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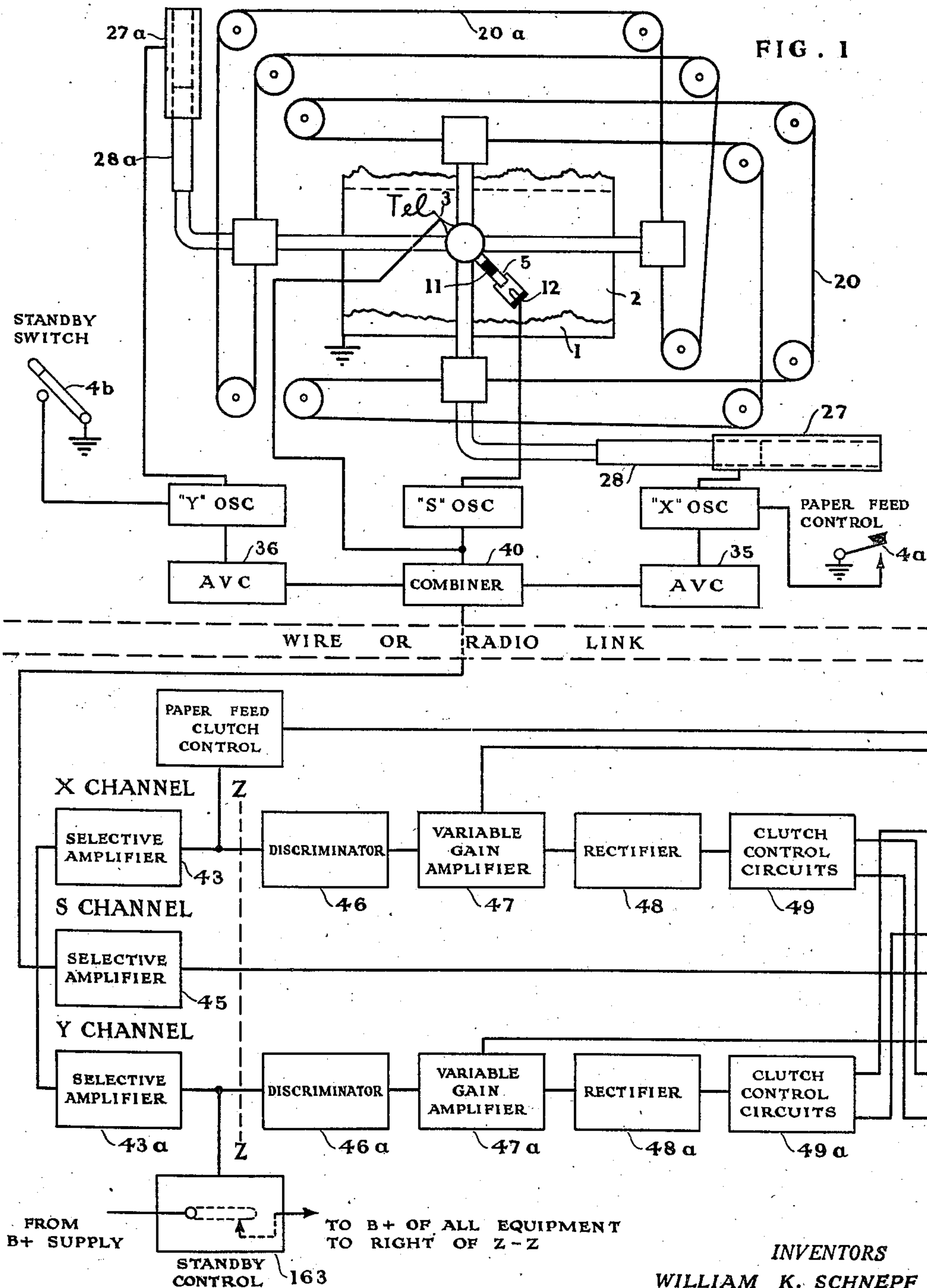
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2,415,718

TELESCRIPT COMMUNICATION SYSTEM

Filed June 22, 1944

8 Sheets-Sheet 1



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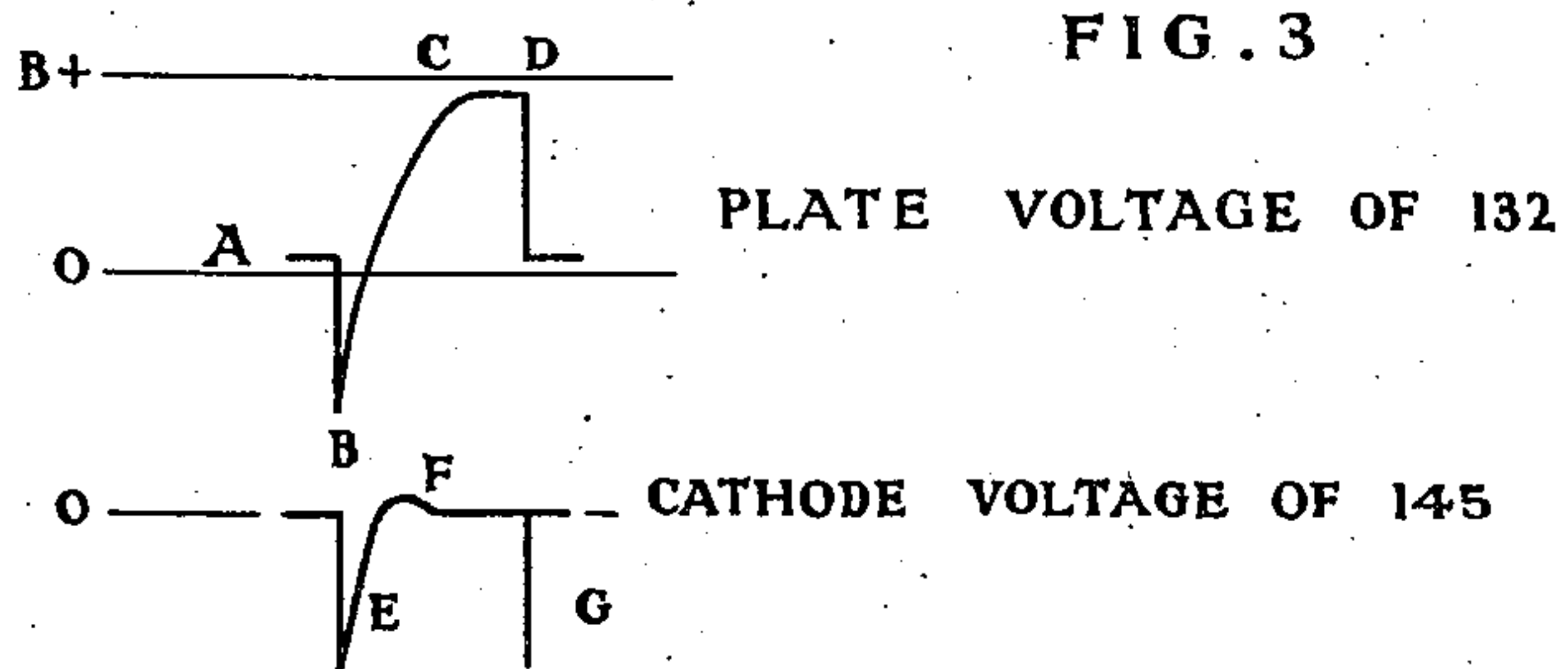
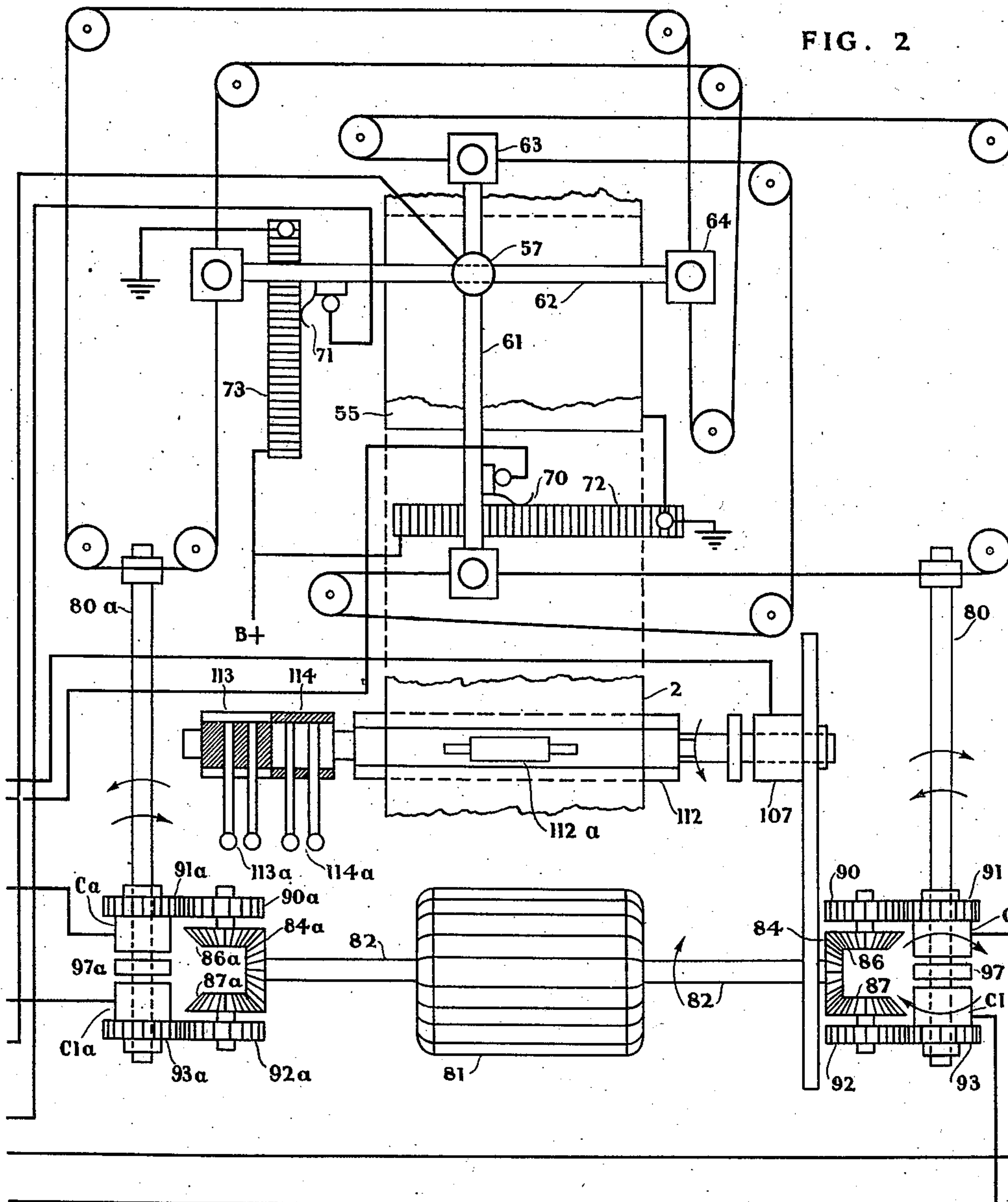
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TELESCRIPT COMMUNICATION SYSTEM

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8 Sheets-Sheet 2



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FIG. 4

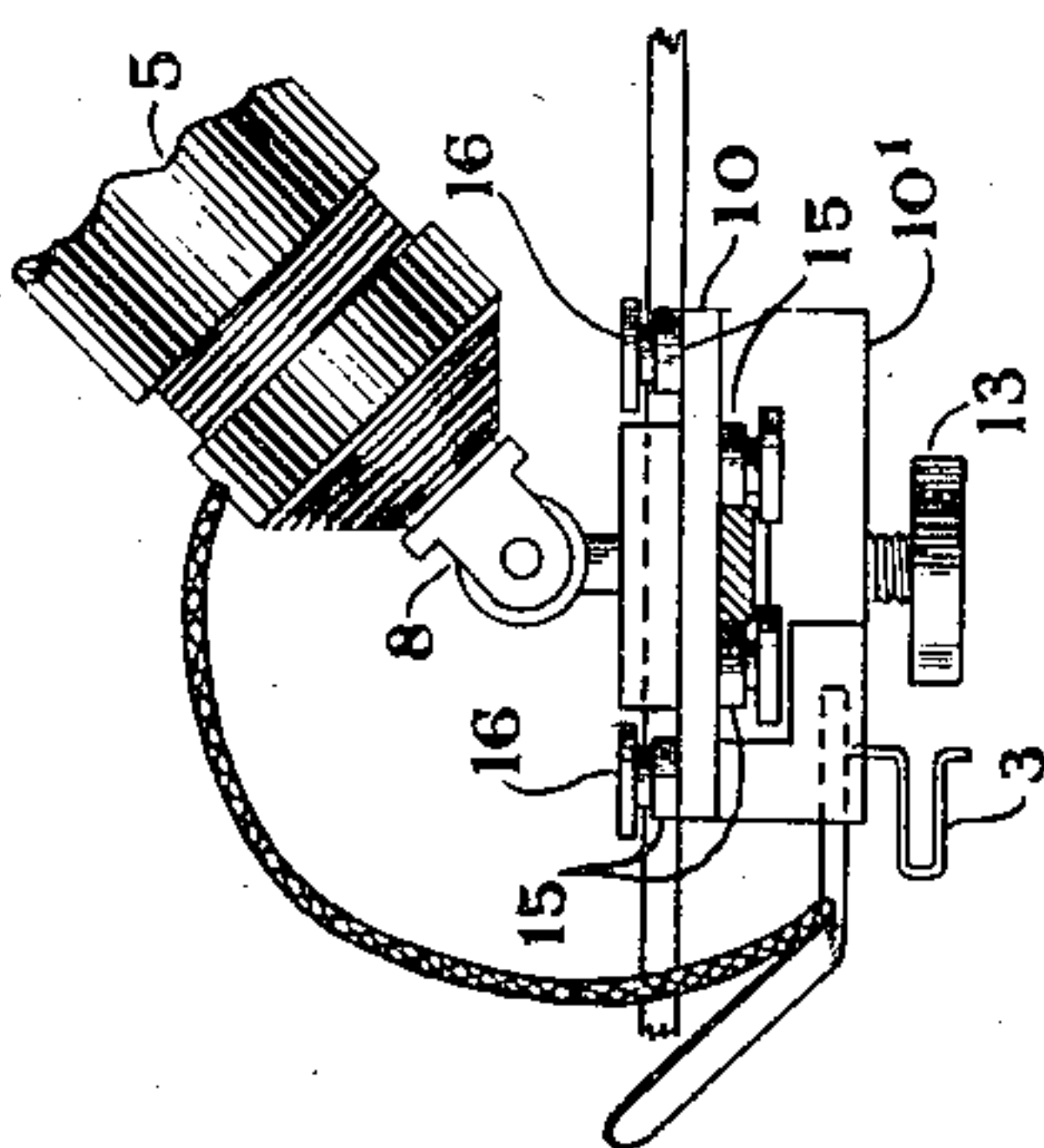
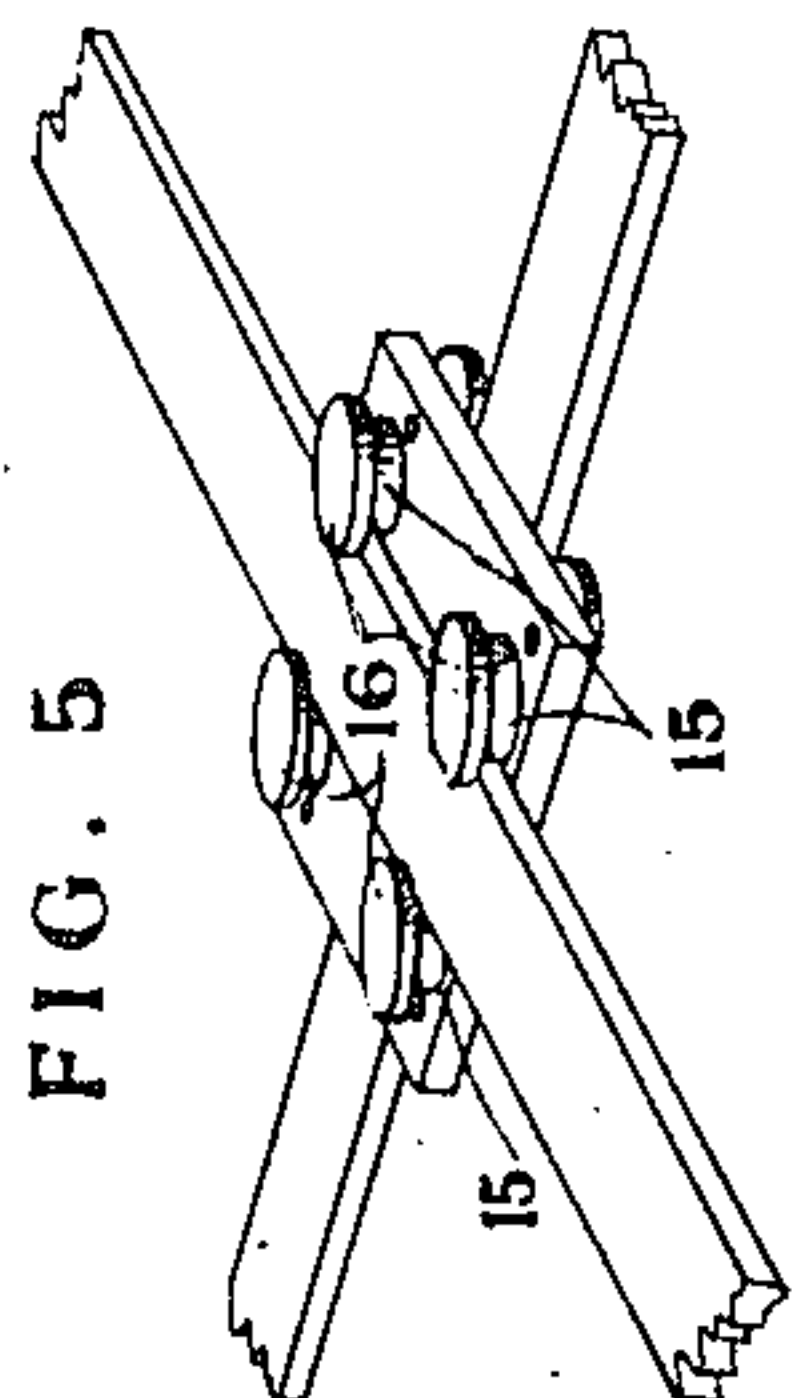
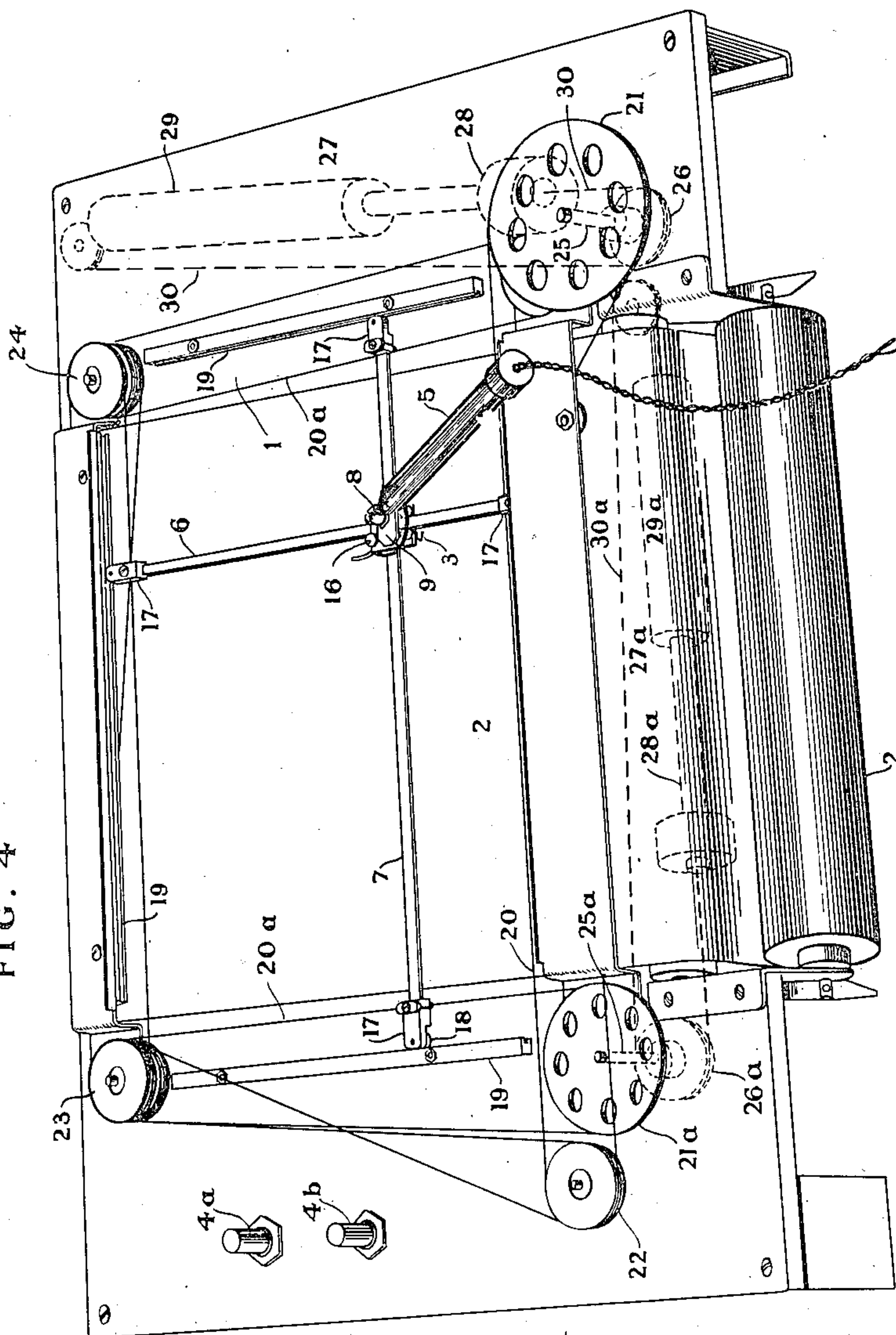


FIG. 6

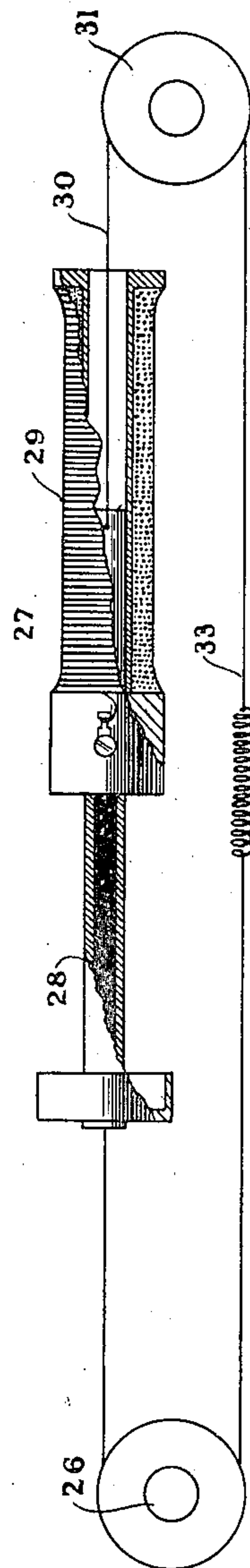


FIG. 7

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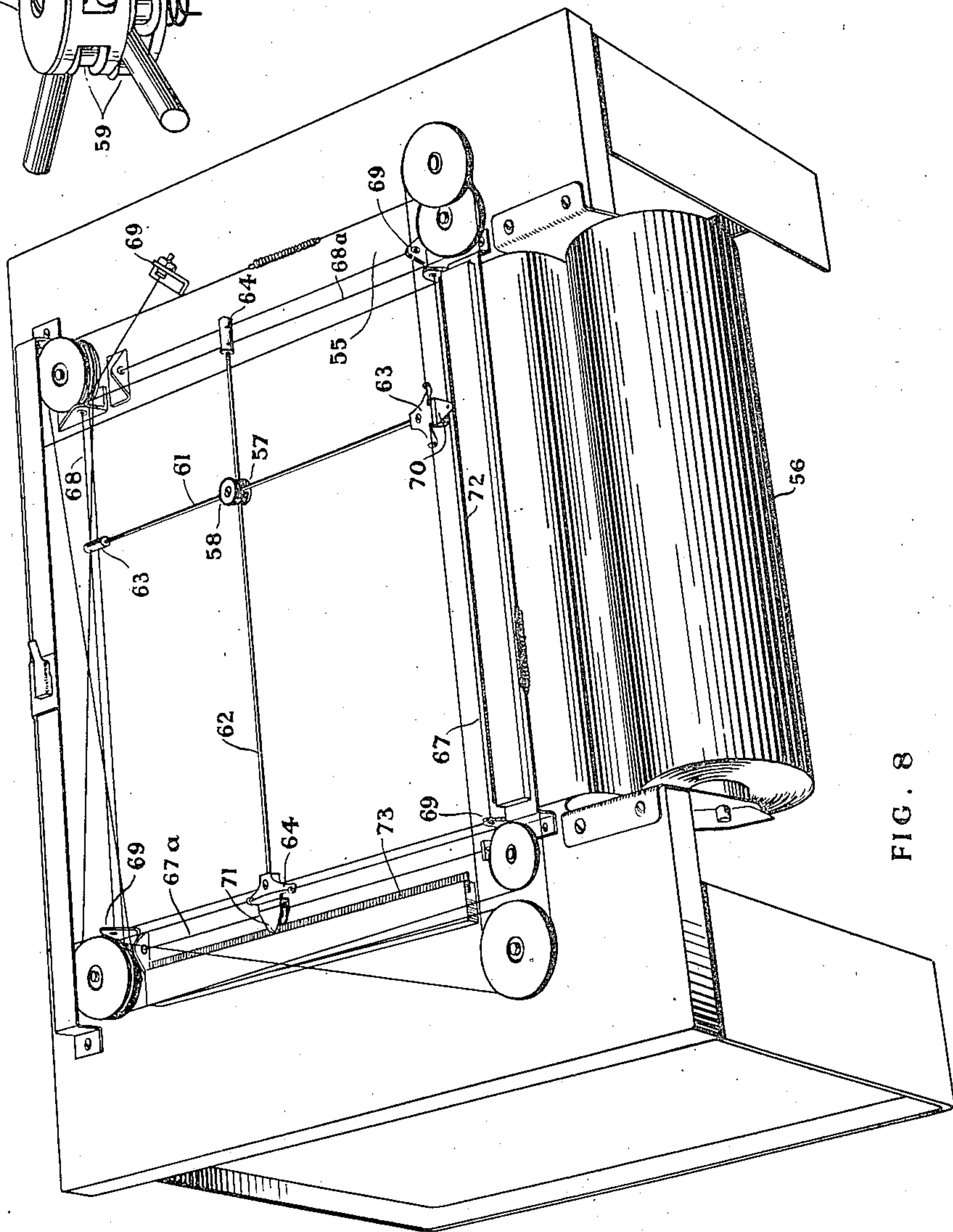
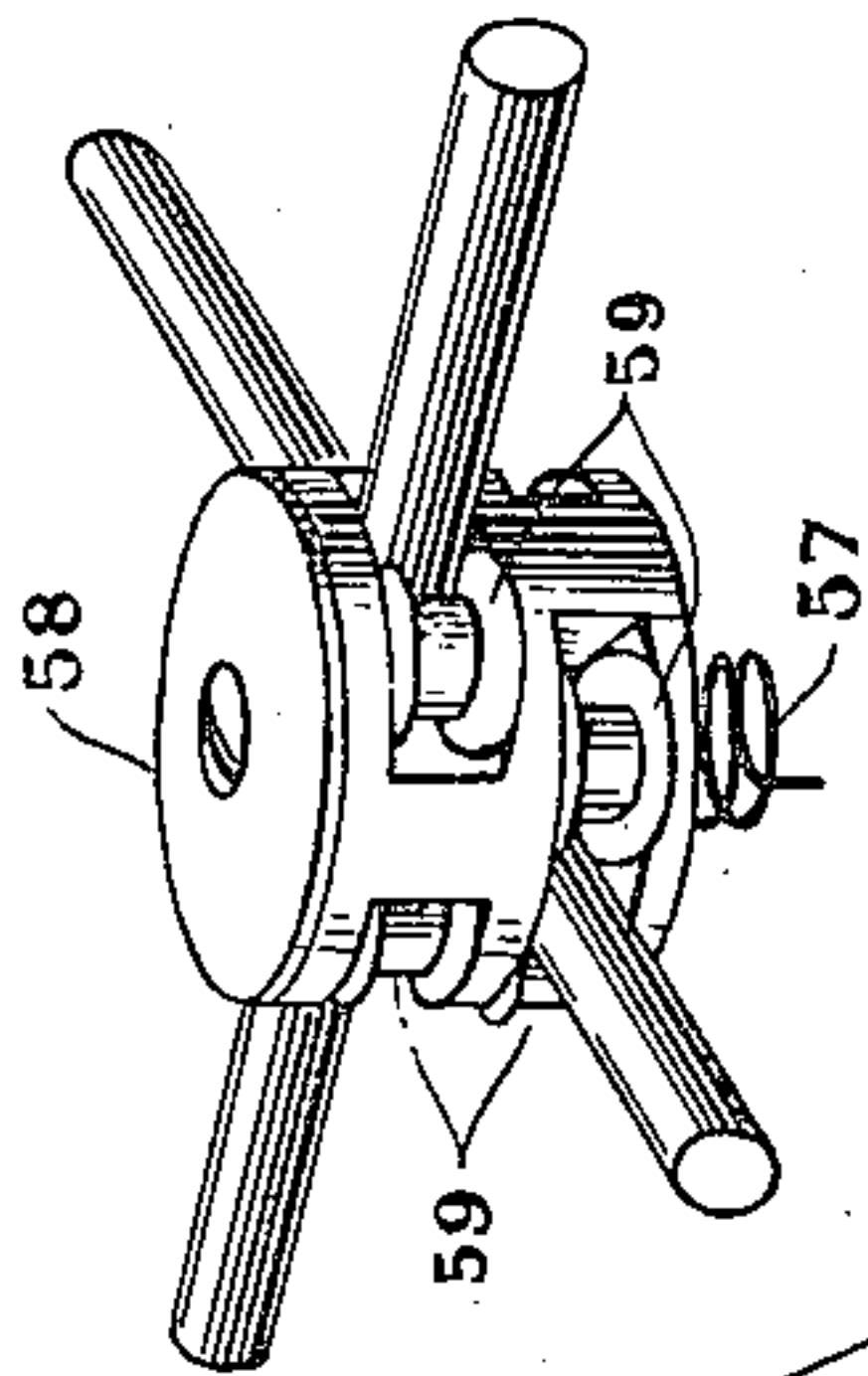
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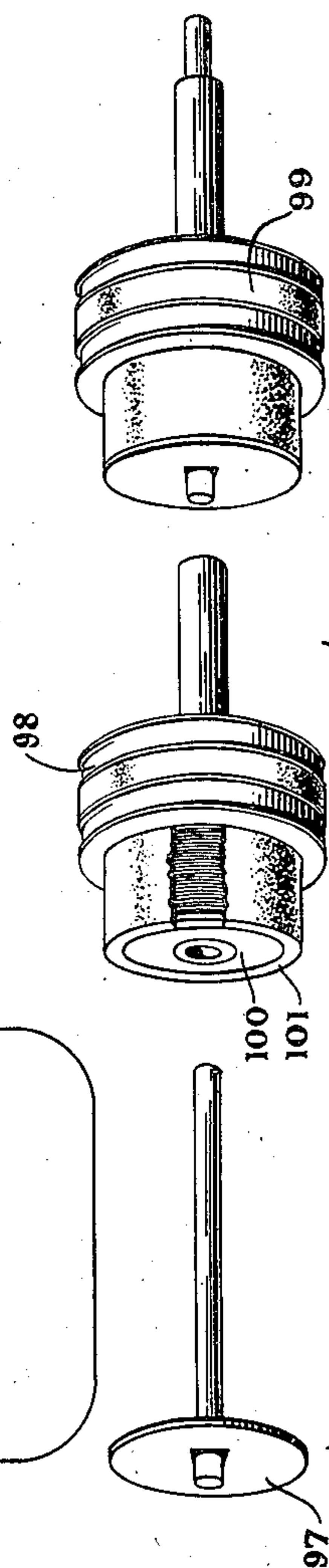


FIG. 11

FIG. 11a

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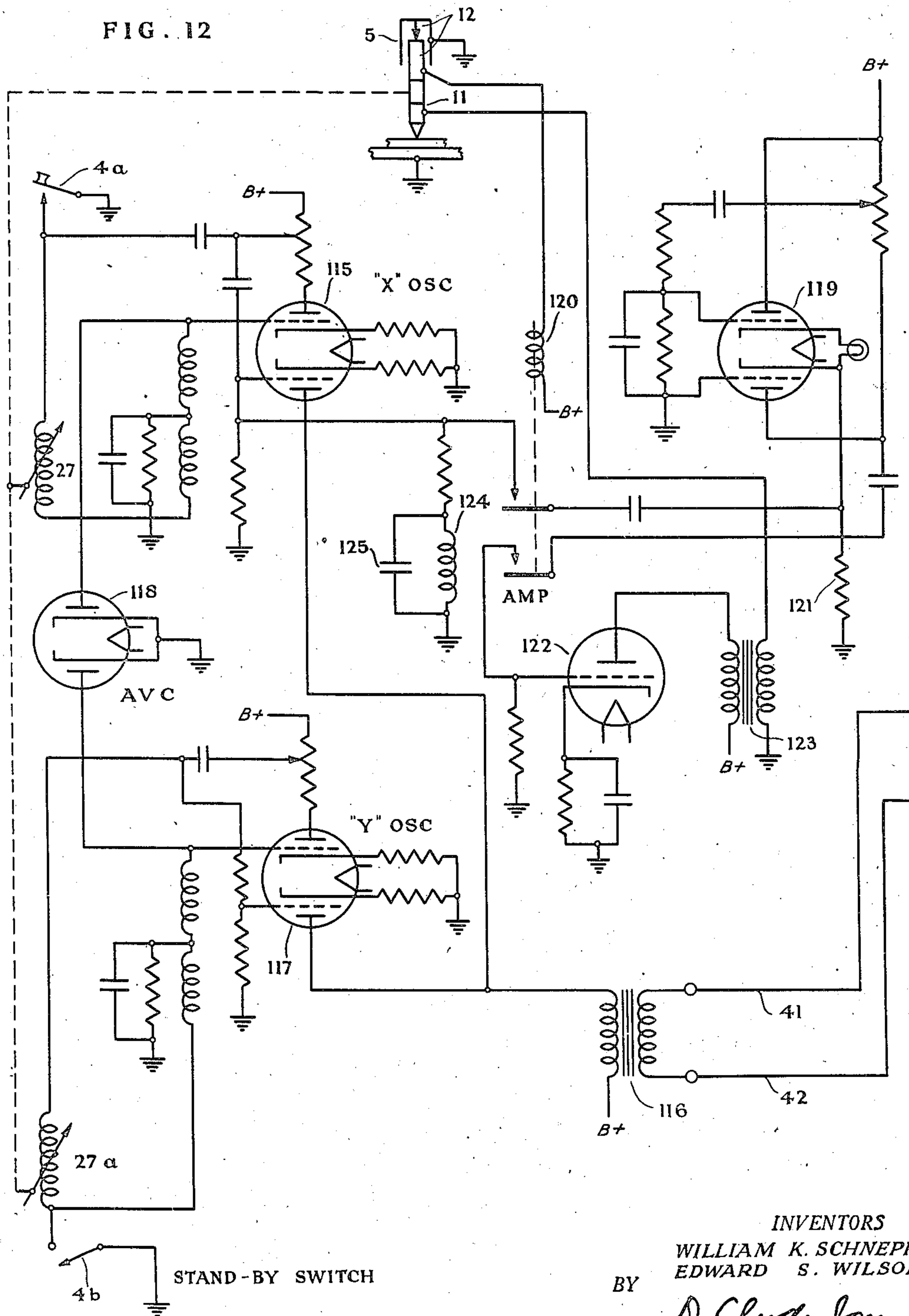
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FIG. 12



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TELESCRIPT COMMUNICATION SYSTEM

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FIG. 13

"X" CHANNEL

SELECTIVE AMP 43

127 128

129

130

B+

"S" CHANNEL

126

45

B+

STYLUS
PAPER
PLATEN

57
2
55

DISC. 46

132 141 137

140 143 133

136 149

138 146

RECT.

145

"Y" CHANNEL 43a

127a 128a

129a

130a

B+

DISC. 46a

132a 141a 137a

140a 143a 133a

136a 149a

138a 146a

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The diagram illustrates a three-channel electronic circuit, labeled "X" CHANNEL, "S" CHANNEL, and "Y" CHANNEL, which are selective amplifiers. Each channel consists of a tuned input stage (127, 128; 126; 127a, 128a) followed by a vacuum tube stage (129, 130; 45; 129a, 130a). The "X" and "Y" channels are connected to a common output stage (DISC. 46 and DISC. 46a) which drives a rectifier (145) and a stylus assembly (57, 2, 55) on a paper platen. The output stage includes vacuum tubes 132, 141, 137, 140, 143, 133, 136, 149, 138, and 146. The circuit is powered by B+ and includes various resistors and capacitors for tuning and biasing.

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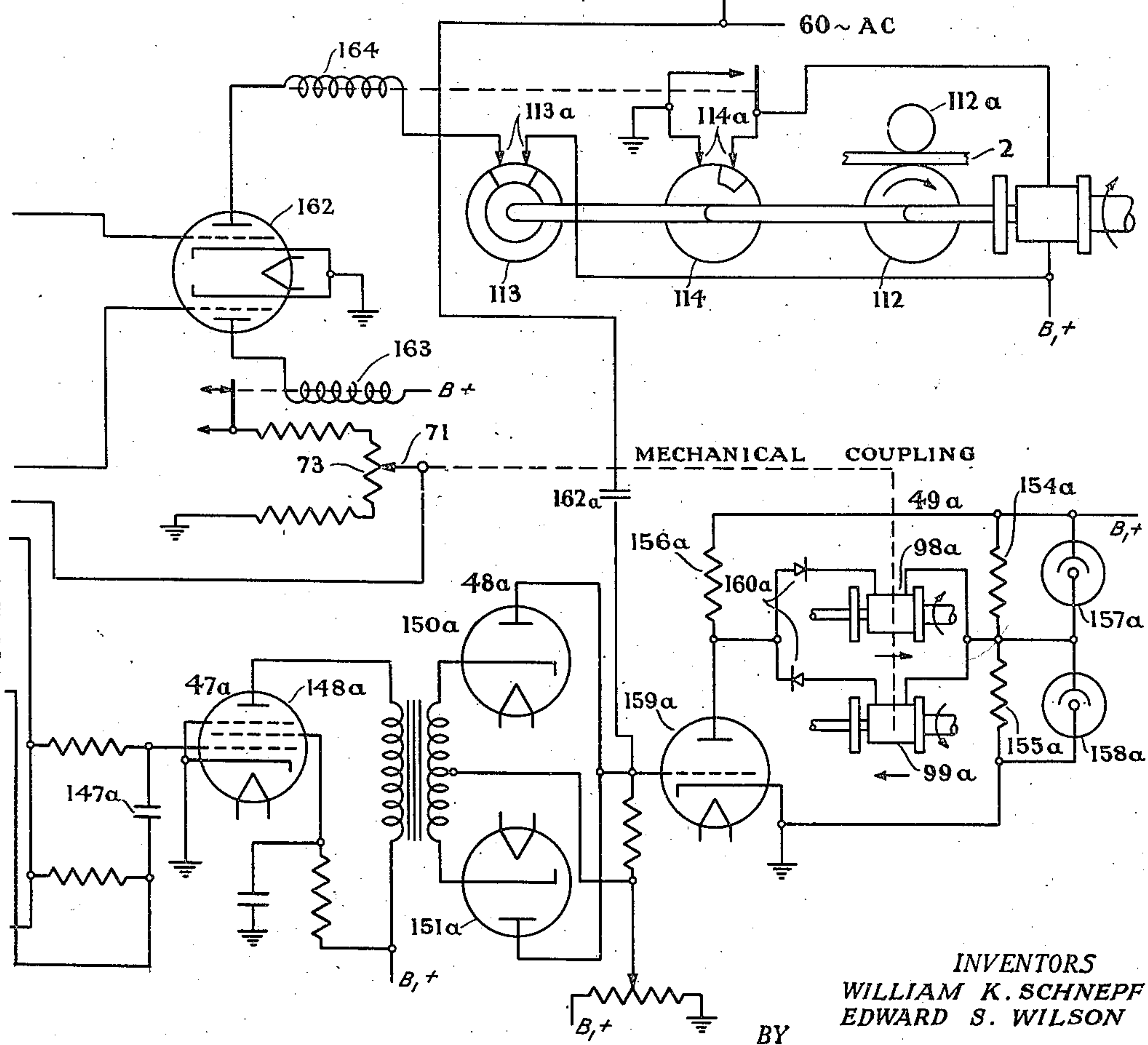
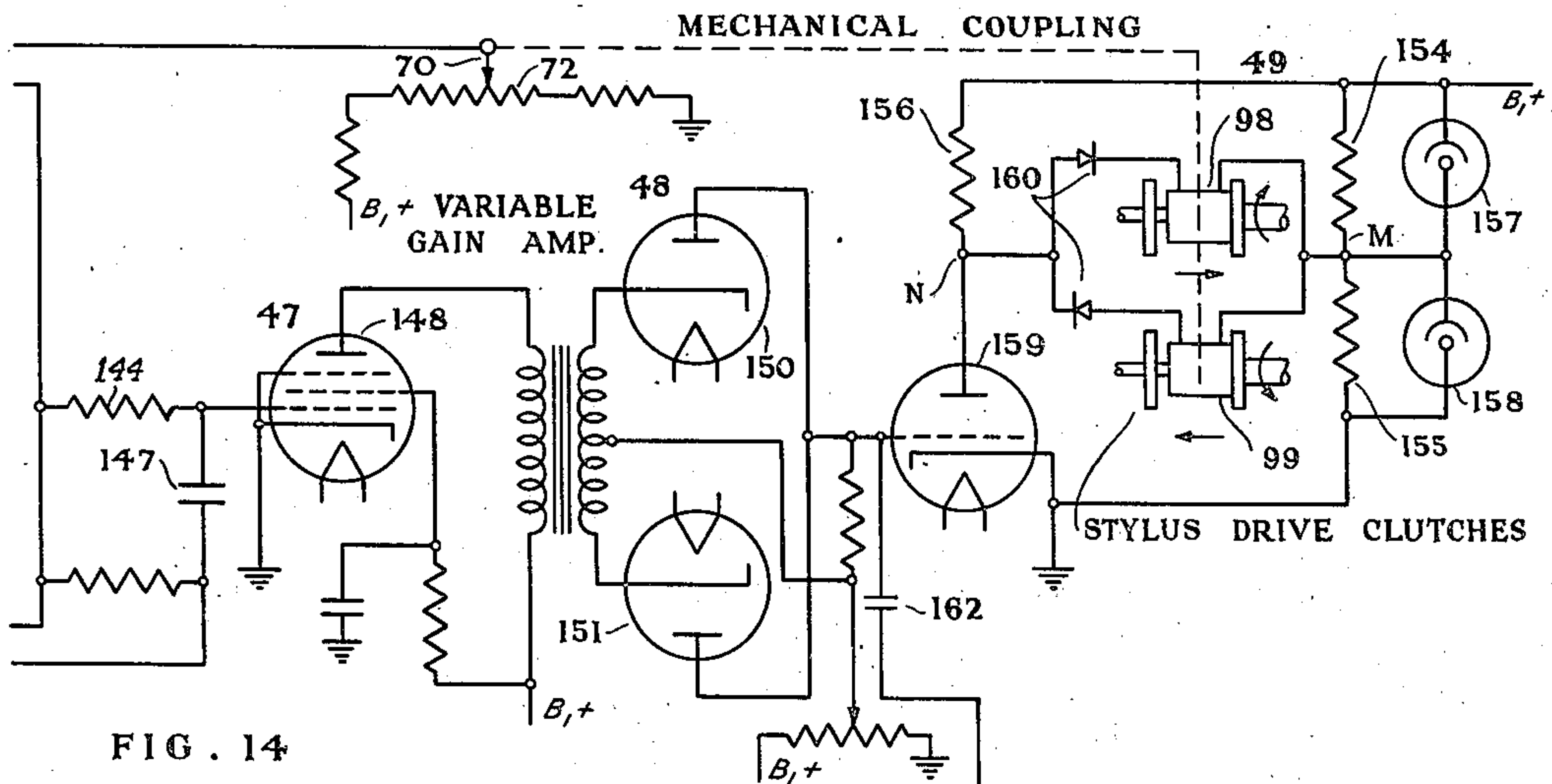
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TELESCRIPT COMMUNICATION SYSTEM

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8 Sheets-Sheet 8



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UNITED STATES PATENT OFFICE

2,415,718

TELESCRIPT COMMUNICATION SYSTEM

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Application June 22, 1944, Serial No. 541,504

14 Claims. (Cl. 178—19)

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This invention relates to a method of and to apparatus for communicating information by a writing or drawing movement at a transmitting station, to be reproduced in facsimile at a remote receiving station of a telescript system.

The main feature of the invention relates to the provision of a telescript system, the electrical and mechanical characteristics of which are linear over substantially the entire writing field.

Another feature of the invention relates to a telescript system in which the operations of the sending stylus do not differ materially from usual writing movements so that a minimum amount of attention on the part of the writer is required.

A further feature relates to the novel arrangement for controlling over the transmitting link from the sending station, the feeding of the recording paper at the receiving station.

An additional feature includes the arrangement whereby relatively weak electrical control effects initiated at the transmitting station, govern a mechanical source of power to directly position the stylus at the receiver.

Still another feature relates to the novel electronic control circuits employed in the system.

Further features relate to the novel construction of the transmitter and of the receiver.

Various other features and advantages of the invention will appear from the detailed description and claims when taken with the drawings in which:

Figs. 1 and 2 when arranged side by side in the order named diagrammatically illustrate the mechanical and electrical portions of the telescript system of the present invention, the upper portion of Fig. 1 illustrating the transmitter, and the lower portion thereof illustrates the electrical circuits, and Fig. 2 illustrating the mechanical portion of the receiver located at the receiving station;

Fig. 3 is a chart illustrating the discriminator wave forms;

Fig. 4 is an isometric view of the transmitter;

Fig. 5 is a perspective view of the coupling with the stylus omitted, which coupling serves to variably position the coordinate bars;

Fig. 6 is a side view of the coupling and the stylus carried thereby;

Fig. 7 is a detailed view with parts thereof broken away to show the construction of a variable inductor or frequency changer as well as the cord and pulley arrangement by which the adjustment of the frequency changer is effected;

Fig. 8 is an isometric view of the top portion of the receiver unit;

Fig. 9 is a detailed view of the coupling which carries the stylus, the coupling being positioned by the movement of the coordinate rods;

Fig. 10 is a front elevation of the driving and

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clutch mechanism located beneath the table of the receiver illustrated in Fig. 8.

Fig. 11 is an exploded view of the several parts of the clutch mechanism; and

Figs. 12, 13 and 14, when placed side by side in the order named, disclose the detailed electric circuits of the present telescript system, which circuits were merely indicated in the block diagram of Figs. 1 and 2.

In the present remote writing system, when the operator writes, the instantaneous position of the transmitting stylus, operating in a coordinate system at the transmitter, correspondingly governs or modulates the frequency of two sources of oscillations at the transmitter into two continuous signals which may be transmitted over a metal or radio link, to a receiving station. At this receiving station, the two signals control a local source of mechanical power which causes the receiving stylus faithfully to follow the movements of the transmitting stylus since the mechanical power is applied to the receiving stylus by means of a direct acting coordinate system similar to that at the transmitting station.

The system operates by variation of the frequencies of the transmitted signals rather than by their amplitude, thus avoiding difficulties due to fading in an intervening radio link. The specific frequencies employed in the present system are a band of 700 to 1000 cycles corresponding to the X or horizontal axis and a band of 2500 to 3000 cycles corresponding to the vertical axis or Y axis of the writing area. A fixed frequency of 325 cycles is also used for the stylus current of both transmitter and receiver.

The complete system is illustrated in the schematic diagram of Fig. 1 in which certain detail parts thereof, although correct as to principle, have in certain instances departed from the actual construction in order to permit a clearer showing of the operation thereof. The transmitter used in this system will be understood, by reference to the diagrammatic showing of Fig. 1 and to the actual construction illustrated in Figs. 2, 3 and 4. This transmitter includes a metal table or platen 1 which supports a strip of recording material such as electroresponsive paper 2 of the type now known as "Teledeltos" paper. This paper consists of a core of black, semi-conducting material coated on the back with a metallic film, and on the writing surface with a thin, light-colored material. In practice, this paper is placed with its metallized side in contact with the metal platen which is connected to one side of a source of moderate voltage (Fig. 1), the other side being connected to a metallic point or stylus 3 which bears lightly on the writing surface of the paper. As the stylus is moved, it leaves a permanent mark on the paper, due to the burning away of the light-colored coating by

the current passing from the stylus through the semi-conducting core of the paper, to the platen.

The Teledeltos paper carried on a roll mounted on the transmitter frame, passes over the top of the platen or writing table to which it is fed, as needed, by suitable manually operated friction rolls (not shown). Buttons 4a and 4b shown at the left side of the table (Fig. 4) govern respectively the paper feed control and the standby switch located at the receiver, as will be further described. The electric stylus 3 (Fig. 6) is operated by a writing handle 5, which is grasped and moved in the same manner as a pencil, this handle being attached by means of a ball and socket joint 8 to a bridge 9 (Fig. 4), mounted on the top of coupling 10. Thus, the handle can be swung freely in all directions in accordance with the writing movement. The handle 5 contains a telescoping section 11 (Fig. 1) in its lower part and also contains stylus current control contacts 12 which are closed when downward axial pressure is exerted upon the writing handle to cause the telescoping section to yield. The insulating bridge 10' mounted on the lower surface of the coupling carries the writing stylus 3 and also a supporting shoe 13 (Fig. 6). This shoe bears upon the surface of the Teledeltos paper and limits the flexing of coordinate bars 6 and 7 (hereinafter described) toward the platen. Stylus 3 consists of a current conducting spring wire so formed that its tip exerts pressure in a downward direction. The relative positions of the lower side of the shoe 13 and the stylus tip are so coordinated as to provide a uniform pressure of the stylus tip upon the paper.

The motions of the writing handle 5 are transmitted through the action of coupling 10, to movable coordinate bars 6 and 7 which extend at right angles to each other. The two bars are slidably movable in the coupling through the medium of four sets of roller bearings 15 (Fig. 5) embracing each bar. These rollers rotate on flanged studs 16 secured in the coupling. Bars 6 and 7 terminate at their ends in forked fittings 17 which carry the rollers 18. The rollers of each bar travel in well fitting grooves in the inner surfaces of a pair of spaced tracks 19 secured in fixed parallel relation to each other and to the platen. This mounting prevents endwise movement of the bars 6 and 7.

These bars are connected at their ends to the parallel motion arrangement of cords and pulleys (indicated schematically in Fig. 1 but shown in their actual positions in Fig. 4) which constrain the bars to motions always at right angles to each other.

In the present instance, the cord system for bar 6 may be traced from the lower end of this bar to which cord 29 is fastened, thence the cord passes to the right around the single grooved pulley 21 and thereafter to the left around the upper groove in the double grooved idler pulley 22 from which it proceeds vertically to the upper groove in the double grooved pulley 23. After passing around this pulley in a counterclockwise direction, the cord is fastened to the upper end of bar 6 and continues to the right to pass around the groove of pulley 24 in a counterclockwise direction. The cord then continues to the left and in a counterclockwise direction around the lower groove of pulley 23, from whence it proceeds downward and around the lower groove of pulley 22 in a clockwise direction and to the right to arrive at its starting point where it is attached to the lower end of bar 6. It will be noted that

pulley 21 is secured to a vertical shaft 25 which passes through a bearing in the frame of the transmitter and carries pulley 26 at its lower end. This pulley drives the movable element of a variable inductance or frequency changer 27. The frequency changer, the details of which are shown in Fig. 7, comprises a powdered iron core 28 mounted to move endwise through its related coil 29. The core is adjustable in its endwise movement through the coil by a second cord 30 attached at its ends to the respective ends of the core 28. The cord passes around the driven pulley 26 and idler 31. A spiral spring 33 connected in the cord system serves to maintain the cord 30 under the required driving tension.

In a similar manner, the cord system for the bar 7 may be traced from the left end of this bar to which the cord 29a is fastened, thence the cord passes down around the single groove pulley 21a and thereafter upward to pass in a clockwise direction around the upper groove in the double grooved pulley 23a. It will be understood that the pulleys 23 and 23a rotate freely on a common vertical axis. After passing around the pulley 23a, the cord passes to the right and in a counterclockwise direction around the upper groove of the double grooved pulley 24a. It will be noted that the pulleys 24 and 24a rotate freely on a common vertical axis. After passing around this pulley 24a, the cord 29a is fastened to the right hand end of the coordinate bar 7. Thence, the cord passes downward and in a counterclockwise direction around the single groove pulley 22a. Thence, the cord passes in a counterclockwise direction around the lower groove in the pulley 24a. From this pulley, the cord proceeds in a clockwise direction around the lower groove in the pulley 23a from which the cord extends and is tied to the left end of the coordinate bar 7. In like manner, the pulley 21a is secured to a vertical shaft 25a which passes through a bearing in the frame of the transmitter and carries the pulley 26a at its lower end. The pulley 26a drives a cord 33a which variably adjusts the inductance of the frequency changer 27a.

From the foregoing description, it will be seen that corresponding to any position of the stylus tip 3, bars 6 and 7 will position themselves along the rectangular coordinates of the stylus position in the writing field. It will also be seen that the displacement of the slidable cores 28 and 28a of the frequency changers or inductors 27 and 27a from their fully inserted position will be directly proportional to the displacements of the connected bars 6 and 7 from their normal positions at the margins of the writing field. The frequency of each of the transmitting oscillators to be described, must vary linearly with the displacement of the core of the associated variable inductor. This is accomplished not only by suitable distribution of the turns of the coils 29 and 29a, as indicated by coil 29 in Fig. 7, but also by the provision of the armatures 28' and 28'a carried on the end of the slidable cores 28 and 28a, the armature being composed of compressed powdered iron. Each of these inductors constitutes one of the frequency determining elements of each of the oscillators X and Y (Fig. 1), and the core and coil of each frequency changer is so constructed that the frequency emitted by the connected oscillator is directly proportional, within an assigned band, to the displacement of the corresponding bar. For example, the frequency of oscillator X with the

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bar 6 at the left-hand margin of the writing field is 1000 cycles, while its frequency with this bar moved to the extreme right-hand margin of the field, is 700 cycles. The frequency of the Y oscillator likewise varies with the position of bar 7 in a corresponding and strictly linear manner except that the range covered is 2500 to 3000 cycles per second. It is thus seen that for every position of stylus 3 in the writing field, there is generated by oscillators X and Y a unique pair of frequencies. Automatic volume control circuits 35, 36 (Fig. 1) are associated with the X and Y oscillators and maintain their output at a constant level regardless of frequency variations. A third oscillator, the S or stylus oscillator, generates a frequency of 325 cycles per second, the output of the oscillator being connected to the transmitting stylus 3 to provide the writing current at the transmitting station, since a permanent record of the transmitted matter is desired. The S oscillator may be switched on and off by a contact 12 incorporated in the writing handle 5, the oscillator being switched on, when the handle is depressed axially, and off when pressure is released.

A portion of the output of the S oscillator is transmitted to the receiving station and is there used to provide the writing current. The outputs of all three of the oscillators at the transmitter are carried into the combiner 40 (Fig. 1) where they are impressed upon a single output channel without intermodulation. The resulting complex or composite signal conveys information as to the instantaneous position of the transmitting stylus 3 and also as to whether or not the writing handle 5 is depressed. This signal may be transmitted to the receiving station of the system, either over the conductors 41 and 42 (Fig. 12) of a two-wire circuit without ground return, or over a radio link.

At the receiving station, the composite signal is separated by the selective amplifiers 43, 43a and 45 in the X, Y and S channels, into its original frequency bands. Since the operation of both coordinate channels X and Y are identical, it will be sufficient to describe only the channel X. It will be understood, however, that the parts of channel Y will be designated by the same reference characters used in connection with channel X but with the letter "a" added thereto. Following the selective amplifier 43, the signal passes through a discriminator 46 from whose output there is derived a direct current voltage of a value directly proportional to the frequency of the input signal. The discriminator incidentally supplies an alternating current voltage of signal frequency but of a constant amplitude independent of either the frequency or the amplitude of the input signal. This alternating signal is amplified in a variable gain amplifier 47 whose gain is controlled by the algebraic sum of the direct current output voltage of the discriminator and an opposing direct current voltage which is dependent upon the position of the receiving stylus to be described. The output of the controlled amplifier 47 is rectified in rectifier 48 and is then supplied to the clutch control circuits 49. These circuits are so arranged that with a certain definite input level, there will be no direct current output to either of the connected magnetic clutches C or C' located at the receiver, as will be described, or there can be an equal output in both. However, if the level rises, for example, above a predetermined value, in one channel, direct current will flow in one clutch, and as the

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level decreases below the predetermined value, direct current will be applied to the other clutch, or as current increases in one it will decrease in the other, depending upon initial biasing voltage.

The receiver, in which the signals corresponding to the transmitted message are translated into a facsimile record, is illustrated in Figs. 2, 8 thru 11 and also at the lower right hand portion of the diagrammatic showing of the system in Fig. 1 to the right of line ZZ.

It will be observed that the general arrangement of the stylus positioning bars, the slidable coupling and the pulley and cord system of the receiver, bear a marked similarity to the corresponding parts of the transmitter. However, an important requirement of the moving system of the receiver is that it shall have as low a moment of inertia as possible. Consequently, the masses of the parts must be kept small. This is quite feasible in the design of the receiver, inasmuch as the receiver parts during the act of recording are not subjected to large forces, such as those applied to the manually operated stylus at the transmitter.

Like the transmitter, the receiver includes a metal platen 55 (Fig. 8), on which there is supported the Teledeltos paper, supplied from a roll 56. A spring wire stylus 57 which is mounted on a coupling 58, engages the paper on the platen. This coupling comprises four pairs of grooved rollers 59 which are held in a cage-like unit and which embrace the coordinate rods 61 and 62 that are the counterparts of the corresponding coordinate bars 6 and 7 at the transmitter. The ends of the rods 61 and 62 are equipped with fittings 63 and 64 which slide with small friction on the pairs of opposed taut wires 67, 68 and 67a, 68a respectively. The supports 69 of these wires are insulated from the platen, so that the wires, 68, 68a besides serving as guides and supporting members, are also used to conduct the stylus writing current to the rods 61 and 62 and thence through coupling 58 to stylus 57. The fitting at one of the ends of each rod, such as 63 and 64 is insulated from the main body of its related rod and the mentioned fittings of the two rods bear contacts 70 and 71 which slidably engage the resistance strips 72 and 73 respectively, extending at right angles to the respective rods with which they cooperate. The electrical connection to these contacts is made through the guide wires 67 and 68 which are insulated from the platen, as mentioned. The position of the insulated contactor 70 which is carried on the coordinate rod 61 for adjustable engagement with resistor 72, determines the value of the direct current voltage which is fed back to the variable gain amplifier 47, referred to above. In like manner, the position of the insulated contactor 71, which is carried by rod 62 for adjustable engagement with resistor 73, determines the value of the direct current voltage which is fed back to the variable gain amplifier 47a, also referred to above.

Two cord and pulley systems control the movements of the rods 61 and 62. These systems are virtually identical with those of the transmitter, and need not be described again except to state that the pulleys of the receiver are independently driven by a motor through suitable clutches in order to position the receiving stylus, as will be described later, whereas, in the transmitter, the pulleys are driven by the manual movement of the transmitting stylus. It will be seen from the foregoing description that rods 61 and 62 are

moved at right angles to each other by rotation of the two systems of pulleys respectively, and that due to its freely slidable connection to these rods, the coupling 56 with the stylus attached thereto will always assume a position at the intersection of these rods.

It has been mentioned that power driven mechanism rotates pulleys and cords to position the rods 61 and 62. This mechanism is located beneath the platen 55, the pulleys being mounted directly upon the projecting ends of shafts 80 and 80a (Fig. 10). Mechanical power is supplied from the constantly rotating motor 81 which drives horizontal shaft 82 through the worm shaft and worm wheel, concealed by the housing 83.

The right hand portion of the mechanism will now be described, it being understood that the left-hand portion of the mechanism is identical therewith and that the parts thereof are designated by the same reference characters with the letter "a" added. There is attached to the right hand end of shaft 82 a bevel gear 84 which drives similar bevel gears 86 and 87 in opposite directions. The latter gears through the medium of short shafts 88 and 89 drive the spur gears 90, 91 and 92, 93 respectively. Barrels 95 and 96 of the magnetic clutches C and C1 are driven in opposite directions by quills (not shown) attached to gears 91 and 93 respectively. Shaft 80 passes through both of the quills and is adapted to rotate independently therein. A disc armature 97, of highly permeable, magnetic material, is perforated with a square hole which fits with small clearance over a squared section of shaft 80 and is free to slide lengthwise upon this shaft for a small distance. The clutches C and C1 consist of cup-shaped members 98 and 99 of magnetic material, each having a central hollow core, such as 100 with a winding 101 occupying the annular space inside the cup. In operation, there is very slight clearance permitted between the faces of the armature 97 and the pole faces of the clutch magnet, and negligible driving force is transmitted to shaft 80. However, when one of the clutch windings 101 is energized, the armature 97 is attracted to the clutch face with sufficient force to cause it to rotate with the clutch barrel, such as 95 and 96 and to drive shaft 80 through its squared central section in one direction or the other, depending upon whether the upper clutch or the lower clutch is energized. Current is carried to the clutch windings 101 by means of brushes 102 and 103 bearing upon the insulated slip rings 104 and 105. A paper feed clutch 107 of similar construction to those already described, is also driven by shaft 82 and when actuated drives the gears 108 and 109 which, in turn, drive the gears 110. These last-named gears rotate the shaft 111 which carries the paper feed roll 112 of the receiver and also interrupted slip rings 113 and 114 engaged by the fixed brushes 113a and 114a of the framing contactors.

Let us start with the output of the variable gain amplifier in the X channel of such a value that neither of the clutches C nor C1 is energized, and then assume that an increase in the discriminator output takes place, due to a change in frequency of the input signal. This will unbalance the clutch control circuits so that clutch C is energized causing rod 61 to be driven toward the left. This movement of the rod shifts the position of contact 70 with respect to the resistor 72 and thereby changes the gain of the variable gain amplifier in a direction tending to restore the clutch control circuits to their balanced condition. As

soon as the amplifier gain has changed an amount corresponding to the change in signal frequency, the balance of the clutch control circuits will be restored. Clutch C will then be deenergized and the motion of rod 61 will cease. A similar state of affairs will occur with respect to rod 62 when a change in the input frequency occurs in the Y channel. As the relative signal inputs in the X and Y channels depend upon the frequencies of the X and Y oscillators at the transmitter, it will be seen that the position of receiver stylus 57 in the writing field will also depend upon the relation of these two frequencies and, consequently, upon the position of the transmitting stylus 3.

The writing current for the receiving stylus 57 is derived from the S oscillator output transmitted over the wire or radio link. Consequently, stylus 57 will write whenever the contact 12 on writing handle 5 is depressed. In this way, the recording at both transmitter and receiver is interrupted when the pressure on the writing handle 5 is released, thus permitting the spacing in printed or drawn matter to be produced by natural and familiar manual motions.

When the writing field has been filled and it is desired to shift the Teledeltos paper, the paper feed button 4a at the transmitting station is momentarily depressed, stopping the X oscillator. The paper feed clutch control circuits at the receiver are so arranged that upon the cessation of the X signal, clutch 107 will be energized. This clutch is geared to the driving motor 81 and starts driving the paper shifting roller, the paper 2 being pinched between the driving roll 112 and a pressure roller 112a. Brushes 113a—114a and interrupted slip rings 113—114 are so connected in the circuit that clutch 107 is held energized for one complete revolution of roller 112, even though the paper feed button may have been only momentarily depressed. This shifts the paper at the receiving station one full frame. The paper at the transmitting station is shifted manually.

A feature of the circuit is a so-called standby switch controlled by button 4b at the transmitting station which, when closed, stops oscillator Y. At the receiving station, by means of circuits similar to those employed in the paper feed clutch control, a relay is operated which removes the B supply from all the receiving apparatus to the right of line ZZ (Fig. 1). This results in a large reduction in current drain at the receiving station during periods when no messages are being sent, but retains the apparatus in readiness for instant resumption of operation upon opening of the standby switch when button 4a is actuated.

A schematic circuit of the complete electrical system, as distinguished from the block diagram of Fig. 1, is shown in Figs. 12 to 14. In this instance also, the operation of one of the channels only, for example, the X channel will be described in detail on account of the similarity of the X and Y channels. The X oscillator is a modified Hartley circuit employing the upper half of tube 115. Variable inductance 27 forms part of the frequency determining circuit of this oscillator and is mechanically coupled to the transmitting stylus 3 in the manner previously described. The output of this oscillator is fed into the grid circuit of the lower half of tube 115, which acts as a buffer amplifier and also as part of the combiner. The Y oscillator, including the tube 117, has a similar circuit and the outputs of both the X and Y buffer amplifiers are fed in parallel to the primary of the output transformer 116. The double diode tube 118 serves as an automatic volume con-

trol which, by varying the bias on the X and Y oscillators in response to their output levels, tends to maintain their outputs at a constant amplitude.

The S oscillator 119 is of the resistance-capacitance type and operates at a fixed frequency of 325 cycles per second. A portion of its output taken from across its cathode resistor 121 is fed through the contacts of relay 120 into the grid circuit of the lower half of tube 115, thus combining it there with the signal from the X oscillator. This composite signal is further combined with the output of the Y oscillator 117 in the output transformer 116. A branch of the output circuit of the S oscillator 119 also passes through another pair of contacts on relay 120, after which it is amplified in tube 122 and applied to the writing stylus 3 through a transformer 123. When it is desired to write, the stylus switch 12 is operated by the natural pressure exerted upon the stylus handle 4 in the motion of writing. Relay 120 is thus energized, applying the output of the S oscillator both in the transmitting stylus 3 and to the transmitter output circuits. The function of the parallel circuit, comprising inductor 124 and capacitor 125, which is tuned to the midband frequency of the X oscillator, is to purify the wave form of this oscillator. This precaution is not required in the Y oscillator because the smaller frequency variation ratio of the latter permits a purer output.

Passing now to the receiver over either a radio or a two wire link, the received mixture of frequencies, branches into the X, Y, and S channels through a common volume control 126. In a given channel, the X channel, for example, a primary frequency selection is made by means of the parallel tuned circuits 127 and 128 after which the signal is fed into the tube 129 of the selective amplifier 43. This amplifier is essentially an oscillator whose feedback is reduced to the point which will just not permit oscillation, but will permit considerable regeneration over the desired frequency band. This enables a high degree of selectivity to be obtained by the use of fewer and simpler circuit elements than would be required for a conventional bandpass filter. The output of the selective amplifier is further amplified in tube 130 (not shown in Fig. 1) whose output is coupled to the discriminator 45.

The discriminator circuit is based upon the electronic frequency meter disclosed by Hunt in the "Review of Scientific Instruments" for February, 1935 and which was based in turn on a thyatron inverter described by Hull in the "General Electric Review," volume 32, 1929. The present circuit comprises two Thyratrons 132 and 133 coupled to the double-diode rectifier 48, including tubes 145, 146, through a differentiating network 136, 137; 138, 139. It operates as follows: Assume Thyatron 132 to be conducting and Thyatron 133 cut off, and the oppositely phased signal voltages on the grids of Thyratrons 132 and 133 to be approaching zero from positive and negative directions, respectively. The plate voltage of Thyatron 132 is at the tube drop value shown at A in Fig. 3. Capacitor 140 becomes charged to the voltage drop in resistor 141 produced by the plate current of Thyatron 132. In the meantime, the grid of Thyatron 133 is being carried positive and eventually causes the Thyatron to fire. The plate resistance of a Thyatron being very low, the lower side of capacitor 140 becomes effectively connected to the cathode of Thyatron 132, the polarity of the upper side of the capacitor 140 connected to the

plate of Thyatron 132 being at this time negative. Inasmuch as the charge on capacitor 140 cannot change instantaneously, there is momentarily impressed from plate to cathode of Thyatron 132 a large negative voltage opposing the small positive drop due to the plate current, and the tube cuts off. The plate of Thyatron 132 is first carried negative to the potential of the upper side of capacitor 140 (point B, Fig. 3), following which capacitor 140 discharges to zero through resistors 141 and 143 and then charged to opposite polarity due to the drop in resistor 143 caused by the establishment of plate current in Thyatron 133 (point C, Fig. 3). In the meantime, the grid of Thyatron 132 is being carried positive and eventually this tube fires (point D, Fig. 3), restoring the plate voltage to its original value and completing the cycle of events. A similar cycle occurs in the plate voltage of Thyatron 133, but displaced 180 degrees in time phase from that in Thyatron 132. The time constant of the circuit, including capacitor 140 as well as resistors 141 and 143 is so related to the maximum operating frequency that capacitor 140 can always become fully charged before the (at the moment) inactive tube fires; that is, it is made impossible for event D, Fig. 3 to occur before the point C is reached.

The constants of the resistor-capacitor network which couples Thyratrons 132 and 133 to the rectifiers 145 and 146 are so chosen that the output voltage wave of the network is approximately the derivative of the input voltage wave. The output voltage of the upper section, applied to the cathode of rectifier 145, is shown in Fig. 3 in proper phase relation to the plate voltage wave of Thyatron 132. The unfiltered plate voltage of rectifier 145 has the same shape as the cathode wave except that the positive lobe (F, Fig. 3) is cut off.

From the foregoing description, it can be seen that the unfiltered output wave of each of the rectifiers 145 and 146 consists of the negative pulse E (Fig. 3) and the spike G. The area of the latter is negligible compared with that of E and it will hereinafter be neglected. It can also be seen that the shape and area of pulse E are independent of the frequency, amplitude and wave form of the input signal voltage to Thyratrons 132 and 133. However, the total number of pulses per second delivered by rectifiers 145 and 146, is equal to twice the frequency of the input signal voltage. These pulses are smoothed by the filter, including capacitor 147 and resistor 144, the output of the filter being a D.-C. voltage of negative polarity to ground, whose value is a linear function of the frequency of the discriminator input signal. In series with this negative voltage is one of positive polarity taken from the sliding contact 70 on resistor 72, the net biasing voltage on the grid of the variable gain amplifier 47, which includes tube 143, being, of course, the algebraic sum of the two.

There is also introduced into the grid circuit of tube 143 a small A.-C. voltage taken from the drop in capacitor 149 due to the flow through the latter of a portion of the output of the differentiating network via resistors 136 and 138. The amplitude and wave form of this voltage are independent of those of the discriminator input signal for reasons previously discussed, and the circuit impedances are so proportioned that the variation of amplitude with frequency is insignificantly small at the grid of tube 143. This voltage is used as a convenient constant signal

source for exciting the grid of tube 148 and obviates the necessity of providing a separate oscillator of stable output.

Amplifier tube 148 functions virtually as an A.-C. generator whose output voltage is proportional to the D.-C. grid potential. The grid potential, however, and likewise the output voltage of tube 148 is required to vary only over a small range determined by the response lag of the receiving stylus 57 and its mechanically associated sliding contact 70 on resistor 72. The output of tube 148 is rectified by the diodes 150 and 151 and this negative voltage is applied unfiltered to the grid of control tube 159, in series with an adjustable positive bias of such value as to give tube 159 a certain definite value of plate-cathode resistance. This plate-cathode resistance forms a portion of a circuit network comprising also resistors 154, 155 and 156. The B supply voltages across resistors 154 and 155 are maintained equal by the voltage regulator tubes 157 and 158. Resistor 156 is made equal to the plate-cathode resistance of control tube 159 when a certain definite D.-C. voltage is applied to the grid of the latter. When this condition obtains, there will be no potential difference between points M and N. However, any change in the grid potential of tube 159 will result in an unbalanced condition in the clutch control circuits which will give rise to a D.-C. potential difference between points M and N. The polarity of this potential depends upon whether the grid of tube 159 has been raised or lowered from the balanced voltage value. The two clutch magnets 98 and 99 of the pair of clutches C and C1, are connected in parallel between M and N, and are effectively polarized with respect to the voltage appearing between these points by the oppositely poled dry rectifiers 160 in series with the clutch coils. It will be seen that a change of grid bias of tube 159 in one direction from the balanced value will thus cause energization of one of the clutches C and C1 while a change in the opposite direction will energize the other clutch.

It was mentioned previously that the output of rectifier 150 was unfiltered. This fact, in conjunction with the arrangement of the clutch control circuit, contributes an important operating advantage. Inasmuch as the direct current plate resistance of a triode is higher than its dynamic plate resistance, the clutch control circuits, when balanced for direct current, are not balanced for the ripple appearing in the rectifier output. This alternating component assists in overcoming the residual magnetization in the clutches and results in prompt release when the circuits are balanced for a direct current. This is important as quick action is necessary to enable the mechanism to follow normal writing movements. Also to increase this action a 60 cycle or other low frequency signal is injected into the grid input of tubes 159 and 159a, through coupling condensers 162 and 162a to reduce static friction in the clutches. As explained before in connection with Fig. 1, due to the mechanical coupling between the clutch system and the slider 70 of resistor 72, the system tends to maintain, by the automatic adjustment of resistor 72, a uniform output from amplifier 148, and the motions accompanying this adjustment are employed to produce the writing operation.

It should be explained that the D.-C. output variation of rectifiers 145 and 146 is too small to provide satisfactory operation of the clutch

control circuit. It is to avoid the use of D.-C. amplifiers, which are difficult to adjust and to maintain at stable gain, that the conversion to the amplified A.-C. signal and the reconversion to D.-C. in rectifiers 150 and 151 are made. It will be understood that one or more stages of amplification may be introduced, as desired, between the variable gain amplifier 148 and rectifiers 150 and 151 where greater power output is required.

Referring now to the S channel, it will be seen that its input circuits are similar to those of the other two channels, but that a selective amplifier is not employed as the frequency discrimination of the selective circuits is found sufficient. The 325 cycle signal is merely amplified in amplifier 45 and applied directly to the stylus point 57.

The operation of the auxiliary circuits comprising the paper feed clutch control and the standby control will now be described. It will be noted that a portion of the discriminator input from both the X and the Y channels is carried to the grids of the double rectifier 162. This rectifier operates on the grid leak detector principle, the grid being biased nearly to cut-off by a normal input signal. Under these conditions, the plate currents in the rectifiers 162 are incapable of operating relays 163 and 164. However, upon the cessation of the input signal, sufficient plate current will flow to operate these relays.

Now assume the paper feed control button 4a at the transmitter to be momentarily depressed. This stops oscillator X which, in the manner described, removes the negative bias from the upper section of rectifier 162 causing relay 164 to operate. The operation of relay 164 energizes the paper feed clutch which immediately starts driving the paper feed drum, together with the interrupted slip rings 113 and 114. As soon as slip ring 114 has turned a short distance, the contacts of relay 164 are short-circuited, while the energizing circuit of relay 164 is opened at slip ring 113. This causes the clutch 107 to remain energized and to drive the paper feed roller one complete revolution, whereupon the clutch circuit is broken at slip ring 114. In this idealized representation, one revolution of the paper feed roller is assumed sufficient to feed one new frame of paper onto the platen.

The standby control relay 163 operates, in a manner similar to that just described for relay 164, when the Y oscillator is stopped by closing the standby switch 4b. The B supply to all circuits past amplifier 130 is broken at the contacts of relay 163, thus resulting in a smaller current drain while the receiver is inactive.

While a specific type of oscillator has been disclosed, it will be understood that the oscillators may be of any type in which the frequency can be varied by variation in the value of one or more of its tuning elements. For example, the oscillators may be of the resistance-capacitance type, the frequency being varied by variation of either the resistance or the capacitance. Other changes and modifications, within the scope of the appended claims, can be made without departing from the present invention.

What we claim is:

1. In a telescript system, a platen providing a generally rectangular writing field, a pair of independently supported coordinate members extending in intersecting relation at right angles to each other, a coupling movably engaging both

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of said members at the intersection thereof, whereby movement of said coupling to any part of the writing field correspondingly moves said members, an electrical stylus supported by said coupling and arranged to contact a record sheet supported on the writing field of said platen, a handle having its lower end movable on said coupling, and an electric switch operated in response to the writing movement of said handle, said switch serving to apply electrical energy to said stylus.

2. In a teletscript system, a platen providing a generally rectangular writing field, a pair of coordinate members extending in intersecting relation at right angles to each other and each member being movable to a plurality of parallel positions covering said writing field, a coupling movably engaging both of said members at the intersection thereof, whereby movement of said coupling to any part of the writing field correspondingly moves said members, and an adjustable frequency changer individual to each member, each frequency changer comprising an inductance coil and a core relatively movable with respect to each other in accordance with the movement of its individual coordinate member and in a direction at right angles to the direction of movement of its individual coordinate member.

3. In a teletscript system, a platen providing a generally rectangular writing field, a pair of coordinate members extending in intersecting relation at right angles to each other and each member being movable to a plurality of positions covering said writing field, a coupling movably engaging both of said members at the intersection thereof, whereby movement of said coupling to any part of the writing field correspondingly moves said members, and an adjustable frequency changer individual to each member, each frequency changer having linear electrical characteristics and comprising a fixed inductance coil and a core movable into and out of said coil in accordance with the movement of its individual coordinate member and in a direction at right angles to the direction of movement of its individual coordinate member.

4. In a teletscript system, a platen providing a generally rectangular writing field, a pair of coordinate members extending at right angles to each other, pairs of parallel opposing supports along the edge of the writing field, the respective ends of one coordinate member being adjustably mounted for movement along one pair of opposing supports and the respective ends of the other coordinate member being adjustably mounted for movement along the other opposing pair of supports, a coupling movably engaging both of said members at the intersection thereof, whereby movement of said coupling to any part of the writing field correspondingly moves said members, an electric stylus supported by said coupling and arranged to contact an electrically responsive record sheet supported on the writing field of said platen, a handle having its lower end universally movable on said coupling, and an electric switch operated in response to the writing movement of said handle, said switch serving to control the application of electrical energy to said stylus.

5. In a teletscript system, a transmitter unit and a receiver unit, each unit comprising a platen providing a generally rectangular writing field, a pair of independently supported coordinate members extending in intersecting relation at right angles to each other, a coupling movably engaging

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both of said members at the intersection thereof, a stylus supported by said coupling and arranged to contact a record sheet supported on the writing field of the platen, the relative movement of the coupling with respect to said members being effective to write a message, the coupling of the transmitting unit being provided with a handle whereby it can be moved along the coordinate members to variably position the same, an electric circuit including electric switch means associated with said handle, signal sending means associated with the transmitter unit to transmit continuous signals corresponding to the coordinates of the position of the transmitter stylus, means associated with said receiver unit and governed by said signals for effecting uninterrupted relative movement of the coupling and cooperating coordinate members of said receiving unit, said last-mentioned coupling being provided with a stylus whereby the mentioned movement of said coupling records at the receiving station a facsimile of the message written at the transmitting unit when said electric circuit is closed.

6. In a teletscript system, a transmitter unit and a receiver unit, each unit comprising a platen providing a generally rectangular writing field, a pair of independently supported coordinate members extending at right angles to each other, a coupling movably engaging both of said members at the intersection thereof, the coupling of the transmitting unit being provided with a handle whereby that coupling can be moved relative to the coordinate members to variably position the same in accordance with a message being transmitted, an electric circuit including circuit closing means associated with said handle, signal sending means associated with the transmitter unit to transmit continuous signals corresponding to the coordinates of the position of the transmitter coupling, means associated with said receiver unit and governed by said signals for effecting uninterrupted relative movement of the coupling and cooperating coordinate members of the receiving unit, said last-mentioned coupling being provided with a stylus whereby the mentioned movement of this coupling records at the receiving station, the message being transmitted when said circuit closing means is closed.

7. In a teletscript system, a transmitting station and a receiving station, each station being provided with a stylus and electrically responsive material cooperating with said stylus, means for transmitting electrical control signals from said transmitting station to said receiving station and arranged so that the stylus at the receiver unit follows the movement of the transmitter stylus, and means responsive to the writing movement of the stylus at the transmitter for supplying electrical energy both to the transmitter stylus and to the receiver stylus for recording messages on the responsive material at the respective station.

8. In a teletscript system, a transmitting station and a receiving station, each station being provided with a stylus and electrically responsive material cooperating with said stylus, the transmitter stylus being provided with a handle, means for transmitting electrical control signals from said transmitting station to said receiving station and so arranged that the stylus at the receiver unit follows the movement of the transmitter stylus, a source of electric energy for operating said receiving station, and means responsive to a movement of the stylus handle at the transmitter for supplying electrical energy to both the

transmitter stylus and to the receiver stylus for recording messages thereat and for connecting said source of electric energy to said receiver station.

9. The method of transmitting a message by a writing or drawing movement at a primary station and recording a facsimile of the message at a second station which comprises varying the frequency of two signals at the primary station in accordance with the rectilinear coordinates of each point of the message, combining said signals into a composite signal at the primary station, receiving said composite signal at the second station, separating the received composite signal into independent frequency varied signals, selectively and regeneratively amplifying said signals, translating each frequency varied signal into a direct current voltage proportional to the frequency of its related signal, and utilizing said voltages in applying a mechanical source of power for adjusting a recording stylus into positions corresponding to the various coordinates of the transmitted message.

10. In a telescript system, a transmitting station and a receiving station, each station being provided with a stylus and a sheet of electrically responsive material cooperating with said stylus, the stylus at the transmitter being provided with a handle, an electrical link connecting said stations and arranged so that the stylus at the receiver unit follows the movement of the transmitter stylus, means responsive to the movement of the stylus handle at the transmitter for supplying electrical energy to both the transmitter stylus and to the receiver stylus for recording messages thereat, and means at the receiver station for supplying a fresh area of the sheet thereat under control effected at the transmitter station.

11. The method of transmitting a message by a writing or drawing movement at a primary station and recording a facsimile of the message at a second station which comprises varying the frequency of two signals at the primary station in accordance with the rectilinear coordinates of each point of the message, combining said signals into a composite signal at the primary station, receiving said composite signal at the second station, separating the received composite signal into independent frequency varied signals, translating each frequency varied signal into a direct current negative voltage, the value of which is a linear function of its independent signal, applying in series with this negative voltage a positive voltage determined by one coordinate of the position of a receiving stylus, using the algebraic sum of said voltages to govern an impedance balance, using the unbalance thereof to determine one coordinate of said receiving stylus position, the unbalances resulting from the two signals determining both coordinates of said stylus position.

12. The method of transmitting a message by a writing or drawing movement of a stylus at a primary station and recording a facsimile of the message at a second station which comprises varying the frequency of two signals in accordance with the rectilinear coordinates of each point of the message, combining said signals into a composite signal, electrically receiving said composite signal at the second station, separating the received composite signal into independent frequency varied signals, translating each frequency varied signal into a direct current voltage proportional to the frequency of said last-mentioned signal, utilizing said voltages in applying a mechani-

cal source of power for adjusting a recording stylus into positions corresponding to the various coordinates of the transmitted message, and disconnecting at the second station under control effected at the primary station, the electric energy utilized in translating said composite signal.

13. In a telescript system, a platen providing a generally rectangular writing field, a resistor extending along each of two adjacent margins of said field, a pair of independently supported coordinate members extending in intersecting relation at right angles to each other, and to opposed sides of said field, one end of each member being provided with an electric contactor insulatedly mounted thereon for engagement with that one of the resistors extending at right angles thereto, a coupling movably engaging both of said members at the intersection thereof, a stylus supported by said coupling in writing relation to said platen, and means including both contactors and resistors as well as a normally balanced impedance network in the region of said platen for moving said members to position the intersection thereof at substantially any desired location in the writing field determined by electrical signals from a remote point.

14. The method of transmitting a message by a writing or drawing movement at a primary station and recording a facsimile of the message at a second station which comprises varying the frequency of two signals at the primary station in accordance with the coordinates of each point of the message, combining said signals into a composite signal at the primary station, receiving said composite signal at the second station, separating the received composite signal into independent frequency varied signals, translating each frequency varied signal into a direct current negative voltage, the value of which is a linear function of its independent signal, applying in series with this negative voltage a positive voltage determined by one coordinate of the position of a receiving stylus, using the algebraic sum of said voltages to govern an impedance balance, using the unbalance thereof to determine one coordinate of said receiving stylus position and to couple a source of power to move the receiving stylus to said position, the unbalances resulting from the two signals determining both coordinates of said stylus position, and superimposing on said voltages, alternating current effects to cause prompt uncoupling of the source of power.

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