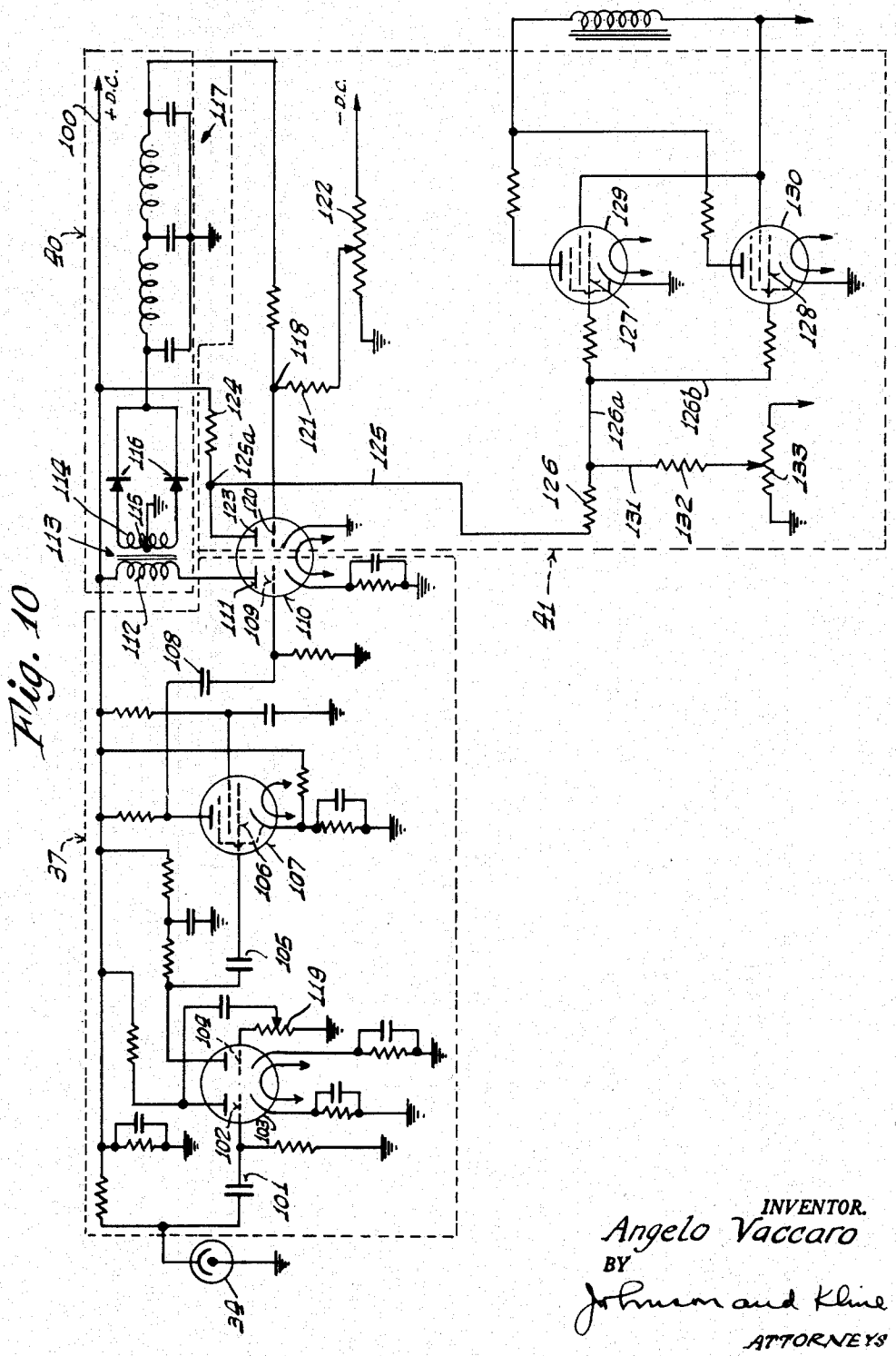

Fig. 10

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3,190,956

FACSIMILE APPARATUS HAVING A MAGNETICALLY BIASED MARKING STYLUS

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Filed Sept. 9, 1959, Ser. No. 838,931
8 Claims. (Cl. 178—6.6)

The present invention relates to methods and apparatus for making facsimile copies of original subject matter such as pictures, drawings, photographs, typed and printed matter, etc., and more particularly to the making of a facsimile copy on a copy sheet by utilization of pressure-responsive transfer mediums such as carbon paper or like material and pressure-applying means such as a stylus.

According to the present invention, the apparatus employed involves suitable means for supporting in superposed position a copy sheet and a transfer sheet, said sheets being herein collectively called "copy-producing material," and also means for supporting the stylus and operating mechanism therefor with means for providing relative movement between the respective supporting means so that the stylus may be progressively brought into operative relation with the entire area of the copy-producing material by which the facsimile is to be made.

The stylus and its operating mechanism to produce a facsimile copy are responsive to electrical variations derived from the subject matter of the original by photoelectrically scanning the latter and converting the results of the scanning operation to electrical signals.

According to the broader aspects of this invention, the scanning of the original may be performed at a point remote from the facsimile-producing apparatus and the signal may be transmitted to the apparatus electrically.

When, as is preferable, the original is available at the facsimile-producing station, the latter may be scanned on the same apparatus which produces the facsimile copy.

To do this, it has been proposed heretofore to place the original side by side with the copy-producing material on a drum or cylinder so that the original could be scanned by photoelectric means and the copy-producing material separately traced or tracked by the stylus simultaneously while making a copy.

It has been discovered, however, that with the apparatus of the present invention it is possible to superpose the original on the copy-producing material provided the original is not so thick or stiff as to prevent the marking pressure applied by the stylus to be effective on the copy-producing material. By so superposing the original on the copy-producing material the cost of the apparatus may be substantially reduced and the machine may be made substantially less wide than when the original and the copy-producing material are supported side by side on a drum for instance.

The superposing of the original and the copy-producing material on a single support has the further advantage that when the facsimile copy is to be placed as an insert on prepared material on the copy sheet, the operation of locating the original with respect to the prepared material on the copy sheet is greatly facilitated both with regard to time and effort, since the original may be applied to the copy-receiving material as an applique.

It will be understood by those skilled in the art that the copy-receiving sheet and the transfer medium may be of various kinds and may be variously superposed depending upon the purpose for which the facsimile copy is to be used. For instance, if the facsimile copy is to be used as a hectograph master sheet for use in the spirit process of duplication, the master sheet will be above the hectograph transfer sheet which will have its transfer surface face-up and in contact with the working face of

the hectograph master sheet so that the image produced thereon will be in mirror reverse. If the copy-receiving sheet is to be used as a master sheet in a planographic duplicating machine of the offset type or is merely to be used as a record, the transfer sheet is placed uppermost in the pile having its transfer surface adjacent the working surface face-down on the copy-receiving sheet. If the copy sheet is translucent, it may be placed above the face-up carbon sheet, in which case the subject matter may be read through the copy sheet. If duplicate facsimile copies are required, several copy-receiving sheets and several transfer sheets are properly arranged in the pile.

One of the important features of the present invention is that the facsimile copies may be made by the methods and apparatus of this invention more rapidly than was heretofore possible. This has been accomplished by reducing to a minimum the movements of the stylus between marking and nonmarking positions so that the stylus is instantly made effective to produce a mark upon receiving a signal requiring a mark to be made.

For this purpose, the present invention provides for maintaining the stylus in operative engagement with the copy-receiving sheet (and the original when the latter is superposed thereon) during the entire time that the stylus is tracing the area of the copy sheet which is to receive the facsimile copy with a pressure which is insufficient to produce a mark on the copy sheet except when a signal is received requiring a mark to be made at which time the pressure produced by the stylus on the copy-receiving material is increased to produce a mark. In this way the marking movement of the stylus is infinitesimal and instantaneous, permitting the rate of relative tracing movement between the stylus and the copy-receiving material to be substantially increased over that which would be necessitated were the stylus taken out of contact with the copy-receiving material when no mark is to be made during the making of a facsimile. In addition to increasing the speed of the operation, the danger of chattering of the stylus incident to the impact which would be produced if the stylus were taken off and applied to the copy-receiving material during the making of a copy is obviated.

According to the present invention in its broader aspects, the stylus may be held in operative engagement with the copy-receiving material (and on the original if the latter is superposed on the copy-receiving material) by any suitable means so long as the pressure applied is insufficient to cause a mark to be made on the copy sheet when no mark is called for by the signal, but it has been found particularly advantageous and preferable to cause the stylus to be held in such engagement magnetically when no mark is called for and by an increased magnetic force as a result of the electrical variations derived from the original by increased pressure sufficient to cause a mark to be made on the copy sheet. In this way it is possible and convenient to vary the pressure applied to the stylus according to the work at hand so that no mark is made on the copy sheet when no mark is called for and yet a mark of sufficient intensity is made when the electrical variations call for marks to be made.

In the broader aspects of this invention, the magnetic force controlling the stylus may be created and controlled by any suitable means. For instance, the stylus may be connected by suitable linkage to a reed or armature under the influence of an electromagnet responsive to the electrical variations derived from the original to be copied. However, it has been found that substantially more faithful response of the stylus to such electrical variations results when the stylus itself constitutes the armature responsive to the magnetic force. This is particularly noticeable when, as pointed out above, the

stylus remains in operative engagement with the copy-producing material during the entire time that the copy is being made because this arrangement avoids the necessity of using linkage means, spring biasing and damping means to operate and control the stylus.

In the form of this invention at present preferred, this is accomplished by making the stylus, or a substantial part thereof, magnetizable material, making the copy-supporting drum hollow, i.e. in the form of a sleeve or tube, locating an electromagnet within the sleeve with a pole piece opposite the stylus, and completing the magnetic circuit from the other pole piece to the stylus through structural parts of the apparatus. The copy-supporting drum being made of non-magnetic material, the flux from the electromagnetic freely passes through it and through the copy-receiving material to the armature-forming stylus to attract the latter toward the drum when the electromagnet is energized.

The relative movement between the stylus support and the support for the copy-receiving material may be effected by holding the one stationary while the other travels, but, regardless of which one of the supports travels across the other, the support for the stylus and a support for the electromagnet are so interconnected that the pole piece of the electromagnet continuously remains opposite the stylus.

In some forms of this invention, it is advantageous to arrange for the stylus and the electromagnet to be located on the same side of the copy-producing material and the support therefor. This may be done, while retaining most of the advantages of the arrangement described above where the electromagnet is on one side of the support and the stylus is on the other side, by arranging for the stylus and/or magnetic means inside the support for the copy-receiving material to be permanently magnetized so that the stylus is held in nonmarking engagement with the copy-receiving material by the force of the permanent magnet while the force to apply marking pressure to the stylus is supplied by an electromagnet responsive to signal variations located adjacent the stylus and outside the copy-receiving support. In this aspect of the invention, a permanent magnet may be positioned under the support in position to attract the stylus.

In another embodiment of this invention, the permanent magnet may be capable of applying sufficient force to cause a mark to be made on the copy-receiving sheet by the stylus. In this case, the electromagnet, when energized by a signal calling for no mark, will counteract the force of the permanent magnet so that it is then insufficient to make a mark and yet does not have the copy-producing material. Alternatively, the stylus may be permanently magnetized and the support for the copy-receiving material may be made of magnetizable material so that the stylus is held against the copy-producing material with a force insufficient to make a mark. In this case, the electromagnet, which is responsive to signal variations, has a pole piece having the same polarity as the permanent magnet of the stylus carrier so that when a mark is called for the repelling effect of the flux will force the stylus toward the copy-producing material with force sufficient to make a mark, but upon response to a non-marking signal the repulsive action of the electromagnet would cease.

Other features and advantages will hereinafter appear.

In the drawings:

FIGURE 1 is a plan view of one embodiment of the apparatus of the present invention.

FIG. 2 is a front view thereof, partly in section.

FIG. 3 is a vertical section taken on the line 3—3 of FIG. 1.

FIG. 4 is an end view of the machine looking in the direction of the arrows 4—4 of FIG. 2.

FIG. 5 is a diagrammatic representation of the driving mechanism for driving the scanning means, stylus and stylus-operating means of the present invention.

FIG. 6 is a diagrammatic representation of the interconnection of the various elements of the present invention.

FIG. 7 is a diagrammatic view of the magnetic flux path of the embodiment of the present invention disclosed in FIGS. 1–6.

FIG. 7*a* and FIG. 7*b* are diagrammatic representations of other methods according to the present invention of magnetically controlling the operation of the stylus.

FIG. 8 is a detail of a releasable locking mechanism for the means for feeding the scanner and marking stylus.

FIG. 9 is a diagrammatic view indicating the light path to and from the original, and also showing a plurality of copy and transfer sheets superposed on the supporting drum.

FIG. 10 is a schematic diagram of the electrical system for converting the light reflected from an original to electrical variations for energizing the electromagnet which operates the stylus.

Referring to FIGS. 1 to 10 of the drawings, particularly FIG. 6 in which the apparatus of the present invention is illustrated schematically, a piece of sheet material, herein called the original 30 from which a facsimile copy is to be made, and which has subject matter such as a picture, diagram, etc. which may consist of or include written, typewritten or printed matter, is mounted on a suitable support such as a rotatable drum 31.

Means for scanning the original comprises a lens 32, a restricted aperture 33, and a photocell 34. As the drum 31 rotates, the photocell 34, traveling laterally along the drum by means hereinafter described, scans the original on the drum along a helical line whose width is such that the entire surface of the original to be copied is sensed. The varying amount of reflected light, from the lighter background and the darker image-portions of the original, received by the photocell causes electrical variations to be derived from the original through the response of the photocell to the light. Light of substantially constant intensity is caused to impinge upon the original 30 from a lamp 35 in a concentrated beam directed by a lens 36 to the spot on the original being scanned by the photocell.

The signal from the photocell having electrical variations is fed to an amplifier 37 which, in the form of the invention herein disclosed, is a band pass A.C. amplifier. Because the signal from the photocell is D.C. and hence is not as readily amplified as an A.C. signal, the present invention provides for converting the signal to A.C. While this may be done by using an A.C. carrier frequency with the D.C. signal superposed thereon, the present invention employs a motor 38 and a toothed wheel chopper 39 rotated thereby interposed in the light beam between the photocell and the original to cause the normal D.C. signal to have a selected frequency depending on the characteristics of the chopper 39. The signal from the A.C. amplifier is fed through a rectifier 40 (preferably full-wave) and then fed to a D.C. amplifier 41. The signal current from the amplifier 41 varies the amount of magnetic flux emitted from a stylus-operating electromagnet 42 by reason of being fed into a coil 43 thereof.

Mounted adjacent the periphery of the drum is a stylus 44 having a small point 45 and a lever 46 which is pivoted at one end as at 47 for movement toward and away from the drum.

According to the present invention, the facsimile is produced by pressure applied to copy-producing material 48 which may include a copy sheet 49 and a pressure-responsive transfer sheet 50, such as a carbon paper sheet, and these are mounted on the drum in any suitable manner so as to rotate therewith.

In order to decrease the width of the machine, particularly the length of the drum or other support for the copy-producing material and the original, the original is superposed on the copy-producing material to form a pile so that the original is uppermost and the copy-producing material 48 is beneath it, thereby permitting the length of

the drum to be virtually reduced by half. The original and the copy-producing material are offset either laterally along the drum or around the drum a slight amount so as to avoid the stylus interfering with the light reflected from the original passing to the photocell.

According to the present invention, the sylus 44 itself forms the armature of the electromagnet 42, and for this purpose the stylus lever 46, or at least a sufficient portion of it, is made of magnetizable material, such as soft iron, and the electromagnet 42 is placed in such position relative to the stylus that when the electromagnet is energized the stylus point 45 will be forced toward the drum and against the original and the copy-producing material carried thereby, the pressure applied by the stylus depending upon the degree of excitation of the electromagnet.

The elements in circuitry controlling the electromagnet 42 are adjustable so that when the photocell 34 senses the background area on the original, the stylus point 45 is pressed against the original and copy-producing material so lightly that no mark is transferred from the transfer sheet 50 to the copy sheet 49, but when an image portion of the original is sensed the stylus is attracted toward the drum with a force sufficient to cause a mark to be made on the copy sheet by the transfer sheet. By having the stylus normally engage with the original and copy-producing material, the movement required of the stylus to make a mark is virtually imperceptible and instantaneous upon the receipt of a signal calling for a mark to be made. Therefore, the time required to make a facsimile copy can be greatly reduced over arrangements where the stylus moves on and off the copy-producing material in performing its marking and no marking functions.

Referring to FIGS. 1 to 4, the drum 31 is rotatably mounted at opposite ends on ball bearings 51 secured in stationary hubs 52. The hubs are secured on vertical side plates 53 mounted on a base 54. In order to rotate the drum, a gear 55 fastened thereto meshes with a gear 56 which is fast on a shaft 57 having a pulley 58 driven by a belt 59. As diagrammatically illustrated in FIG. 5 the belt 59 may be driven by a variable speed device such as a variable speed motor 59*a* or alternatively by a constant speed motor and a variable speed transmission.

Extending between the vertical side plates 53 and rotatably mounted therein is a feed screw 60 which is rotated (FIG. 5) by a gear train 61 having gears 61*a*, 61*b*, 61*c* and 61*d* with the gear 61*a* being fast on the shaft 57 and the gear 61*d* being fast on the feed screw 60.

The feed screw causes axial movement of a carriage 62 on which the photocell 34 and stylus 44 are mounted, by means of a split feed nut 63 secured to the support 62 and engaging the feed screw. The carriage 62 is supported for traveling movement on a rod 64 connected between the two side plates 53 which passes through a bearing sleeve 65 connected to the carriage 62 and also by a wheel or roller 66 secured to a depending plate 67 of the carriage 62 riding on a rail 68 fastened between the side plates 53.

The carriage 62 includes a bracket 69, such as shown in FIGS. 2 and 3, on which is mounted the light bulb 35 and a light tube 70 having the lens 36 therein to throw a bright spot of light on the drum. Also mounted on the bracket 69 is a light tube 71 having a lens 32 therein, and the small aperture 33 (which may be on the order of one-thousandth of an inch in diameter) formed in a cover 72. Positioned above the tube 71 in alignment with the light passing through the aperture 33 is the photocell 34. A box 73 substantially encloses the photocell to prevent stray light from affecting it.

Mounted in back of the vertical plate 69 is the motor 38 which carries and drives the light chopping wheel 39 with the peripheral toothed portion of the wheel being positioned to interrupt the light through the aperture 33.

While the stylus 44 may be mounted to hang vertically if desired as indicated in FIGS. 7*a* and 7*b*, in the specific embodiment of the invention shown in FIGS. 1 to 6, it is mounted to extend horizontally on the carriage 62 to operate adjacent the point on the original being scanned. The stylus is pivotally mounted at 47 on an arm 74 secured by screws 75 to the vertical plate 69 and projecting outwardly therefrom. At its other end the arm 74 has a downwardly depending ear 76 to which is pivotally connected as at 47, a lever 46 of the stylus 44. The lever 46 is formed in whole or in part of magnetizable material, such as soft iron, so that it will be attracted by the electromagnet 42.

It will thus be understood that as the drum revolves, the carriage 62 with the photocell 34 and the stylus 44 move transversely thereof to scan and trace the original and copy-producing material respectively in a helical line. The pitch of the helical line is determined by the pitch of the threads of the feed screw 60 and its speed relative to the drum. Thus, for example, if the feed screw has 100 threads per inch, and rotates at one-quarter the speed of the drum the spacing between turns theoretically would be one-hundredth of an inch. However, by having the beam of light reflected to the photocell original from an area one-hundredth of an inch wide and the point 45 of the stylus of a size which produces a mark on the facsimile copy sheet of approximately one-hundredth of an inch, substantially the entire surface of the original and copy-producing material will be scanned and traced respectively.

In this embodiment of the invention, the electromagnet 42 which actuates the stylus 44 is positioned within the drum 31 so as to have magnetic flux lines generated thereby pass through the drum 31, the copy-producing material and the original. While it is contemplated that the electromagnet could extend for a full length of the drum and hence be stationary, the embodiment disclosed enables the use of a smaller electromagnet by moving it in the drum transversely thereof synchronously with the carriage 62 and stylus 44. The electromagnet 42 includes a magnetic core 77 about which is wrapped the coil 43, which when energized magnetizes the core 77 to attract the stylus 44. The electromagnet 42 is fastened on the inverted U-shaped member forming a carriage 78 having bushings 79 through which pass guide rods 80 secured to and extending between the hubs 52, thereby supporting the electromagnet 42 for transverse, sliding movement.

To correlate movement of the stylus 44 and the electromagnet 42, there is connected at one end of the stylus carriage 62 a length 81 of flexible wire as by a clamping screw 82. The wire extends over pulleys 83*a*, 83*b*, 83*c* and 83*d* through the drum 31 (see FIG. 5) and has its other end connected to the electromagnet carriage 78. For movement in the reverse direction, a second length 84 of flexible wire is clamped to the carriage 62 by screws 85 and is trained over pulleys 86*a*, 86*b*, 86*c* and 86*d* through the drum 31 and has its other end connected to the carriage 78. The wires 81 and 84 pass through apertures 87 in the hubs 52 to reach the carriage 78. It will thus be appreciated that movement of the stylus carriage 62 will cause similar movement of the electromagnet carriage 78.

In order to facilitate positioning of the carriage 62 on the feed screw 60, the feed nut 63 as shown has two separable half sections 88*a* and 88*b* slidable in a slotted guide plate 89 mounted on the carriage 62 and movable to engage and disengage the feed screw. Each half 88*a* and 88*b* has a cam pin 90 engaging a cam slot 91 in a disk 92 (see FIG. 8) secured to a shaft 93 which rotates within a bushing 94 that is fast on the depending plate 67. The other end of the shaft 93 has a handle 95 secured thereto to rotate the circular plate 92 and cause the pins 90 to separate the two feed nut selections 88*a* and 88*b* to release the threaded engagement thereof with the feed screw 60 or bring them together on the feed

screw after the carriage 62 has been adjusted to the desired position.

As shown in FIG. 9, if it is desired to produce directly more than one facsimile copy at a time, the copy-producing material 48 may consist of one or more additional interleaved carbon sheets 98 and copy sheets 99 on which the reproductions are produced. It will be appreciated that the number of facsimile copies which can be made simultaneously depends upon the force of the attraction between the electromagnet 42 and the stylus 44 that presses the stylus against the reproduction sheet, the thickness of the copy-producing material, and the character of the transferable carbon coating on the carbon paper sheets.

FIG. 9 also shows schematically the rays 96 from the light source impinging on an increment of the original adjacent the stylus but transversely spaced therefrom to permit the light reflected rays 97 from the increment to pass by the stylus 44 to the photocell.

Shown in FIG. 10 is a schematic electrical diagram of the scanning means and the inscribing means including the photocell 34, the A.C. amplifier 37, the rectifier 40 and the D.C. amplifier 41. The photocell 34 is connected between the positive side of a D.C. supply 100 and ground so that there is conduction therethrough when the photocell is sensing white or background color, while a darker color, such as black ink, renders the photocell substantially non-conducting. The toothed chopper wheel 39 causes the photocell to produce a pulsating signal which is fed through a condenser 101 (having low resistance to the pulsating frequency) to a grid 102 of the first stage of a double stage amplifying electron tube 103. The signal is amplified from the first stage of tube 103 to the grid 104 of the second stage of tube 103 and successively amplified and passed through condenser 105 to the grid 106 of tube 107, then through condenser 108 to the first stage grid 109 of a double stage tube 110. The components of the A.C. amplifier are considered to be well known and the sole function thereof is to amplify the pulsating D.C. signal from the photocell 34.

The amplified signal from the plate 111 of the first stage of tube 110 is conducted to a primary winding 112 of an isolated transformer 113 in the rectifier 40. This latter includes a secondary winding 114 which is center tapped as at 115 while the winding ends are connected through rectifiers 116 to an inductive capacitive filter circuit, generally indicated by the reference numeral 117, to produce a voltage of approximately 20 volts between the point 118 and ground. This voltage may be adjusted by a variable resistance 119 connected between the first stage plate and second stage grid 104 of tube 103 in the second stage of the tube.

Connected between the point 118 and the grid 120 of the second stage of tube 110 is a line containing a resistance 121 and a variable resistance 122 connected to the negative side of the D.C. supply. This line supplies a voltage at the junction 118 which is positive with respect to the voltage at the junction 118 and its value is less than 20 volts so that even when it is subtracted from the 20 volts, there is sufficient plus voltage remaining to cause the second stage of tube 110 to be fully conducting whenever the signal has a value of 20 volts. When the photocell senses "black," i.e. an image portion of the original, there is no plus voltage at junction 118 while the voltage on the grid 120 is relatively negative, derived solely from the negative D.C. supply through the resistors 121 and 122 and this is of a value sufficient to render the second stage of the tube 110 non-conducting.

Connected between the lead 100 to the positive D.C. supply and the plate 123 of tube 110 is a resistance 124, and a lead 125 is connected at a junction 125*a* between the plate 123 and the resistance 124 to a resistance 126. The other end of the resistance 126 has leads 126*a* and 126*b* connecting it in parallel to the grids 127 and 128 of tubes 129 and 130 of the D.C. amplifier 41. It will

be understood that with a plus voltage on the grid 120 of the second stage of tube 110 to render it conducting, there is a relatively large voltage drop across the resistance 124 by reason of the current flow through the tube, while when the tube is non-conductive (as when the photocell senses "black") there is a smaller voltage drop across the resistance 124. Thus when the photocell senses "black" the positive voltage to ground in the lead 125 is higher than when the photocell senses "white."

The voltage in line 125 is impressed (after passing through resistance 126) on the control grids 127 and 128 of the tubes 129 and 130. With the higher voltage in lead 125, the tubes 129 and 130 are rendered conducting causing current flow through the electromagnet 42 which causes the stylus to be attracted against the copy-producing material with sufficient force to impress a mark on the copy sheet. When the voltage in the lead 125 is at its lower value, as when the photocell senses "white," and the second stage of tube 110 is conducting, there is insufficient positive voltage on the control grids of tubes 129 and 130 so that they do not conduct sufficient current to render the electromagnet 42 effective to produce a mark on the copy.

It will accordingly be understood that when the photocell senses a "black" increment, its signal is amplified by the A.C. amplifier, rectified in the rectifier 40 and causes a high positive voltage in the lead 125, by reason of the second stage of tube 110 being non-conducting. This voltage when impressed on the control grids of the tubes 129 and 130 causes conduction therethrough and since their output is connected to the positive D.C. supply through the electromagnet 42, sufficient current passes in the electromagnet to cause the stylus to be attracted with a force sufficient to cause a mark on the facsimile copy. When the photocell senses a "white" increment, the signal from the photocell is amplified causing the second stage of tube 110 to be conducting which decreases the positive voltage in the lead 125 and hence on the grids of tubes 129 and 130 to a value which shuts off the current through the electromagnet 42.

It has been found, in carrying out the present invention, that although the residual magnetism of the electromagnet 42 and/or the weight of the stylus may under most favorable conditions be sufficient to maintain the stylus against the copy-producing material at all times, particularly when the photocell is sensing background or "white" increments, more satisfactory results can be obtained by applying a greater force yet one which is insufficient to produce a mark. To do this, the present invention, in its form at present preferred, provides for employing the stylus-operating electromagnet 42. It has been found that by passing a minimum positive value of current through the electromagnet 42 the value of the current can be adjusted to maintain the stylus forced against the copy-producing material with a pressure which is insufficient to produce a mark on the facsimile copy, yet which is firm enough to hold the stylus from vibrating or chattering.

This is accomplished in the form shown by impressing on the control grids of the tubes 129 and 130 a bias voltage which has a value that renders the tubes conducting for only the adjusted value of current at all times, it being, of course, effective when the photocell senses a background or "white" increment. Thus there is provided a connection to the control grids 127 and 128 by a lead 131 through a resistance 132 and a variable resistance 133 to the negative side of the D.C. supply to the control grid. It will be appreciated that by adjusting this resistance 133 with relation to the voltage when the photocell is sensing "white" at the connection, the minimum constant value of current through the electromagnet 42 may be applied and this can determine the amount of force with which the stylus is pressed against the copy-producing material and yet not mark the facsimile copy.

In FIG. 7 is shown the lines of flux from the electromagnet **42** which pass through the rods **80**, the hub **52**, the side plates **53**, the rods **64**, the carriage **62**, the stylus lever **46**, through the original and the copy-producing material **48** and the drum **31** to complete its path. All parts in the path except the original **30**, and the copy-producing material **48** are formed of magnetizable material.

To carry the current to the electromagnet **42** and yet permit the latter to travel back and forth relative to the drum, the present invention provides a half-round rod **140** having a pair of contact strips **141** thereon located under the electromagnet carriage **78** to be engaged by a pair of contact pins **142** connected by wires to the energized coil **43**.

In FIG. 7*a*, the magnetic means for controlling the stylus to cause marks to be made on the copy-receiving sheet in response to variations in the signal may be a permanent magnet **42***a* located within the drum **31** opposite the stylus and traversing the drum with the stylus, as in FIG. 7. The stylus **46** is made of magnetizable material and is attracted with sufficient force to the permanent magnet **42***a* so as to be capable of making a mark. However, an electromagnet **142** traveling with the stylus **46** is positioned to control the stylus so as to normally, that is when no mark is to be made, counteract the force of the permanent magnet **42***a* and reduce the pressure of the stylus on the copy-receiving material without removing the stylus therefrom. When the flux in the electromagnet is reduced in response to a variation in the signal calling for a mark to be made, the permanent magnet pulls the stylus toward the copy-receiving material with sufficient force to make a mark.

As stated above, the stylus carrier may be permanently magnetized so as to be attracted to the drum **31***a* of magnetizable material with sufficient force to hold the stylus against the copy-receiving material but with insufficient force to cause a mark to be made on the copy sheet. This arrangement is illustrated in FIG. 7*b* in which the stylus carrier **46***a* is a permanent magnet having one pole piece located at the end at which the stylus **45** is mounted in position to engage the drum. For purposes of explanation, it its assumed that the stylus carrier **46***a* has a north pole adjacent the stylus and a south pole adjacent its pivot point. The means to control the marking or non-marking of the copy sheet comprises an electromagnet **242** which has its pole piece located adjacent the pole of the stylus carrier at which the stylus is mounted. The electromagnet **242** is so wound that it presents a north pole adjacent the north pole of the stylus carrier **46***a*. When the electromagnet **242** is energized in response to a variation in the signal calling for a mark to be made, it being confronted with a permanent magnet of like polarity on the stylus carrier **46***a*, the flux from the electromagnet **242** causes the stylus carrier to be forced away from the electromagnet toward the drum, and thus causes marking pressure to be applied to the copy-producing material. When no marking signal is received by the electromagnet **242**, the permanent magnet stylus carrier **42***a* holds the stylus against the copy-receiving material with insufficient pressure to make a mark.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. Apparatus for producing a facsimile copy of an original from variations in electrical signals derived from areas of different light reflective values in the original, comprising non-magnetizable means for supporting copy-producing material including a copy sheet; a stylus for producing marks on said copy sheet; means for relatively moving the stylus and the support to scan said copy-producing material; and electromagnetic means for continuously pressing the stylus against said copy-producing material on the support with either a positive marking pressure or a positive non-marking pressure depending on the variations in said signals.

2. Apparatus for producing a facsimile copy of an original from variations in electrical signals derived from areas of different light reflective values in the original, comprising non-magnetizable means for supporting copy-producing material including a copy sheet; a stylus for producing marks on said copy sheet and having at least a portion of magnetizable material mounted for movement toward the support; means for relatively moving the stylus and the support to scan said copy-producing material; and electromagnetic means positioned behind the support and in close proximity thereto for transforming the electrical signals into magnetic flux lines of sufficient density to cause the stylus to be attracted against the support through the copy-producing material with sufficient force to mark the copy sheet when the original has a predetermined value range, and means for supplying a constant flux to cause the stylus to be continuously attracted against the support through the copy-producing material with insufficient force to mark the copy sheet when the signal has a lower predetermined value range.

3. Apparatus for producing a facsimile copy of an original from variations in electrical signals derived from areas of different light reflective values in the original, comprising non-magnetizable means for supporting copy-producing material including a copy sheet; a stylus for producing marks on said copy sheet and having at least a portion of magnetizable material mounted for movement toward the support; means for relatively moving the stylus and the support to scan said copy-producing material; and electromagnetic means comprising a coil wound about a magnetizable pole located adjacent and positioned behind the support for transforming the electrical signals into magnetic flux lines of sufficient density to cause the stylus to be electromagnetically attracted toward the support and against the copy-producing material with sufficient force to mark the copy sheet when the signal has a predetermined value range and to be electromagnetically attracted with insufficient force to mark the copy sheet when the signal has a lower predetermined value range.

4. Apparatus for producing a facsimile copy of an original from variations in electrical signals derived from areas of different light reflective values in the original, comprising non-magnetizable means for supporting copy-producing material including a copy sheet; a stylus for producing marks on said copy sheet and having at least a portion of magnetizable material mounted for movement toward the support; stylus operating means positioned behind the support for transforming the electrical signals into magnetic flux lines of sufficient density to cause the stylus to be attracted toward the support and against the copy-producing material with sufficient force to mark the copy sheet when the original has a predetermined value range, and means for supplying a constant flux to cause the stylus to be continuously attracted against the support through the copy-producing material with insufficient force to mark the copy sheet when the signal has a lower predetermined value range; and means for causing traveling movement between the support and the stylus and stylus operating means as a unit whereby the stylus scans the copy-producing material.

5. Apparatus for producing a facsimile copy of an original from variations in electrical signals derived from areas of different light reflective values in the original, comprising non-magnetizable means for supporting the original and copy-producing material including a copy sheet in superposed position with the original exposed; a stylus for producing marks on said copy sheet and having at least a portion of magnetizable material mounted for movement toward the support; a photocell in front of the support to scan the original; means for caus-

ing relative movement between the support and the sylus and photocell to scan the original and said copy-producing material; and electromagnetic means comprising a coil wound about a magnetizable pole being located adjacent and positioned behind the support for transforming the electrical signals into magnetic flux lines of sufficient density to cause the stylus to be attracted toward the support and against the copy-producing material with sufficient force to mark the copy sheet when the signal has a predetermined value, and means for supplying a constant flux to cause the stylus to be continuously attracted against the support through the copy-producing material with insufficient force to mark the copy sheet when the signal has a lower predetermined value, said coil and magnetic pole being mounted in fixed position relative to the position of the stylus and photocell.

6. An apparatus for producing a facsimile copy of an original comprising a support for the original, a photocell; means including the photocell for producing a signal indicative of the amount of light reflected from a small increment of the original; means for relatively moving the support and the photocell to cause the photocell to traverse the original to scan it; a marking stylus adapted to mark pressure sensitive copy-producing material; means for relatively moving the stylus and the material; electromagnetic means controlled by the signal for magnetically holding the stylus against the copy-producing material as it traverses the same with insufficient pressure to mark the sheet when the signal is of one value and for increasing the pressure sufficiently to mark the sheet when the signal is of a different value; and means in the signal means for adjusting the value of the signal with respect to the light reflective value of the original whereby the different value signal which causes marking may be adjusted relative to the amount of light reflected as scanned by the photocell.

7. An apparatus for producing a facsimile copy of an original comprising a support for the original, a photocell; means including the photocell for producing a signal indicative of the amount of light reflected from a small increment of the original; means for relatively moving the support and the photocell to cause the photocell to traverse the original to scan it; a marking stylus adapted to mark pressure sensitive copy-producing material; means for relatively moving the stylus and the material; electromagnetic means controlled by the signal for magnetically holding the stylus against the copy-producing material as it traverses the same with insufficient pressure to mark the sheet when the signal is of one value and for increasing the pressure sufficiently to mark the sheet when the signal is of a different value; and means in the signal means for adjusting the pressure with which the stylus is held against the copy-producing material in non-marking engagement thereto.

8. An apparatus for producing a facsimile copy of an original comprising a support for the original, a photocell; means including the photocell for producing a signal indicative of the amount of light reflected from a small increment of the original; means for relatively moving the support and the photocell to cause the photocell to traverse the original to scan it; a marking stylus adapted to mark pressure sensitive copy-producing material; means for relatively moving the stylus and the material; electromagnetic means controlled by the signal for magnetically holding the stylus against the copy-producing material as it traverses the same with insufficient pressure to mark the sheet when the signal is of one value and for increasing the pressure sufficiently to mark the sheet when the signal is of a different value; means in the signal means for adjusting the pressure with which the stylus is held against the copy-producing material in non-marking engagement thereto; and means in the signal means for adjusting the value of the signal with respect to the light reflective value of the original whereby the different value signal which causes marking may be adjusted relative to the amount of light reflected as scanned by the photocell.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,190,956 June 22, 1965

Angelo Vaccaro

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 59 and 60, for "prepared", each occurrence read -- preprepared --; column 2, line 57, for "applied to" read -- applied by --; column 3, line 8, before "magnetizable" insert -- of --; line 15, for "electromagnetic" read -- electromagnet --; line 50, for "have" read -- leave --; column 5, line 6, for "sylus" read -- stylus --; column 6, line 43, for "the" read -- an --.

Signed and sealed this 30th day of November 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents