

July 4, 1961

B. WEINGART ET AL

2,991,329

HYDRAULICALLY ACTUATED REMOTE WRITING INSTRUMENT

Filed May 23, 1955

4 Sheets-Sheet 1

FIG. 1

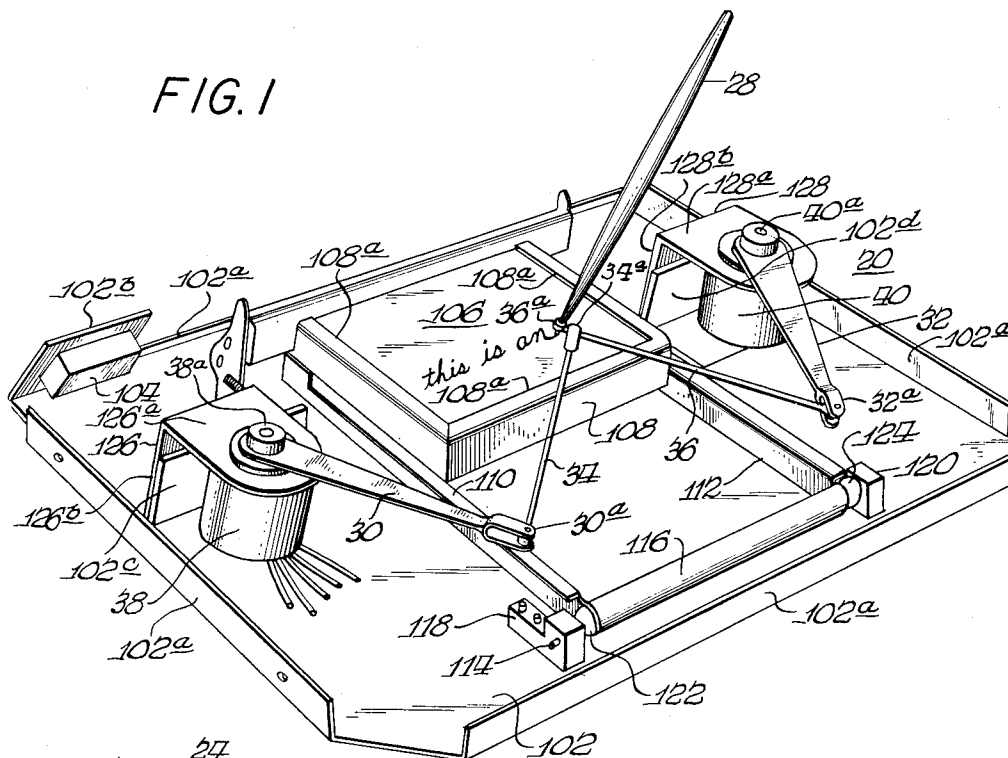
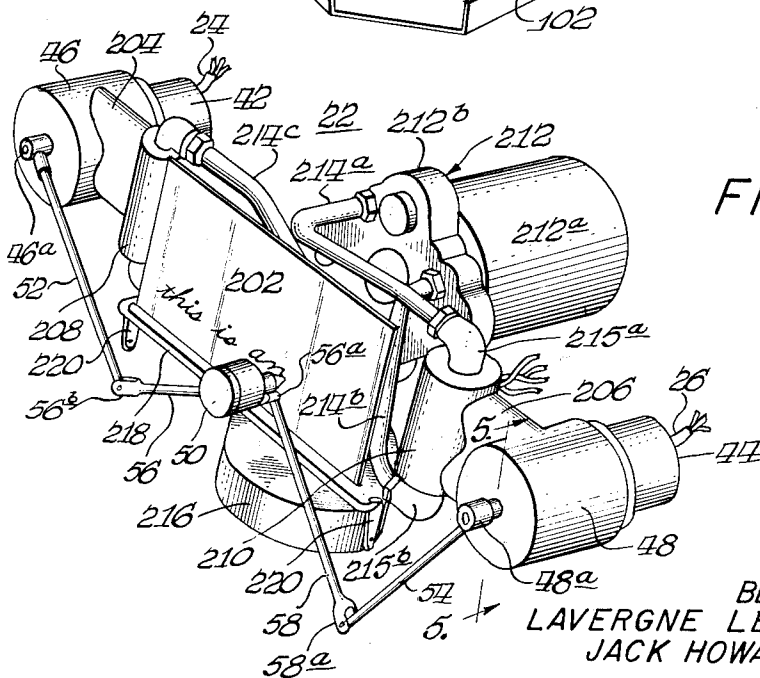


FIG. 2



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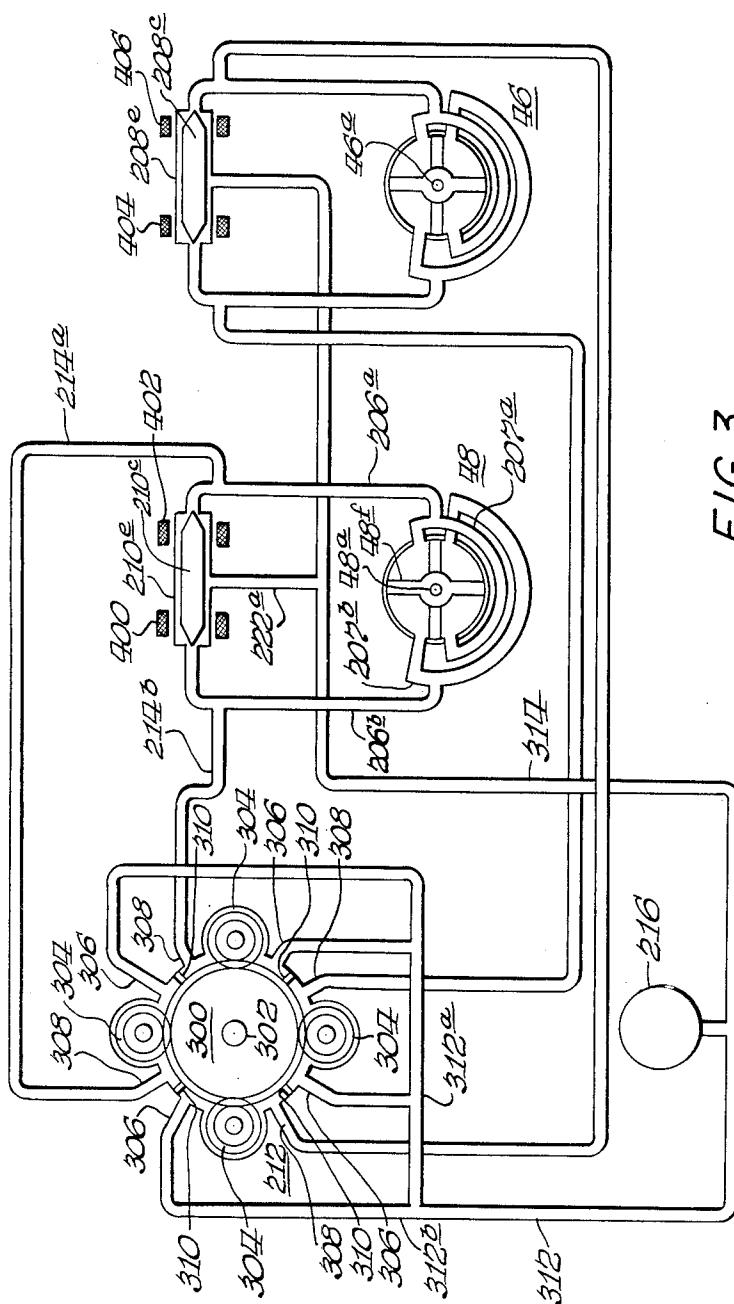
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FIG. 4

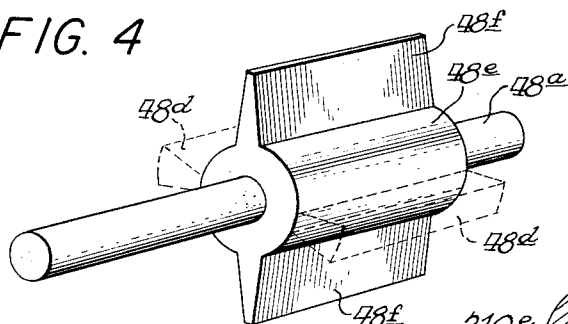


FIG. 6

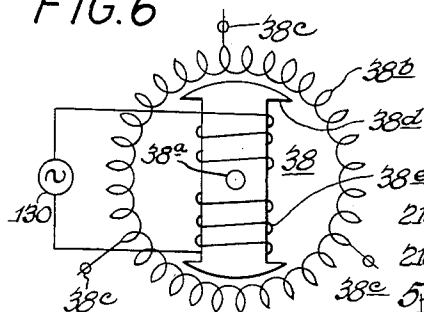


FIG. 5a

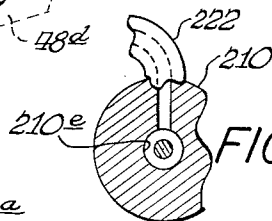
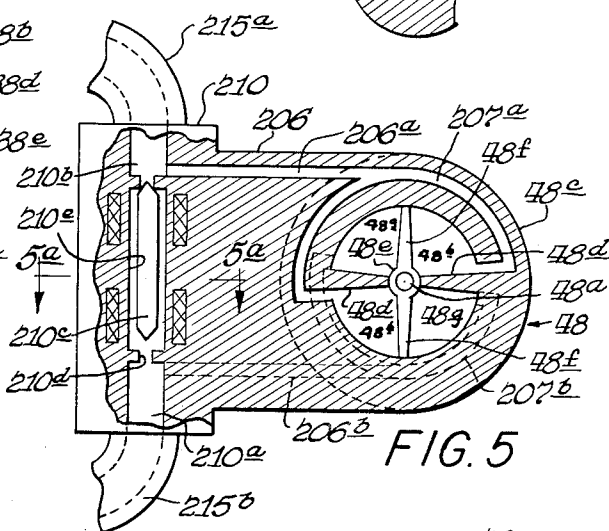


FIG. 5

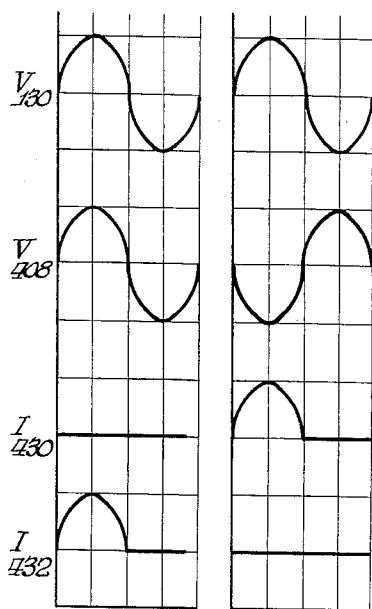
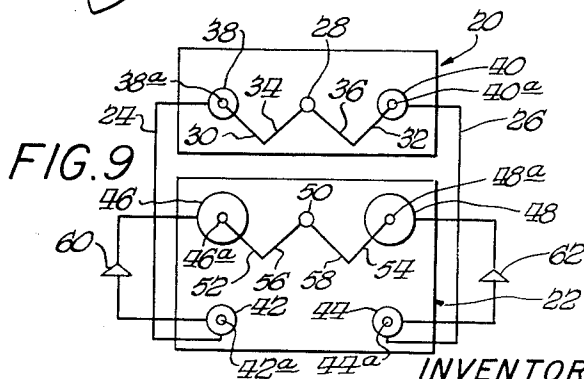


FIG. 8a

FIG. 8b



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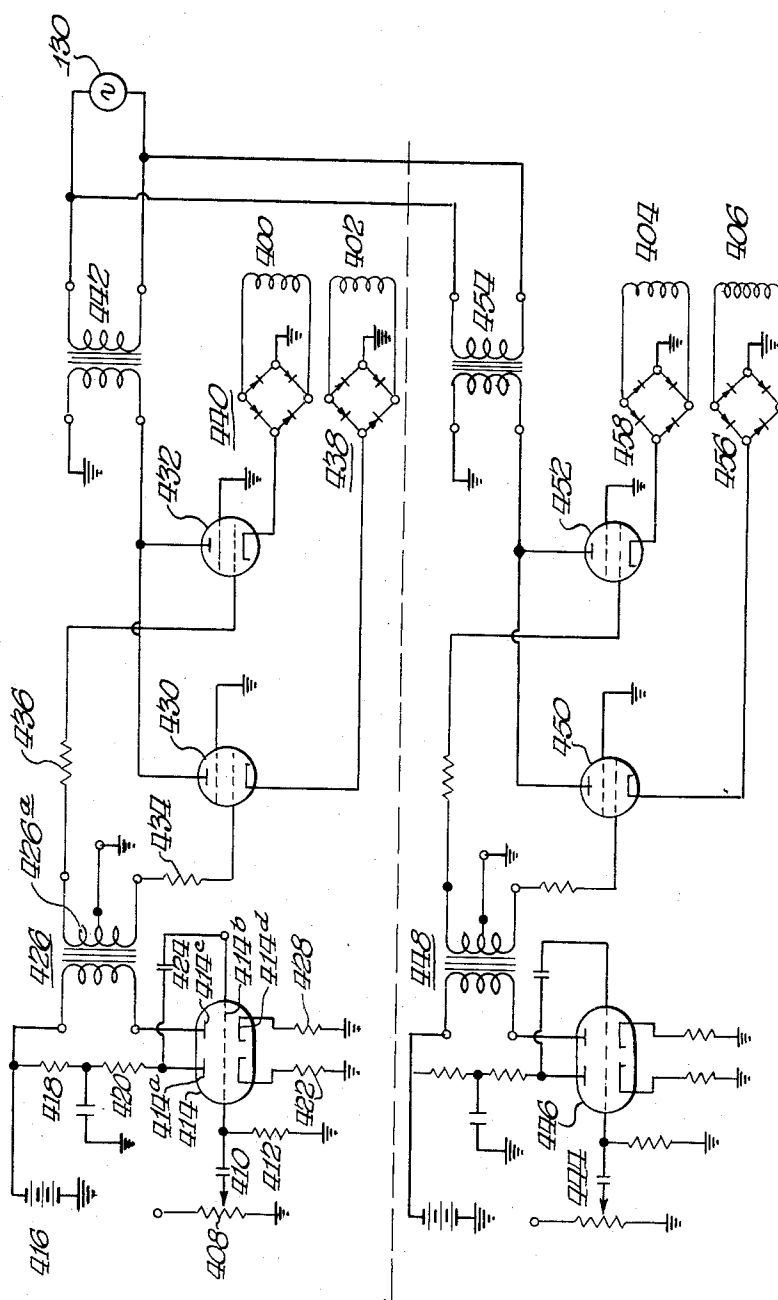


FIG. 7

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Filed May 23, 1955, Ser. No. 510,282

5 Claims. (Cl. 178—18)

The present invention relates to an improved instrument for writing at a distance.

In remote writing instruments it is necessary for practical reasons to use communication circuits having low power transmitting capacity to transmit the signals indicating the required movements of the writing member. At the receiving instrument, however, it is desirable to convert these feeble electrical signals to controlled mechanical power at a comparatively high power level. By so doing, it is possible to use a ball point pen advantageously and to avoid any need for a precisely balanced, low friction, mechanical writing system.

The present application relates to an improved mechanism by which the comparatively great torque capabilities of a hydraulic system are used to drive the writing instrument. In brief, the writing device, preferably a ball point pen, is supported over a writing surface by a linkage mechanism driven by arms connected to the shafts of a pair of hydraulic motors outboard the writing surface. A hydraulic pump having four independent pressure discharge channels is located behind the writing surface. Pairs of these channels communicate with the pairs of chambers in the hydraulic motors, respectively, to furnish driving power to the motors. Hydraulic pressure is selectively unbalanced in the chambers by means of solenoid valves integral with the housings of the hydraulic motors. Energizing power for the solenoids is derived from a pair of suitable amplifiers responsive to electrical signals indicating the relation of the actual position of each hydraulic motor and the position it should have for coincidence with the corresponding transmitter arm.

It is therefore a general object of the present invention to provide an improved remote writing instrument using hydraulic means for moving the receiver pen.

Further it is an object of the present invention to provide an improved remote writing instrument capable of producing sufficient mechanical power for operation with a ball point pen.

Still another object of the present invention is to provide an improved hydraulic remote writing instrument wherein the hydraulic system is entirely self-contained and the unit can be controlled by comparatively feeble control signals.

Yet another object of the present invention is to provide a remote writing instrument involving a unitary housing which includes both a hydraulic motor and the solenoid mechanism required to control the motor.

Other objects of the present invention include the provision of a hydraulically actuated remote writing instrument which is simple; an instrument which is reliable; an instrument of small size; an instrument containing its own sealed hydraulic system; and an instrument embodying features of construction, combination and arrangement rendering it suitable for a wide range of practical applications.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention, itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be

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understood by reference to the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a view in perspective of a transmitter or sending instrument of the type used in connection with the present invention;

FIGURE 2 is a view in perspective with covering parts removed of a receiving mechanism constructed in accordance with the present invention;

FIGURE 3 is a diagrammatic view of the hydraulic system of the receiver of FIGURE 2;

FIGURE 4 is a view in perspective of the rotor portion of one of the hydraulic motors used on the receiver of FIGURE 2 and showing the stator baffle wings in phantom;

FIGURE 5 is a fragmentary view in axial cross-section of a complete hydraulic motor and control valve mechanism of the type used in the receiver of FIGURE 2;

FIGURE 5a is a fragmentary view in cross-section through axis 5a—5a, FIGURE 5;

FIGURE 6 is a diagrammatic view of a selsyn unit of the kind used in the transmitter of FIGURE 1 and the receiver of FIGURE 2;

FIGURE 7 is a circuit diagram of the amplifier and solenoid control mechanism of the receiver;

FIGURES 8a and 8b are charts showing the operation of the circuit of FIGURE 7; and

FIGURE 9 is a diagrammatic view of a complete remote writing system constructed in accordance with the present invention.

THE OVERALL SYSTEM

The overall remote writing system herein described in detail is shown in diagrammatic form in FIGURE 9. The system includes a transmitter unit shown generally at 20, a receiver unit shown generally at 22 and a pair of three-conductor connecting cables 24 and 26 which transmit signals from the transmitter to the receiver. In brief, the transmitter 20 includes a writing instrument 28 which is preferably a ball point pen. This instrument is attached to the linkage defined by arms 30 and 32 and links 34 and 36 so that the shafts 38a and 40a of the selsyn generators 38 and 40 are rotated as the pen 28 writes.

The rotations of the arms 30 and 32 and the shafts 38a and 40a induce corresponding sets of voltages in the three-conductor cables 24 and 26. These are connected respectively to the selsyn receivers 42 and 44. The positions of the rotors of the selsyn receivers 42 and 44 are determined by the hydraulic motors 46 and 48, respectively. The shafts 46a and 48a of these motors carry the writing pen 50 which is preferably a ball point pen through the linkage 52, 54, 56 and 58 which corresponds to the linkage by which the transmitter pen 28 is carried.

The shafts 46a and 48a of the hydraulic motors 46 and 48 rotate both the arms 52 and 54, respectively, and the shafts 42a and 44a of selsyn receivers 42 and 44, respectively. The voltages induced in the two selsyn receivers are applied to amplifiers 60 and 62, respectively, to control admission of hydraulic fluid to the hydraulic motors 46 and 48 and thereby swing the arms 52 and 54 in direction and amount to bring the selsyn rotors 42a and 44a to the zero-voltage position.

In overall operation, the arms 30 and 32 are rocked as writing with pen 28 proceeds. Corresponding voltages are generated in the three-conductor cables 24 and 26, which voltages are applied to the selsyn receivers 42 and 44. Through the action of amplifiers 60 and 62

and the hydraulic motors 46 and 48, the rotors of selsyns 42 and 44, respectively, are rotated in follow-up movements to bring them to the positions corresponding to the initial movement of arms 30 and 32. Since this limitation is likewise imparted to arms 52 and 54, the pen 50 is caused to write over the writing surface in the same movements as the transmitting pen 28. The writing of pen 28 is accordingly reproduced by the pen 50.

The transmitter

FIGURE 1 shows the construction of the transmitter in further detail. This unit consists of a base 102 having upturned edges 102a to receive a suitable cover (not shown). The back edge 102a has an extending ear 102b which receives the socket 104 into which the plugs carrying the ends of the conductors 24 and 26, FIGURE 9, are inserted. The pen 28 writes on a pad of paper 106. This pad is carried by the sheet metal housing 108 having inturned upper edges 108a overlaying the top margin of the paper 106 to hold the same in position.

The frame 108 is affixed to and carried by a cradle defined by the arms 110 and 112 which extend upwardly of the unit and are received on shaft 114. The arms 110 and 112 are held in desired spaced position by the sleeve 116 and the carriage is held in centered relation to the trunnions 118 and 120 by the marginal sleeves 122 and 124, respectively.

Selsyn generator 38 is carried by an L-shaped bracket 126 having a horizontal portion 126a which receives the selsyn motor and a vertical portion 126b which is welded or otherwise affixed to the upturned ear 102c struck up from the base 102 as shown.

The selsyn generator 40 is similarly supported by an L-shaped bracket 128 having a horizontal upper face 128a and a vertical portion 128b. The latter is welded or otherwise affixed to the ear 102d struck up from the base 102 as illustrated.

The pen 28 is held in the end of arm 36 by a ball joint 36a. This permits full swinging motion of the pen while the end of arm 36 is moved over the paper 106 as writing proceeds. A ball joint is also provided at the clevis portion 34a of the link 34.

Each of the arms 30 and 32 terminates at its outer end in a clevis 30a and 32a, respectively. Each arm 34 and 36 is secured in the clevis 30a and 32a by a ball joint which permits swinging motion of the pen 28 and at the same time pivotally connects the arms 30—34 and 36—32.

It will be observed from the foregoing that as the pen 28 shifts in writing movements over the paper 106, the arms 30 and 32 swing in accordance with the pen movements. This swinging action completely defines the position of the pen inasmuch as for every position of the pen on the paper the arms 30 and 32 have predetermined positions, and conversely, for every pair of positions of arms 30 and 32 there is only one possible pen position.

FIGURE 6 shows in electrical diagrammatic form the selsyn transmitters 38 and 40, specific reference being made to transmitter 38. In brief, the transmitter consists of a stator having a continuous winding 38b about its periphery. This winding has three equally spaced taps 38c as shown. As hereinafter described, the taps 38c are connected to the three conductors of cables 24, FIGURE 9. The selsyn transmitter 38 further includes a magnetic rotor 38d affixed to shaft 38a. This rotor is of the salient-pole type and carries a winding 38e which is energized by alternating voltage from source 130.

In operation, alternating voltage impressed on winding 38e generates a like alternating magnetic flux which is in alignment with the alignment of the axis of the rotor 38d. This induces voltages in the winding 38b and thereby creates three separate voltages between each pair of taps 38c. The value of these voltages is determined by the rotational position of the rotor 38b and hence the

shaft 38a. Since the latter rocks in unison with arm 30 the voltages between the taps 38c are determined by the position of the arm 30.

In like manner, the selsyn generator 40 induces three voltages determined by the rotational position of arm 32, which voltages are applied to the conductors of cable 26, FIGURE 9.

Receiver mechanical construction

The receiver indicated generally at 22, FIGURE 9, is shown in further detail in FIGURE 2 which shows the operative mechanism of the receiver in perspective view without the supporting parts, cover, and other mechanism. As shown, the receiver pen 50 is positioned to write upon the writing surface defined by the paper 202 carried by a suitable back plate (not shown). The pen 50 is carried in the upper end of link 58 and the latter is pivotally connected to the link 56 at 56a as shown. Links 56 and 58 terminate in clevis portions 56b and 58a at which points they pivotally receive the arms 52 and 54, respectively. Arms 52 and 54 are in turn carried by the shafts 46a and 48a, respectively, of the hydraulic motors 46 and 48.

The arms 52 and 54 are made of length corresponding to arms 30 and 32, FIGURE 1. Links 56 and 58 are likewise of length corresponding to links 34 and 36, FIGURE 1. In addition, the shafts 46a and 48a are spaced the same distance as shafts 38a and 40a, so that the arms 52 and 54 define the position of pen 50 over the writing surface 202 in the same respect as the arms 30 and 32 define the position of pen 28.

It will be noted that selsyns 42 and 44 are mounted coaxially with the hydraulic motors 46 and 48, respectively. The shafts 42a and 44a of the two selsyns are affixed to the shafts 46a and 48a so that as the shafts 46a and 48a rotate the selsyn shafts rotate in unison with them.

Each of the hydraulic motors 46 and 48 is supported by an inwardly extending housing 204 and 206, respectively. As is described in detail hereinafter, these housings define the fluid passageways through which actuating fluid flows to and from the respective motors. At their inward margins housings 204 and 206 are affixed to the vertically extending generally cylindrical control valve housings 208 and 210, respectively. In each instance the hydraulic motor, the selsyn, and the inwardly extending passage-defining housing inward the control valve housing are joined to form a unitary structure, which can be supported in any convenient way by support members affixed to one of the parts.

The hydraulic pump, hereinafter described in detail, is located directly behind the writing surface as shown at 212, FIGURE 2. This pump is driven by electric motor 212a and is of the gear type with a housing 212b which forms the pumping mechanism. A set of four upwardly extending outlet sockets on the front face of housing 212b receives the four fluid pipes 214a, 214b, 214c and 214d (not shown in FIGURE 2). These pipes are connected through suitable hydraulic fittings to opposite ends of the two valve housings 208 and 210 as is described hereafter, thereby providing at each end of each control valve housing an independent source of hydraulic fluid at predetermined rate of flow for selective restriction of bypass and return flow by valves 208c and 210c in housings 208 and 210 selectively unbalancing the hydraulic pressure in housings 204 and 206 and hence in the hydraulic motors 46 and 48 respectively.

A reservoir of hydraulic fluid is located in the housing 216, FIGURE 2. It is located below and forwardly of the pump mechanism 212 as shown.

The receiver pen 50 is lifted to spaced position in relation to the writing surface 202 by the pen lifter carriage formed by the arm 218 carried at its opposite ends by the rockers 220. The latter are supported by

suitable means (not shown) and rocked in the counter-

clockwise direction as seen in FIGURE 2 to bear against links 56 and 58 and thereby lift the pen 50 to spaced position in relation to the writing surface. This rocking action may be accomplished by suitable switch mechanism (not shown) actuated by operations of the transmitting pen 28. Mechanism of this type is shown in the co-pending application of Ben Weingart, Jack Howard Zillmann and Robert Emmet Poole, Jr. entitled "Remote Writing Instrument," Serial No. 496,306, now Patent No. 2,935,561, and assigned to the same assignee as the present invention.

FIGURE 5 shows the hydraulic motor 48, the housing 206 and the control valve mechanism 210 with parts broken away in cross-section 5—5, FIGURE 2. As shown, the couplings 215a and 215b, which receive pipes 214a and 214b, respectively, have internal portions in communication with the channel 210a extending through the control valve 210. At its upper end, this channel is in communication with channel 206a extending through housing 206 and the channel 207a of the motor 48. Immediately below the junction of channels 206a and 210a the latter is constricted to define a control port 210b which is selectively closed by the magnetic plunger 210c as hereinafter described in detail. Similarly, the bottom part of channel 210a is in communication with channel 206b, the latter in turn communicating with channel 207b of motor 48. Above the junction of 206b, and 210a the latter is constricted to form orifice 210d as shown. This orifice is closeable by downward shifting movement of the magnetic plunger 210c.

It will be noted that channel 210a forms a chamber 210e located between the two orifices 210b and 210d and that the plunger 210c is received in this chamber in axially shiftable relationship.

The chamber 210e is in turn connected to the reservoir 216 by the fitting 222, FIGURE 5a, which is not seen in FIGURE 2 but extends rearwardly of the housing 210 as shown in FIGURE 5a. The fitting 222 receives a pipe (not shown) which extends to the reservoir 216.

The control valve housing 208 defines channels and is connected to pump 212 and to the reservoir 216 in the same fashion as above described with reference to FIGURE 5.

The hydraulic motor 48 consists of the housing 48c, FIGURE 5, which, in addition to the channels 207a and 207b, defines a cylindrical space 48b concentric with the shaft 48a. A pair of diametrically opposed impervious wings 48d extend radially inward to wipe against the hub 48e formed on shaft 48a as shown in FIGURES 4 and 5. The hub 48e has a pair of diametrically opposed vanes 48f each of which divides the space defined by each pair of wings 48d into two chambers, one on each side of each vane.

It will be noted that the channel 207a communicates with the space 48b on the counterclockwise side of each wing 48d and that the channel 207b communicates with the space 48g on the clockwise side of each wing 48d. These channels are spaced axially of the unit to prevent interference with each other. It will thus be apparent that as fluid is passed into channel 207a and out of channel 207b the vanes 48f—and hence hub 48e and shaft 48a—are rotated in counterclockwise direction. On the other hand, as fluid is passed into channel 207b and withdrawn from channel 207a the vanes 48f and the shaft 48a are rotated in clockwise direction. It follows that selective admission of fluid into and out of channels 206a and 206b, FIGURE 5, serves to turn the shaft 48a.

The motor 46 is similarly constructed to respond to introduction of fluid into one channel or the other of housing 204.

The receiver hydraulic system

The receiver hydraulic system is shown in diagrammatic view in FIGURE 3. As shown, the pump 212 is of the gear type having a drive or bull gear 300 which

is carried by the shaft 302 driven by motor 212a, FIGURE 2. Four pinion gears 304 are in mesh with and in spaced relation about the bull gear 300. The teeth on the respective gears are of the gear pump type so that as the gears rotate the hydraulic fluid, preferably oil, is driven in counterclockwise direction through the nip defined by the bull gear 300 and each of the pinions. Fluid intake passages 306 are provided on the downstream side of each pinion 304 and outlet passages 308 are provided on the upstream side, so that during normal operation a comparatively low fluid pressure exists at each of the passages 306 and a comparatively great fluid pressure exists at each of the passages 308. Baffles 310 are located between each pair of passages 306 and 308 to divide the entire unit into the equivalent of four separate gear pumps.

Each of the fluid inlet passages 306 is connected to the reservoir 216 through the pipes 312, 312a and 312b as shown. This provides a source of operating fluid for the pump 212.

As is shown in FIGURE 3 two of the outlet passages of pump 212 are connected to the pipes 214a and 214b leading to the passages 206a and 206b, respectively. The specific physical construction of this portion of the mechanism is described above with reference to FIGURE 5. The junctions of passages 206a and 206b with the pipes 214a and 214b, respectively, are likewise in communication with the cylindrical space 210e containing the plunger 210c. The space of chambers 210e is also connected through the pipe 222a to the pipe 314 connected to the reservoir 216.

The solenoid windings 400 and 402 embrace the chamber 210e—and hence the magnetic plunger 210c—to pull that plunger either in the right hand direction or the left hand direction as seen in FIGURE 3.

The ends of the plunger 210c are tapered as shown in FIGURE 3, and in FIGURE 5, to cause movement of the plunger under the magnetic field created by the windings when energized.

In operation, the plunger 210c serves to block the connection between the pipe 222a and one or the other of pipes 214a and 214b, FIGURE 3. If, for example, the plunger 210c is shifted in the left hand direction of FIGURE 3 (solenoid 400 energized), the passage 214b is not connected to pipe 222a and full hydraulic pressure is applied to pipe 206b and passage 207b. At this time, however, pipe 214a is in communication with pipe 222a so that the pressure in pipe 206a and channel 207a is comparatively low. The consequence is that hydraulic fluid flows into passage 207b and out of passage 207a to swing the vanes 48f and the shaft 48a in the clockwise direction. Energizing solenoid 402 to shift the plunger 210c in the right hand direction of FIGURE 3 has the opposite effect to rotate shaft 48a in the counterclockwise direction.

The connections to the hydraulic motor 46 are similar to those above described with reference to the motor 48, so that selective energization of the solenoid windings 404 and 406 rotates the shaft 46a in one direction or the other as described.

Receiver electrical system

FIGURE 7 shows the electrical circuit diagram of the mechanism through which the solenoid windings 400, 402, 404 and 406 are selectively energized. The potentiometer 408 is connected across the rotor winding of the receiver selsyn unit 44. This unit is like that shown diagrammatically in FIGURE 6 so that an alternating voltage is induced therein in accordance with the extent and direction the shaft 48a departs from the position of no voltage. Since the stator winding of selsyn 44 is connected to the stator winding of the selsyn generator 40, FIGURE 9, the no-voltage position of selsyn 44 is determined by the position of arm 32.

The voltage across potentiometer 408 is applied through the network defined by capacitor 410 and resistance 412 to the control electrode of the first half of electron tube

414. Unidirectional voltage is applied across the space path of this portion of tube 414 through the circuit which can be traced from source 416 through resistances 418 and 420 to the anode and from the cathode through resistance 422 to ground. As a consequence the anode 414a has an alternating voltage component of opposite sense to that across the resistance 408. This voltage is applied through capacitor 424 to the control electrode 414b of the second half of tube 414. This causes an alternating current flow through the circuit defined by unidirectional voltage source 416, the primary of transformer 426, the anode 414c, the cathode 414d and the resistance 428.

The alternating flow in the second half of tube 414 induces an alternating voltage across the split secondary winding 426a of transformer 426. The center tap of this winding is grounded as shown so that the control electrodes of tubes 430 and 432 receive 180° out of phase voltages with respect to ground through resistances 434 and 436. The cathodes of tubes 430 and 432 are connected to ground through the bridge rectifiers 438 and 440, respectively. The anodes of these tubes are energized from alternating voltage source 130 through the transformer 442.

The solenoid windings 400 and 402 are connected across the rectifiers 440 and 438, respectively, as shown.

The action of the control circuit is shown best in FIGURES 8a and 8b. In these figures the voltage V_{130} is the voltage of the source 130; the voltage V_{408} is the voltage across the potentiometer 408; the current I_{430} is the anode current of electron tube 430; and the current I_{432} is the anode current flow in the electron tube 432. When the voltage V_{408} induced in the selsyn receiver 442 is in phase with the voltage of source 130, the control electrode of tube 432 swings positive in phase with the anode-cathode voltage. As a consequence, the current flow in tube 432 increases in sinusoidal manner as shown in FIGURE 8a. This current flow is rectified and applied to the solenoid winding 400 to energize that winding and shift the plunger 210c, FIGURE 3, towards the lefthand direction as seen in that figure. At this time, however, the voltage in the control electrode 430 is out of phase with the anode-cathode voltage from source 130. Consequently, as the voltage of the anode of tube 430 increases the control electrode voltage decreases and no significant current flows through that tube. Winding 402 is accordingly not energized. For the conditions of FIGURE 8a, the plunger 210c, FIGURE 3, is shifted to the lefthand direction to cause relatively high pressure in pipe 214b and the passage 207b to shift the shaft 48a in clockwise direction.

After shaft 48a swings clockwise the magnitude of the voltage induced in selsyn 44 is decreased until it reaches a minimum value, at which time the current flow in tube 432 ceases and the plunger 210c, FIGURE 3, is relieved of any magnetic action. At this time plunger 210c "floats" and there is no hydraulic torque tending to rotate the shaft 48a in either direction.

If by reason of overshoot or new movement of the transmitting selsyn shaft 40a, FIGURE 1, the shaft 48a deviates in the opposite direction from position of arm 32, the voltages in the selsyn are each shown in FIGURE 8b. At this time, the voltage V_{130} is the same as before. However, the voltage induced in the selsyn receiver is of opposite sense as shown by the curve V_{408} , FIGURE 8b.

The control electrode of tube 430 is now in phase with the anode-cathode voltage so that a one-half cycle current wave passes through tube 430 as shown in I_{430} , FIGURE 8b. At this time the control electrode of tube 432 is out of phase with the anode-cathode voltage and no current flows therethrough. The effect is to create current through winding 402 to shift the plunger 210c in the right hand direction, FIGURE 3. The full hydraulic pressure of pipe 214a is then applied to the channel 207a to shift shaft 48a in the counterclockwise direction.

The diagrams of FIGURES 8a and 8b show the current pulses in the respective tubes in illustrative form. Preferably gas filled tubes, such as type 2D21 tubes, are used, in which event the current pulses are somewhat delayed and depart from the sine wave shape shown. The operation, however, is as above described.

From the above it will be evident that the operation of the hydraulic mechanism of the motor 48 in conjunction with the control mechanism of the upper half of FIGURE 7 and the solenoids 400 and 402, is to cause the shaft 48a to swing towards the zero-voltage position.

The arm 54 is oriented on shaft 48a so that when the shaft has the zero-voltage position arm 54 is at the same angle with reference to the receiving mechanism as the arm 32 is with respect to the transmitting mechanism. Thus, the arm 54 is caused to follow the movements of arm 32.

The mechanism shown in the lower half of FIGURE 7 energizes the solenoid windings 404 and 406 in response to the voltage induced in the rotor of receiving selsyn 42. This action occurs in the same fashion as above described with reference to windings 400 and 402. In brief, the voltage induced in the rotor of selsyn 42 is applied to potentiometer 444; amplified in the two halves of electron tube 446 to produce an in-phase current flow in transformer 448 and a set of 180° out of phase voltages across the cathode-control electrode space paths of tubes 450 and 452, respectively. The anode-cathode space paths of these tubes are energized from source 130 through transformer 454 and bridge rectifier 456 and 458, respectively. In operation, either tube 450 or 452 conducts, depending on the direction the shaft 46a deviates from the zero voltage position. One or the other of solenoid windings 404 and 406 are accordingly energized to apply hydraulic fluid to motor 46 as required to rotate the same in direction to restore the selsyn 42 to the zero-voltage position.

It will be apparent from the above description that the mechanism of the present invention provides a remote writing instrument wherein the torque required to drive the pen-operating arms is derived from the hydraulic system which is located locally in the receiver. That is, the electric transmitting system only serves to induce a voltage in the rotors of selsyns 42 and 44, FIGURE 2, and does not serve as a source of pen-moving power. Since the hydraulic system is characterized by an ability to produce considerable torque the unit has available a comparatively large pen-moving force which serves to assure movement of the receiver pen in strict correspondence with the movements of the transmitter pen. This not only provides a "tight" system wherein there is minimum tendency for "hunting" and error, but also permits the use of a ball point pen or other writing instrument which requires a relatively great bearing pressure and hence actuating force.

It will, of course, be understood that many modifications and alternative constructions may be used without departing from the spirit and scope of the present invention. For example, other electrical position sensing units may be used in place of selsyns 38, 40, 42 and 44. Likewise the electrical control network of FIGURE 7 may be modified such as by using the sources other than the battery sources shown for the cathode-anode voltage of tubes 414 and 446, the use of other amplifier circuits, etc. These and other variations may be made by application of the skill of the art without deviating from the present invention.

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

1. In a hydraulically actuated remote writing device of the type wherein an arm is rotated to move a pen in writing motions, the improvement comprising: a shaft supporting said arm; a hydraulic motor connected to said shaft and having a vane and a housing, the housing defining chambers on opposite sides of the vane so that as

the shaft rotates one chamber enlarges and the other contracts; electrical means operable when energized to admit fluid under pressure to one chamber; electrical means operable when energized to admit fluid under pressure to the other chamber; a pair of electron tubes each having a cathode, control electrode, and anode; a source of alternating voltage; means connecting each of said electrical means across said source in series with the cathode-anode space path of one of said tubes; means to produce an alternating voltage of like phase and frequency with said first alternating voltage, of magnitude determined by the extent of the deviation of the arm from desired writing position and sense determined by the direction of the deviation; and means to apply said last voltage across the cathode-control electrode space paths of said tubes to admit fluid to one chamber or the other in accord with the direction of the deviation of the arm from desired position.

2. In a hydraulically actuated remote writing device of the type wherein an arm mounted on a shaft is rotated to move a pen connected to said arm in writing motions in response to an electrical signal from a transmitting station, which signal is indicative of the position of a corresponding arm at the transmitting station, the improvement comprising: a motor housing having a generally cylindrical opening therein formed about an axis, said housing having a pair of wings extending into said opening toward each other from diametrically opposite sides and dividing said housing into a pair of generally semi-cylindrical cavities, said housing having two ports in each cavity, each port being adjacent one of the wings respectively; shaft means extending axially through said opening and establishing a seal between the adjacent ends of the wings; a pair of vanes attached to the shaft means with each vane being in a cavity respectively, each vane contacting the sides of the housing about the cavity to divide the cavity into two portions of variable size; means for producing fluid under pressure and having at least two pressure lines and a return line; a first conduit means connecting together one pressure line, one port in one cavity adjacent one wing and the port in the other cavity adjacent the other wing; a second conduit means connecting together a second pressure line and the remaining port in each cavity; valve means interconnecting the two conduit means and the return line when said valve means is not actuated, said valve means being operable to selectively disconnect either one or the other of the conduit means from the return line; electrical actuating means for said valve means including a sensing means connected to said shaft to determine the relation between positions of the arms at the transmitting station as indicated by said electrical signal and at the receiving station as indicated by the position of the shaft, said actuating means being effective to operate said valve means to apply fluid pressure to the portion of the cavity to rotate the shaft in a direction to move the arm at the receiving station to the position of the arm at the transmitting station.

3. A fluid actuated control apparatus for use with a source of fluid pressure and a fluid sump, said apparatus including: a fluid motor comprising a housing having an internal opening therein, and moveable means mounted in said opening, moveable in two directions with respect to the housing and dividing said opening into a pair of chambers, one of which expands and the other of which contracts when the means moves in one direction, and said one chamber contracts and said other expands when said means moves in the opposite direction, said housing defining a first channel communicating with the one of said chamber and a second channel with the other of said chambers; a valve having a body defining two inlet passages and an outlet passage, and a plunger moveably mounted in said body for alternative positioning in any one of three positions, in a first position of said plunger both of said inlet passages being in communication with said outlet passage, in a second position of said plunger, only

one of said inlet passages being in communication with said outlet passage, and in the third position only the other of the inlet passages being in communication with said outlet passage, said valve including means to move said plunger between said positions; pipe means connecting said source of fluid pressure with said first channel and said one inlet passage; and pipe means connecting said source of fluid pressure with said second channel and said other of said inlet passages; whereby when said plunger is in the first position the fluid pressure in said chambers will be equal and said moveable means in said motor will remain in its position, when said plunger is in the second position the fluid pressure in the other chamber is greater than the fluid pressure in said one chamber to move said moveable means of the motor in said opposite direction, and when said plunger is in the third position the fluid pressure in the one chamber is greater than the fluid pressure in said other chamber to move said moveable means of said motor in said one direction.

4. A hydraulic actuated control apparatus for use with a first device for supplying hydraulic fluid under pressure and a sump device, said apparatus including: a valve having three fluid passages, and means in said valve to alternatively connect a first passage with both the second and third passages, to connect the first passage with the second passage only, and to connect the first passage with the third passage only; a hydraulic fluid motor, said motor comprising a housing defining an arcuate internal opening therein formed about an axis, said opening having two ends, said housing having a first channel communicating with said opening at one end and a second channel communicating with said opening at the other end, a vane positioned in said housing for rotation about said axis and dividing said opening into two chambers between said ends, and a shaft positioned along said axis, journaled in said housing and connected to said vane; means defining a fluid passageway between said first channel, said second passage and said first device; means defining a fluid passageway between said second channel, said third passageway and said first device; and means defining a fluid passageway between said first passage and said sump device.

5. A fluid actuated control apparatus for use with a first device for supplying fluid under pressure and a fluid exhaust device, said apparatus including: a valve defining an internal chamber with an orifice at each end, a first and second passage respectively communicating with the two orifices, and a third passage communicating with said chamber, said valve including a magnetic plunger in said chamber and having two ends, said plunger being moveable in said chamber between a first position at which one end thereof obstructs only one orifice, a second position at which the other end thereof obstructs only the other orifice and a third position at which both orifices are unobstructed; an electro magnet means surrounding at least a portion of said chamber, said electromagnet means being selectively energizable to create magnetic fields to move said plunger to said first or to said second position; a fluid motor comprising a housing having an internal opening therein, and moveable means mounted in said opening, moveable in two directions with respect to the housing and dividing said opening into two chambers, one of which chambers expands and the other of which contracts when the moveable means moves in one direction and said one contracts and the other expands when the moveable means moves in the opposite direction, said housing defining a first channel communicating with the one of said chambers and a second channel communicating with the other of the chambers; pipe means connecting said first device with the first passage and the first channel; pipe means connecting said first device with the second passage and the second channel; and pipe means connecting said third passage with the exhaust device.

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References Cited in the file of this patent

UNITED STATES PATENTS			
684,579	Michalke	Oct. 15, 1901	2,546,628
2,094,039	Kinsley	Sept. 28, 1937	2,590,294
2,463,931	Wycoff	Mar. 8, 1949	2,604,075
			2,623,943
			2,655,903
			2,697,417

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Briggs	Mar. 27, 1951
Both	Mar. 25, 1952
Naud	July 22, 1952
Adler	Dec. 30, 1952
Tyler	Oct. 20, 1953
Mayer	Dec. 21, 1954