May 3, 1960 B. WEINGART ET AL 2,935,561

REMOTE WRITING INSTRUMENT

Filed March 23, 1955 2 Sheets-Sheet 1

FIG. 7

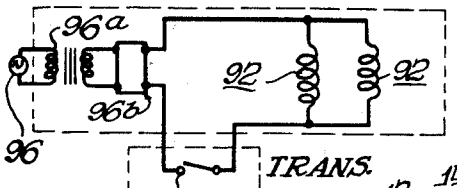
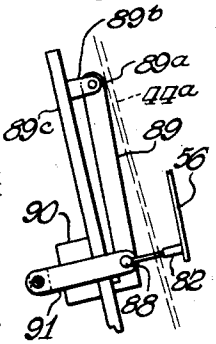


FIG. 1

FIG. 10



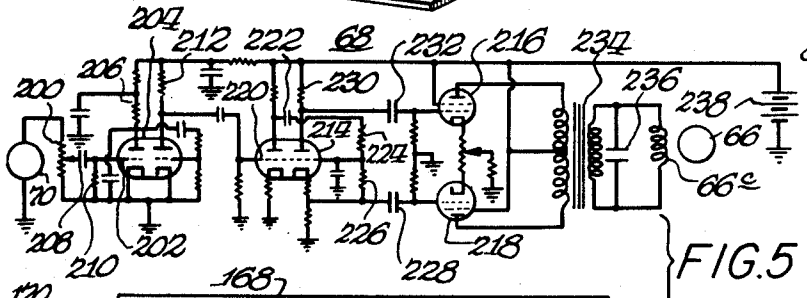
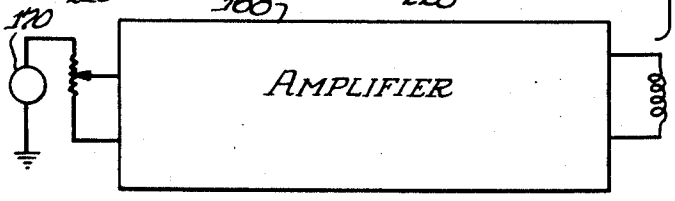


FIG. 5



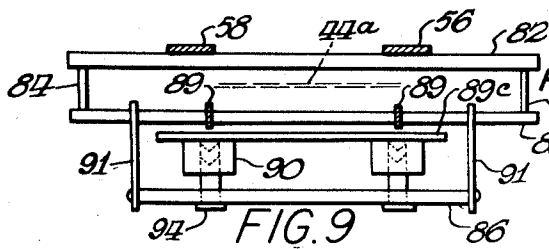


FIG. 9

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FIG. 2

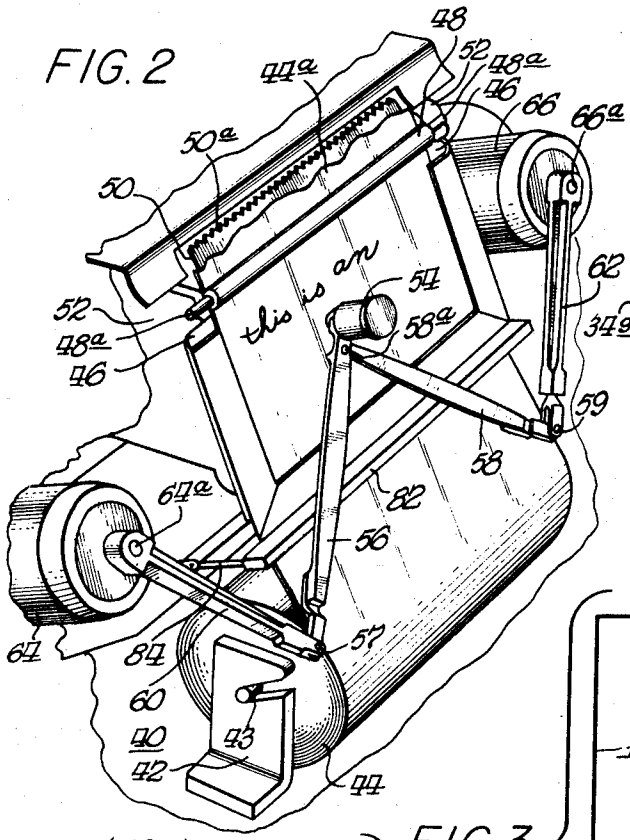


FIG. 4

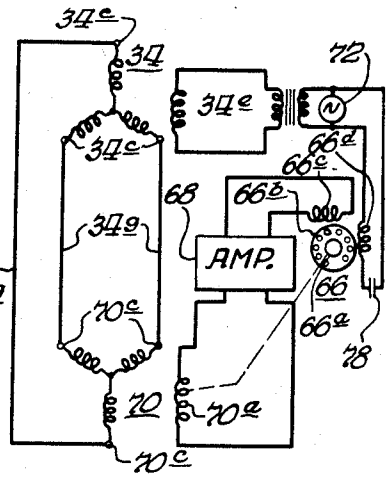


FIG. 3

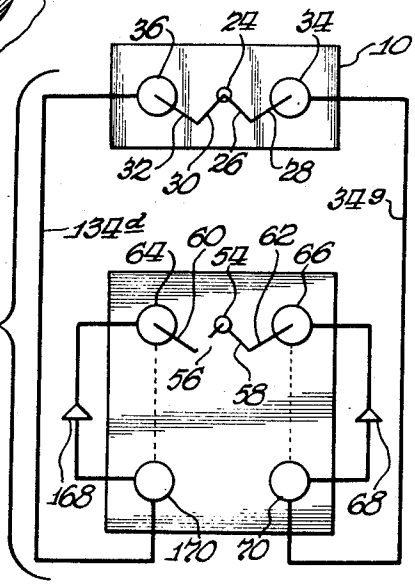


FIG. 8

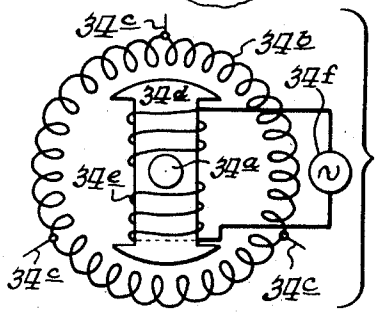
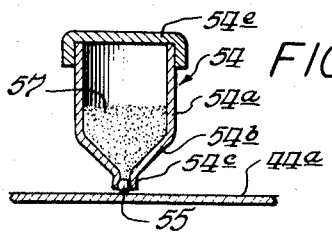


FIG. 6



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2,935,561

REMOTE WRITING INSTRUMENT

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Application March 23, 1955, Serial No. 496,306

1 Claim. (Cl. 178—18)

This invention relates to an improved remote writing instrument capable of writing with a ball point pen.

One of the most troublesome problems with remote writing instruments is that of providing a suitable writing device. Fluid ink type pens have been used for this purpose, but only as a matter of necessity. They require frequent refilling; the ink is readily spilled from the reservoirs provided for it; and in the most common type of instrument heretofore used, the varying mass of the ink as it is used up introduces varying errors which reduce the legibility of the writing. Pencils, crayons and similar non-liquid type writing devices have likewise been suggested but their use has been limited by the fact that they do not retain a pointed writing face, with the consequence that frequent resharpening is required.

The apparatus of the present invention overcomes these difficulties by utilizing a ball point pen. Such pens include an ink reservoir which contains a semi-fluid ink and an outlet opening which has partially spherical walls retaining a ball. As writing proceeds the ball rolls on the paper to deposit a film of ink which adheres to the ball during rotation. Pens of this type, however, require a considerable pressure to cause the ball to roll rather than slide on the surface of the paper. Because of this required pressure—and the incident resistance to movement of the pen over the paper—it has not heretofore been possible to use this type of pen in a remote writing instrument without introducing an intolerable degree of error. In accordance with the present invention this problem is overcome by providing power means independent of the indicating system itself to drive the ball point pen in response to the comparatively feeble signals provided by the indicating system. In this fashion the advantages of a ball point pen are achieved while at the same time the disadvantages heretofore associated with such constructions are overcome.

The present invention also contemplates the use of a ball point pen in the transmitter in conjunction with a pressure sensitive switch. When the pen pressure is sufficient to cause writing by the transmitter ball point pen the switch is actuated to permit full writing pressure on the receiver ball point pen. There is no need for special signals or other indicators to show that sufficient pressure has been applied to the transmitter ball point pen because the act of applying sufficient pressure to cause writing necessarily actuates the switch. This result is achieved from the fact that a ball point pen is characterized by the ability to write only when a definite and substantial pressure is applied. When that pressure is absent—and writing is accordingly not taking place—the pressure sensitive switch assumes the no pressure position and the writing pressure on the receiving ball point pen is removed.

It is therefore a general object of the present invention to provide an improved remote writing instrument which

does not require the use of either a fluid ink type pen or a stylus which must be recurrently sharpened.

More specifically it is an object of the present invention to provide an improved distant writing mechanism which writes with a ball point pen.

Still another object of the present invention is to provide an improved distant writing mechanism which is capable of operating effectively despite resistance to writing movement by the writing device.

It is yet another object of the present invention to provide an improved distant writing instrument wherein the power required to overcome resistance to pen motion is derived from a source at the receiver rather than from the transmitted signal.

Still another object of the present invention is to provide an improved remote writing instrument in which a ball point pen is used on the transmitter.

Further it is an object of the present invention to provide a transmitting device for a remote writing instrument in which the pressure required to make a legible line while writing serves to control actuation of the pen lifting unit on the receiver.

An additional object of the present invention is to provide an improved remote writing device having a pen lifter mechanism taking advantage of the characteristics of a ball point pen.

Still another object of the present invention is to provide an improved remote writing device wherein damping is provided by the inherent characteristics of the sensing device for the control signals.

Other and further objects of the present invention include the provision of a simple, straight forward, reliable, inexpensive, distant writing mechanism which is suitable for use in many practical applications.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claim. Our invention itself, however, both as to its organization and method of operation, together with further objects and advantages, will best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a view in perspective of the transmitting instrument of a remote writing system constructed in accordance with the present invention;

Figure 2 is a fragmentary view in perspective of the receiver of a remote writing system constructed in accordance with the present invention;

Figure 3 is a diagrammatic illustration of the complete remote writing system;

Figure 4 is an electrical circuit diagram of one channel of the receiver mechanism;

Figure 5 is an electrical circuit diagram showing the amplifier construction used in the mechanism;

Figure 6 is a view in axial cross-section of the ball point writing instrument used in the receiver;

Figure 7 is an electrical circuit diagram of the pen lifting mechanism used in the instrument of Figures 1 to 6;

Figure 8 is a schematic diagram showing the construction of a selsyn unit of the type used in the mechanism;

Figure 9 is a fragmentary cross-sectional view of the receiver looking down from the top of the pen lifter bar and showing the actuating mechanism for the pen lifter bar; and

Figure 10 is a fragmentary side elevational view showing the pen lifting mechanism.

Referring now to Figure 1 the transmitting instrument comprises a base **10** of generally rectangular conformation having upstanding edge walls **10***a* which receive a suitable apertured cover plate (not shown). A pad of writing paper **12** is centrally disposed in the back end of the base **10** in a frame **14** having overhanging edges **14***a*. The frame **14** is welded or otherwise affixed

to the spaced arms 16 which extend forwardly to be carried by the shaft 18 which extends between trunnions 20*a* and 20*b* which are affixed to base 10. Sleeves 22*a*, 22*b* and 22*c* provide proper spacing for the arms 16 and hold the entire assembly against shifting movement in relation to base 10.

The frame 14—and hence pad 12—is held above the base 10 by the pressure switch 98 which actuates the pen lifted switch on the receiver as hereafter described.

The top sheet of the pad 12 can be written upon by the pen 24 which is a ball point type pen. Adjacent writing tip portion 24*a* the pen 24 receives the link 26 which at its opposite end is pivotally connected to the swingable arm 28. Link 30 is pivotally connected to link 26 adjacent the pin 24. At its opposite end link 30 is rotatably connected to arm 32 as shown. The pivotal connections linking the arms 28 and 32 to the links 26 and 30 respectively, and the pivotal connection between the two links 26 and 30, are all of the ball joint type to permit freedom of pen movement in all directions of tilt. These ball joints are formed by clevis-shaped ball socket conformations on the ends of the arms or links, respectively, which receive mating ball heads on the connected arms or links. The arms 28 and 32 are carried by the shafts 34*a* and 36*a*, respectively. These shafts are the rotor shafts of the selsyn transmitters 34 and 36 as is hereinafter described in detail.

The selsyn 34 is carried by a U-shaped bracket 38 which has a vertical arm 38*a* welded or otherwise affixed to the upturned tab 10*b* of base 10. Tab 10*b* is formed by a U-shaped cutout on the base 10. The cutout is bent to vertical position to form a vertical ear to which the bracket 38 may be affixed. The selsyn 36 is similarly supported by the L-shaped bracket 40 having a vertical face 40*a* affixed to the upturned ear 10*c* which is likewise cutout from the base 10.

Figure 8 shows in diagrammatic form the construction of each of the selsyns 34 and 36. As shown, each includes a continuous stator winding 34*b* which extends entirely about the stator and has three taps 34*c* located at positions mechanically spaced 120° from each other. A single pole rotor 34*d* has a winding 34*e* which is energized by alternating voltage source 34*f* to provide an alternating flux directed along the axis of the rotor 34*d*. Since the rotor 34*d* is on the shaft 34*a*, Figure 1, and is hence connected to arm 28, it will be evident that the magnitudes and sense of the respective voltages induced between the various taps 34*c* are determined by the rotational position of the rotor 34*d*. The selsyn 36 is constructed and operates in a similar fashion to produce three voltages determined by the position of arm 32.

It will be noted that the pen 24 may be moved over the entire area of the paper 12 since the arms 32 and 28 are pivotally connected to links 26 and 30 and the latter are pivotally connected to each other. However, as the pen is moved over the face of the paper the positions of arms 28 and 32 are determined for each position of the pen 24 on the paper 12. Conversely, with any pair of positions of the arms 28 and 32 there is only one position of the pen 24. The voltage produced in the stator taps of the selsyns 34 and 36 are accordingly a measure of the position of the pen 24 and may be transmitted to a remote receiver to indicate the position of the pen.

The receiver mechanism is shown in perspective in Figure 2. It consists of a base frame 40 which carries a pair of spaced upstanding brackets 42 which in turn carry the shaft 43 and the roll of writing paper 44. The web 44*a* from the roll 44 passes over the frame plate 46 which forms a support surface for writing and underneath the guide roller 48 as shown. A tearing member 50 with a serrated edge 50*a* extends above the roller 48 to permit convenient tearing of the paper as the message is recorded. The roller 48 is carried by vertical plates 52 which have aligned shaft receiving slots at their forward end to receive the shaft portions 48*a* of roller 48. Suitable snap means (not shown) is provided to hold the roller 48 in position.

A ball point pen unit 54 is provided to write on the web 44*a* as shown. This pen is supported by a pair of leaf springs or spring links 56 and 58. The former link is affixed at one end to the ball point pen 54 and at its opposite end is swingably secured to the arm 60 by the pin 57. The link 58 is pivotally conected at 58*a* to the link 56, this connection being close to the ball point pen 54. Link 58 is pivotally connected to the arm 62 by pin 59 as shown. Arms 60 and 62 are respectively carried by shafts 64*a* and 66*a* of the drive motors 64 and 66. The construction of these motors is described in further detail hereafter.

It will be noted that the links 56 and 58 of the receiver of Figure 2 correspond to the links 30 and 26 of the transmitter of Figure 1. Similarly, arms 60 and 62 of the receiver correspond to the arms 32 and 28 of the transmitter, respectively. These links and arms are all made of like length and the shafts 64*a* and 66*a* are spaced by the same distance as shafts 36*a* and 34*a*. Hence when the arms 60 and 62 are rotated to the same positions as the arms 32 and 28 the pen 54 has the same position in relation to the web 44*a* as the position of the pen 24 in relation to the pad 12. Accordingly, remote writing is achieved by swinging the arms 60 and 62 in unison with the arms 32 and 28, respectively.

The construction of the motors 64 and 66 is best explained with reference to the electrical diagram of Figure 4 which shows the motor 66 and its connections to the other mechanisms. In brief, this motor is of the two phase squirrel cage induction type having the squirrel cage rotor 66*b* carried by the shaft 66*a*. The main phase winding 66*c* is energized by 60 cycle alternating current from the amplifier 68 which responds to the voltage induced in winding 70*a* of the selsyn 70 as hereinafter described.

The quadrature winding 66*d* of the motor 66 receives constant voltage from 60 cycle voltage 72 through capacitor 78 as shown. The source 72 either serves as the source 34*f*, Figure 8, or has like phase and frequency with that source so that the rotor winding 34*e* of the transmitting selsyn 34 is energized with voltage of like phase and frequency as the source 72. The taps 34*c* of the transmitting selsyn 34 are connected to like taps 70*c* on the like stator winding of the receiving selsyn 70. This selsyn may be positioned in coaxial relationship with the motor 66, Figure 2, or may be otherwise positioned and mechanically connected to the motor 66 to cause the rotor 70*a* of selsyn 70 to rotate in unison with shaft 66*a* of the motor 66. Preferably the selsyn receiver 70 has like construction with the selsyn transmitter 34.

It will be observed that for every set of voltages induced by rotor 34*e* between the respective taps 34*c*—and hence like voltages impressed on the stator winding of the selsyn 70—there is a position of the rotor 70*a* at which no significant voltage is induced. This position is the position of 180° rotation from the position of the rotor 34*e* of selsyn 34. Until the rotor 70*a* reaches the no-voltage position, it receives an induced voltage which is applied to amplifier 68 and thence to the winding 66*c* of the motor 66. Since the shaft 66*a* is mechanically connected to the rotor 70*a*, the motor 66 turns rotor 66*a* until the voltage induced in the winding 70*a* is substantially zero, at which time no substantial current flows through winding 66 and rotation of rotor 66*b* stops.

The voltage induced in winding 70*a* has one phase position or the opposite phase position, depending upon the direction of the deviation from the null position of the rotor. This varies the sense of the current flow in winding 66*c* to drive motor 66 in one direction or the other as required to bring the winding 70*a* to the null position.

The overall system is adjusted so that the stator of

selsyn 70 is in the no-voltage position when the arm 62 has the same position of rotation in relation to the frame 40 as the position of arm 28 in relation to frame 10. With the mechanism so adjusted, the arm 62 is caused to follow the movements of the arm 28.

The arm 60 is connected to a similar motor and selsyn system so that its rotation follows the like rotation of arm 32. Consequently, as the pen 24 of the sending or transmitting mechanism 10 is moved across the sheets 12 in writing movements—and the arms 28 and 32 are accordingly rotated—the arms 62 and 60 execute rotations in unison with arms 28 and 32. This causes the pen 54—acting through links 56 and 58—to perform similar writing movements over the web 44*a*.

It will be observed that the power required to rotate arms 60 and 62 is derived from their respective induction drive motors 64 and 66 rather than from the signal transmitting equipment. In each instance the selsyn rotor which drives the amplifier to energize the drive motor 64 or 66 merely serves as a source of sensing information. The amplifier in each instance provides the power to drive the respective motor.

Figure 3 shows the entire system in somewhat diagrammatic form. As shown, the transmitter having a base 10 and selsyn stator 34 produces a set of three voltages in the triple conductors 34*g* determined by the position of arm 26. These voltages are applied as above described to selsyn 70, the rotor of which feeds the amplifier 68 as shown to drive the induction motor 66 of the receiver. This rotates arm 62 in unison with arm 28. The shaft or rotor of the motor 66 is mechanically connected to the rotor of the selsyn 70 so that as the shaft of motor 66 turns towards the position of the rotor of selsyn 34, the voltage applied to amplifier 68 is reduced until—when the positions correspond—there is no substantial voltage.

The mechanism to drive the arm 60 is similarly constructed. Here the transmitting selsyn 36 produces voltage in the three conductors 134*d* determined by the position of rotation of arm 32. These voltages are applied to the stator of selsyn 170 to induce a voltage in the rotor determined by the rotor position. The latter voltage is amplified by amplifier 168 and applied to the motor 64 to drive the same in the direction to bring the arm 60 to the same position as arm 32. As this movement of arm 60 takes place, the rotor of selsyn 170 is likewise rotated so that when the arm 60 has the same position as arm 32 the voltage applied to amplifier 68 is reduced to substantially zero and the arm 60 comes to rest.

It will be accordingly observed that the above mechanism operates to move the arms 60 and 62 in unison with arms 32 and 28. Since the arms are respectively linked to the pens 24 and 54 by the links 30 and 26 and the links 56 and 58, the pen 54 is driven over the sheet 44*a* in the same movements as the writing pen 24 is moved over the pad or sheet 12. The writing is accordingly reproduced at the receiver.

The ball point pen 54 is shown in axial cross section in Figure 6. Briefly, this pen consists of a cup-housing 54*a* of stamped sheet metal having a conical base 54*b* which at its end 54*c* embraces the ball 55. In the portions 54*c* surrounding the ball 55, the housing 54*a* has a partially spherical conformation so that the ball 55 is anchored in place. A cap 54*e* is threadedly or otherwise secured on the open end of the housing 54*a*. The ink 57 in semi-fluid form is placed inside the housing 54*a* to fill the interior of the base 54*b* above the ball 55. This ink is a suitable ball point pen type ink which is carried by the ball 55 from the housing 54*a* to the paper 44 as the ball rolls. Thus, as the arms 60 and 62 rotate in unison with arms 32 and 28, Figure 1, the ball 55 rolls on the paper 44 to write thereon.

The amplifiers 68 and 168 are shown in further detail in Figure 5. Amplifier 68 is energized from the rotor winding of the selsyn 70. The voltage from this winding is applied to potentiometer 200 and through the moving terminal of that potentiometer to the control electrode 202 of the first half of the twin triode tube 204. Since the voltage from selsyn 70 is alternating voltage, there is accordingly produced across the resistance 206 a like alternating voltage. The latter voltage, however, is displaced in phase by the lead network defined by capacitor 208 and resistance 210.

The alternating component of voltage across resistance 206 is applied through capacitor 208 and resistance 210 to the control electrode of the second half of tube 204 to produce a similar current flow through the anode resistance 212. Since the effect of the first half of the twin triode 204 is to invert the alternating applied voltage, and the second half of tube 204 accomplishes a like inversion, the alternating voltage across resistance is in phase with the voltage applied to control electrode 202.

The twin triode 214 serves as a limiter and phase splitter to drive the push-pull output tubes 216 and 218. As shown, the control electrode 220 of the first half of triode 214 receives the alternating component of voltage across the resistance 212 and applies like but inverted alternating voltage to the control electrode of tube 218 through the circuit which can be traced from the capacitor 222 through resistances 224 and 226 and capacitor 228 to the control electrode of tube 218. The control electrode of the second half of tube 214 receives voltage from the junction of resistances 224 and 226 to produce an alternating voltage across resistance 230 which is applied through capacitor 232 to control electrode of tube 216. This voltage is 180° out of phase with the voltage at the junction of resistances 224 and 226 by reason of the phase inverting action of the second section of tube 214.

Tubes 216 and 218 serve as a push-pull amplifier with their anodes connected to the push-pull output transformer 234 as shown. The secondary winding of this transformer is connected to the winding 66*c* of the motor 66 as shown in Figure 4. The motor 66 is thus caused to rotate in accordance with the sense and magnitude of the amplified voltage. Capacitor 236 serves as a power factor correcting device for the highly inductive circuit including the secondary winding 236 and the winding 66*c* of motor 66.

The amplifier 168 has similar circuit connections to amplify the voltage produced by the rotor winding of the selsyn 170 to energize the winding of motor 64 as shown diagrammatically in Figure 5.

In the amplifiers 68 and 168 the twin triode tubes 204 and 214 serve as amplitude limiting stages. That is, when the voltage produced by the rotors of selsyns 70 and 170 is above a comparatively small minimum value the output voltage applied to the motors 64 and 66 has a fixed limited value. This voltage, of course, is alternating voltage of the same frequency as source 72, Figure 4, since it is this voltage that is induced in the rotors of selsyns 70 and 170. Consequently, the voltage produced by rotors 64 and 66 has substantially constant value except as the arms 60 and 62 approach very closely the same positions as arms 32 and 28 at which time the voltage decreases to zero.

The anode voltage for amplifier 68 is derived from the unidirectional voltage source 238 as shown. The cathodes of the respective tubes are heated by suitable heaters (not shown).

In order that the ball point pen 54, Figure 2, may write effectively over the face of the paper 44*a*, the links 56 and 58 are designed to press the pen against the paper. This is accomplished by forming these links of a flexible resilient metal, such as steel, and orienting the pins 57 and 59 which connect the links to the arms 60 and 62, respectively, in positions to exert a substantial bearing pressure on the links 56 and 58. By reason of this construction, the pin 54 bears rather heavily on the paper

web 44*a* so that as the pen is moved thereover the ball 55 is rotated and does not slide.

In order to write effectively, it is necessary for the ball point pen 54 to be recurrently lifted from the paper 44*a*. This is accomplished by the shiftable lifting bar 82, Figure 2. This bar extends over the web 44*a* beneath the links 56 and 58 and is connected by arms 84 to the movable bar 88. This arrangement is shown in Figure 9 which is a fragmentary cross-sectional view through the web 44*a* immediately above the bar 82 and looking down. The bar 88 is carried by a pair of swingable arms 89 which are pivotally suspended at their upper ends 89*a* by two aligned ears 89*b* shown in Figure 10. The ears 89*b* are affixed to a support plate 89*c* held in fixed position parallel to and underneath the writing surface 44*a*, shown in phantom in Figure 10. Two solenoids 90 are affixed to support plate 89*c* on the side opposite the movable bar 88. Two solenoid plungers 94 are slidably received in the solenoids 90, and are affixed to bar 86 which is connected to movable bar 88 by nylon connecting rods 91. When the windings of the solenoids 90 are energized the solenoid plungers are drawn into the solenoid windings, pulling the bar 86 and thus shifting the movable bar 88 into its forward position. This causes the lifting bar 82 to react on the pen holding and pressing arms 56 and 58, relieving the force on the pen 54 to arrest further writing. Since the fixed plate 89*c* from which the pivotal arms 89 are suspended is inclined at an angle of about 30 degrees from the vertical, the arms 89 will swing toward the vertical position under the force of gravity when external forces are removed. Thus, when solenoids 90 are de-energized the movable bar 88 carried by the arms 89 moves to its rearward position as does the pen lifting bar 82 connected to it. At this time the pen 54, under the bias of the arms 56 and 58, presses against the writing surface 44*a*.

The energizing circuit for the solenoids 90 is shown in Figure 7. This circuit consists of a source 96 connected to the windings 92 in parallel through the pressure switch 98. This connection may be traced through the transformer 96*a* and the rectifier 96*b*, the latter creating unidirectional voltage for solenoid operation. The latter switch extends beneath the frame 14 of the transmitting unit as shown in Figure 1 and has a pressure sensitive actuating member responsive to down pressure on the frame 14 to open the circuit to windings 92. Thus, as the pen 24 is pressed downwardly for writing purposes, the switch 98 opens to de-energize the windings 92. It will thus be seen that as the user bears down on paper 12 as necessary to write with the ball point pen 24, the solenoids 90 are de-energized to retract the pen lifter arm 82 out of engagement with the arms 56 and 58. The pen 54 accordingly writes on the web 44*a* as pen 24 is moved. However, when pen 24 is lifted such as at the end of a word, the pressure on frame 14 is relieved and switch 98 shifts to the closed circuit condition by reason of the lack of downward force, thereby energizing windings of solenoids 90, Figure 9, and shifting the bar 82 to the pen-lifting position. At this time the pen 54 no longer writes although the links 56 and 58 may slide over the bar 82 to move the pen 54 over the face of the paper 44*a* for the next writing.

Preferably, the mechanism further includes means to advance the paper 44*a* as desired. Such means is not shown in the accompanying drawings but may include suitable switch mechanism in the transmitter of Figure 1 to energize a motor (not shown) in the receiver of Figure 2 to advance the web 44*a* a predetermined distance.

With the mechanism of the present invention the power required to drive the pen 54 over the web 44*a* is derived from motors 64 and 66 which may be of relatively large capacity. Consequently, the arms 60 and 62 follow closely the position of arms 32 and 28, respectively. Also, the resistance created by the pen lifting bar 82 is well within the power capacity of motors 64 and 66 and likewise does not create undue error even though the links 58 and 56 slide over that bar.

If desired, the mechanism described herein may utilize position sensing devices, other than the selsyn devices shown. For example, synchro transmitters and receivers or D.-C. position sensing mechanisms may be provided. Also, in order to improve the stability of the system and minimize transient oscillation, velocity responsive feedback may be employed. Such feedback may, for example, be provided between the motors 64 and 66 and the input circuits of amplifiers 68 and 168, respectively, to cause the input sigals to the amplifiers to appear to decrease as the velocity of the respective rotors increases. Other forms of feedback may be employed as desired to minimize hunting, oscillation, or other errors.

The space between the rotor and the stator of the receiving selsyn 70, Figure 4, is filled with a silicone oil to provide damping effects. A suitable fluid for this purpose is known as Dow DC–200 fluid and has a viscosity of approximately 500 centipoises. This provides a damping effect integral with the control system and serves to reduce the hunting that might otherwise occur.

It should be noted that the pen lifter mehcanism cooperates with the ball point pen characteristics to achieve effective operation. In the case of a ball point pen the writing may be interrupted by relieving the force otherwise pressing the pen against the paper. Unlike a liquid ink system, it is not essential that the pen have any particular spacing from the paper. Hence, the pen lifter mechanism can be retracted by the comparatively feeble force of gravity and the solenoids 90 may be designed to produce such force as is necessary to overcome the pen-pressing action of arms 56 and 58 and the feeble force of gravity. Accordingly these solenoids may be comparatively small and still give effective operation.

While we have shown and described a specific embodiment of the present invention, it will, of course, be understood that alternative forms may be provided without departing from the true spirit and scope thereof. We therefore intend by the appended claim to cover all such modifications and alternative constructions falling within their true spirit and scope.

What we claim as new and desire to secure by Letters Patent of the United States is:

A remote writing system to write on a sheet of writing material for use with a transmitter having a writing instrument positioning a pair of rotatable arms which instrument provides a pair of electrical signals indicative of the rotational position of said arms and a third electrical signal indicative of writing pressure on said writing instrument, said system comprising: means to hold said sheet in a given position in a given plane; a pair of rotatable shafts having fixed axes generally normal to said plane and positioned at opposite sides of said sheet when said sheet is so positioned; power means connected to said shafts to rotationally position said shafts in response to said pair of electrical signals respectively, said power means including a pair of induction motors connected to said shafts respectively and a pair of amplifiers connected to said motors respectively; a first pair of relatively rigid arm members, one end of each of said arms members being affixed to said shafts respectively; a second pair of resilient arm members; a pair of pin connecting means, one of said connecting means affixing one end of each of said second resilient arm members respectively to the other end of said first rigid arm members respectively with said pins of said connections being generally parallel to said shafts and maintaining the connected ends of said arm members substantially in a predetermined plane; a ball point pen member positioned generally normal to said plane; pin connecting means interconnecting the other ends of said second pair of arm members and said pen

member with the pin thereof being generally parallel to said shafts; said resilient arm members being biased to urge said pen member towards said sheet with a relatively strong pressure to cause said ball of said pen member to write on said sheet; a lifter bar operatively associated with said resilient arm members to move said pen member vertically with respect to said sheet, said bar spanning the arm members in all positions and being located outboard said sheet, and in pen lifting position defining a frictional resistance to arm movements; and electrical means connected to said lifter bar and responsive to said third electrical signal to actuate said lifter bar in response to said third electrical signal to lift the pen and simultaneously substitute the frictional resistance of the lifter bar for the frictional resistance of the paper.

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