

July 9, 1946.

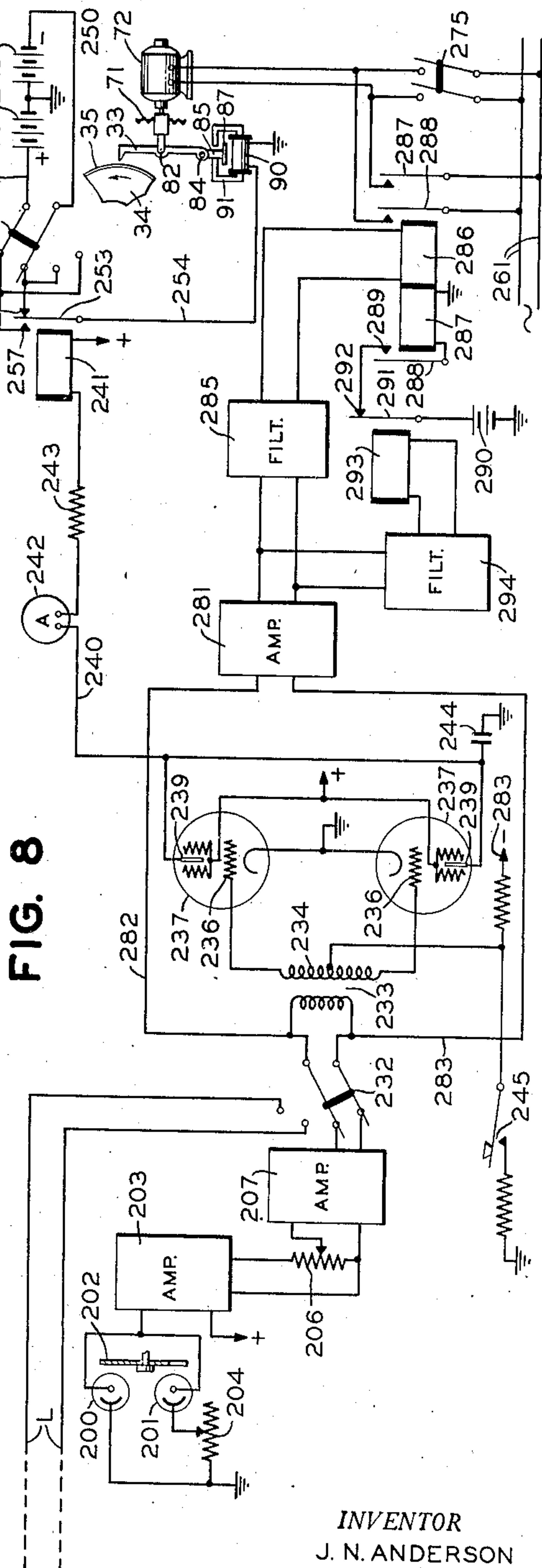
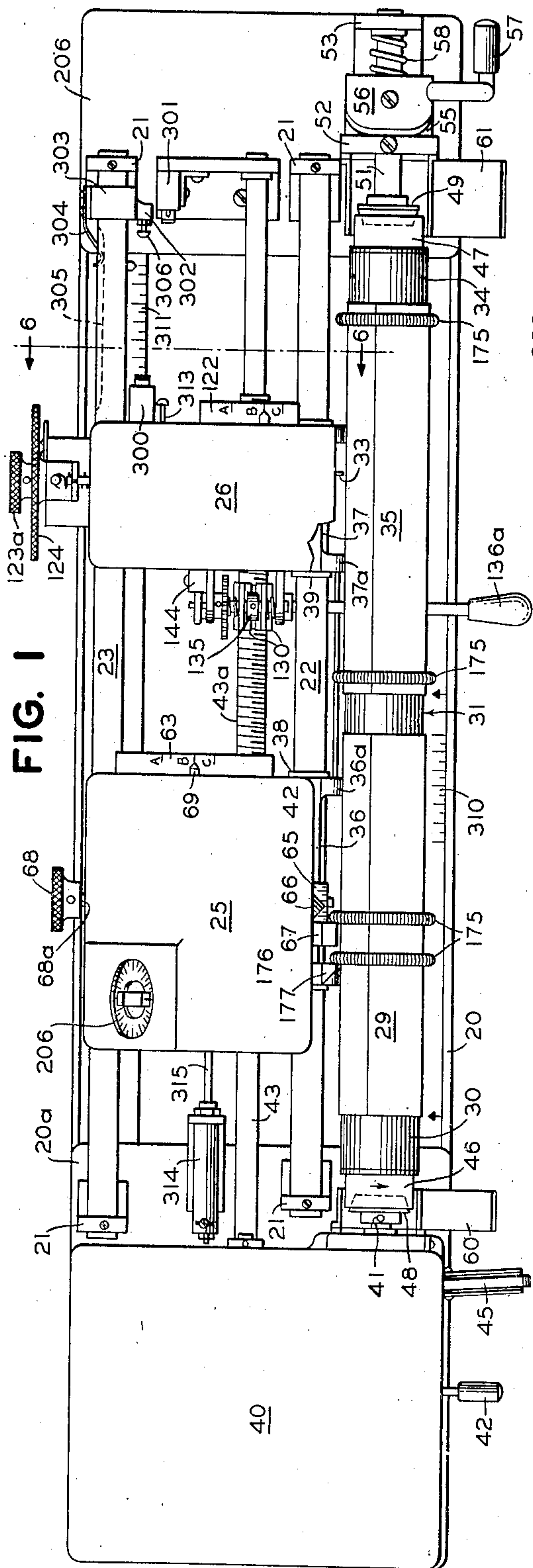
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2,403,472

APPARATUS FOR RECORDING ELECTRICAL SIGNALS

Filed Oct. 2, 1942

3 Sheets-Sheet 1



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APPARATUS FOR RECORDING ELECTRICAL SIGNALS

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3 Sheets-Sheet 2

FIG. 2

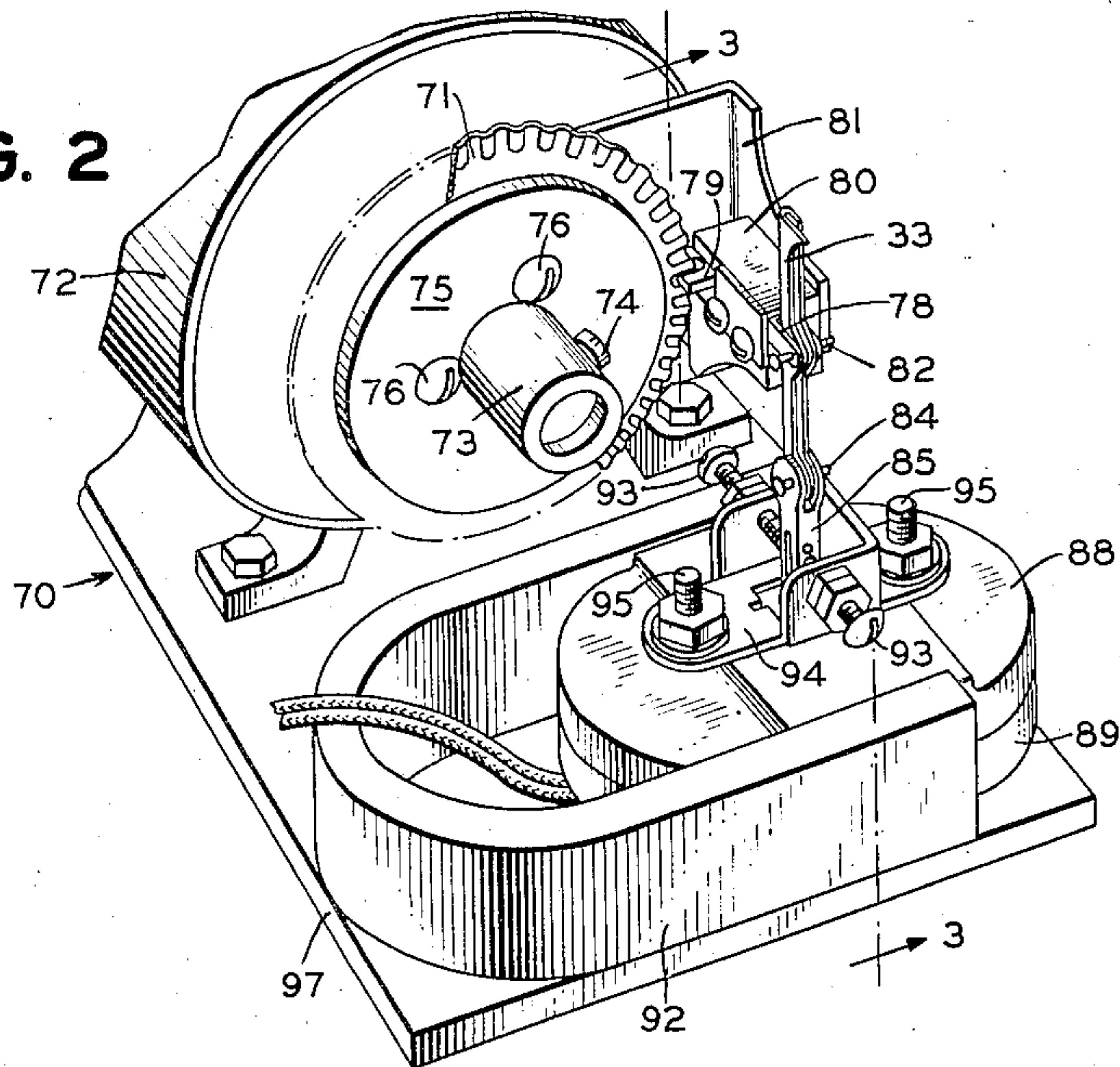


FIG. 4

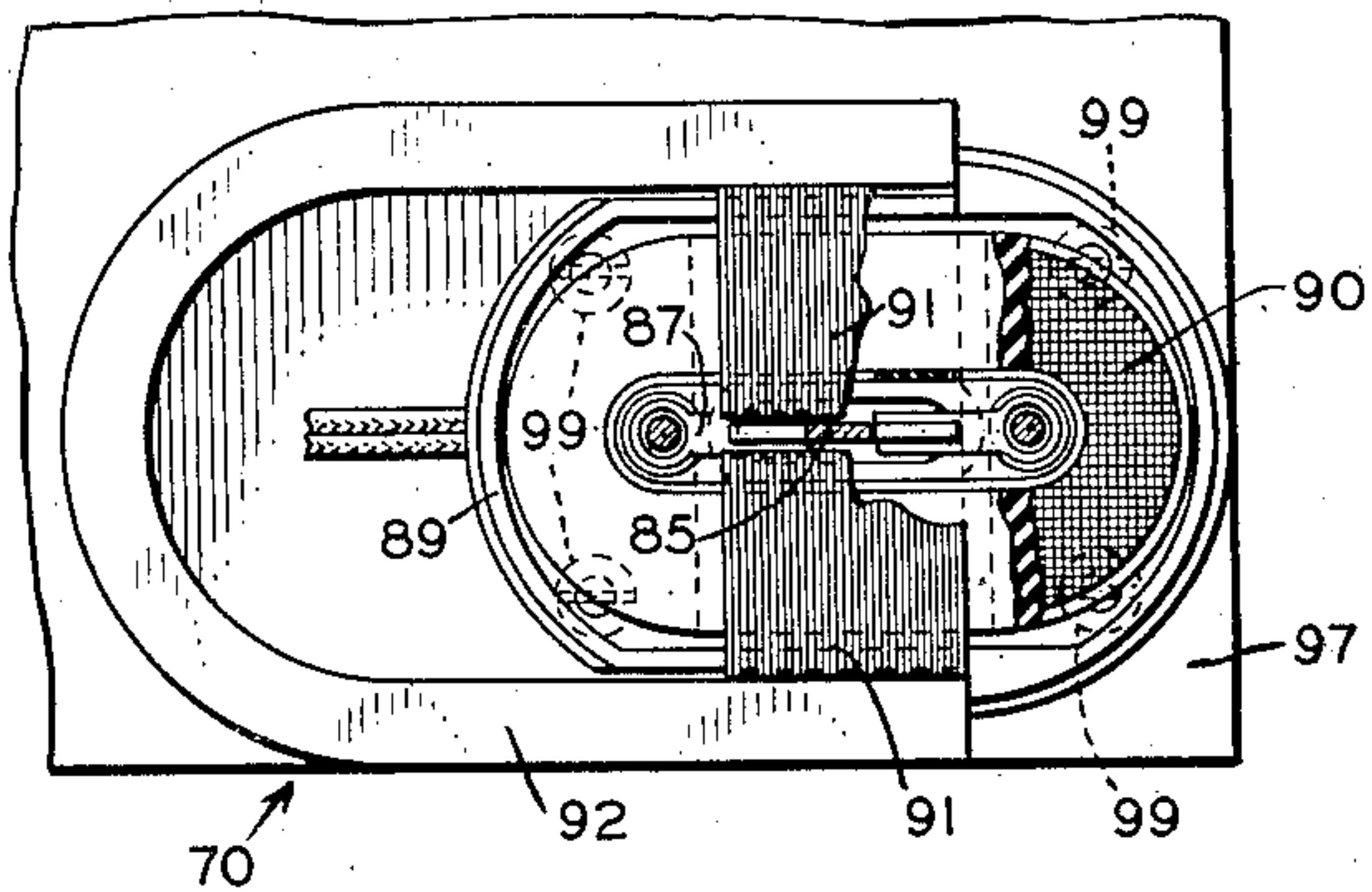


FIG. 3

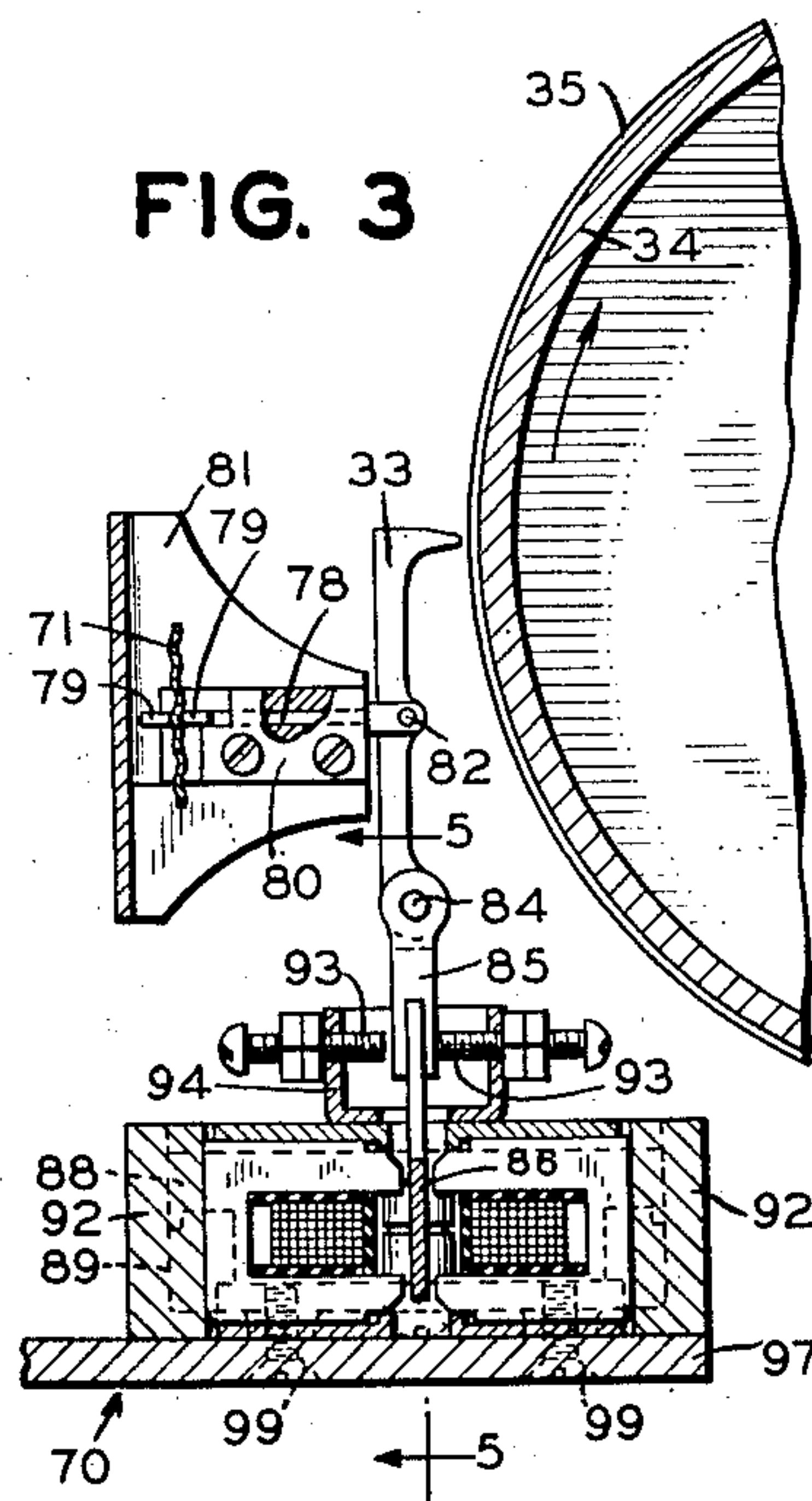
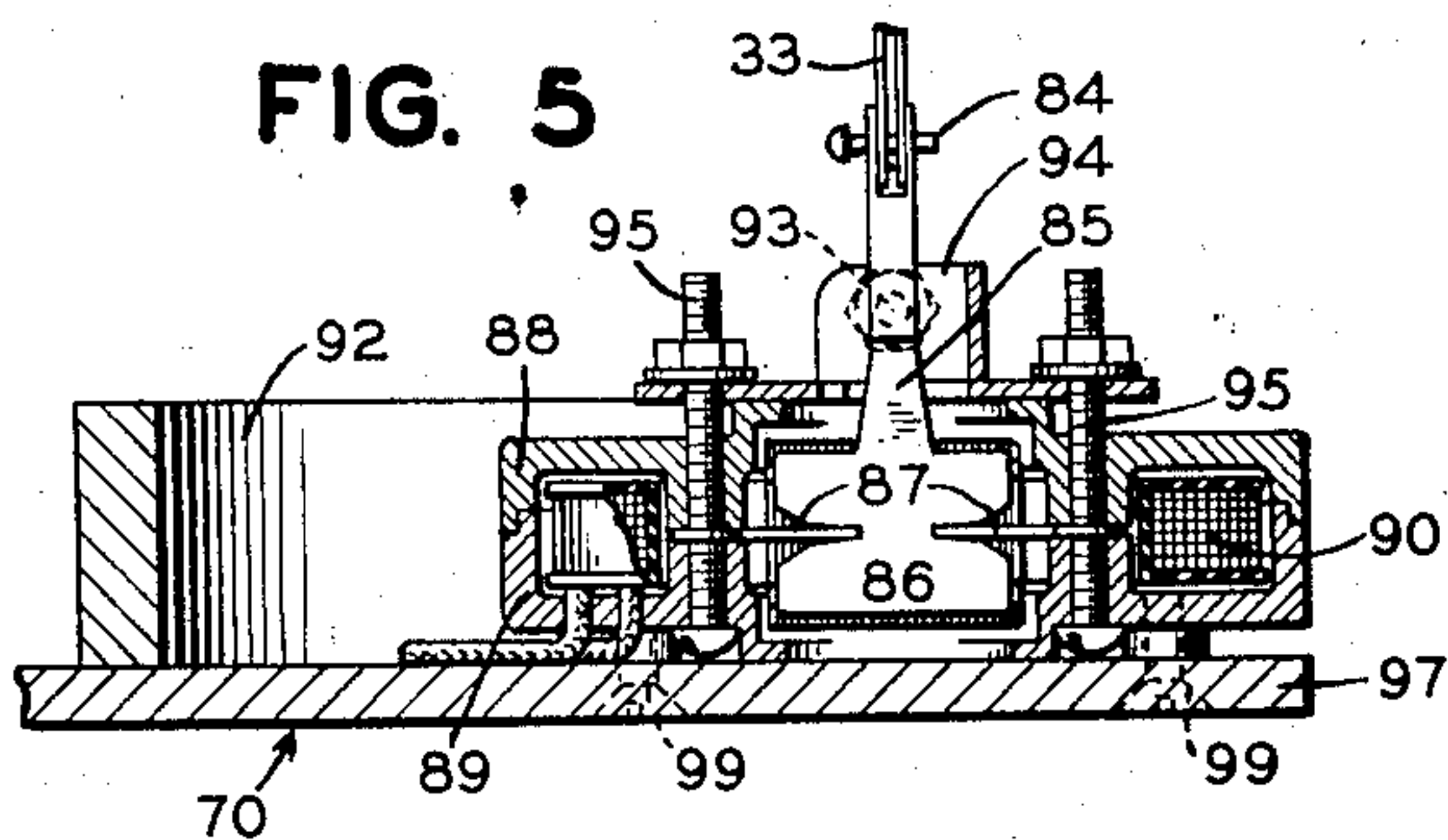


FIG. 5



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3 Sheets-Sheet 3

FIG. 6

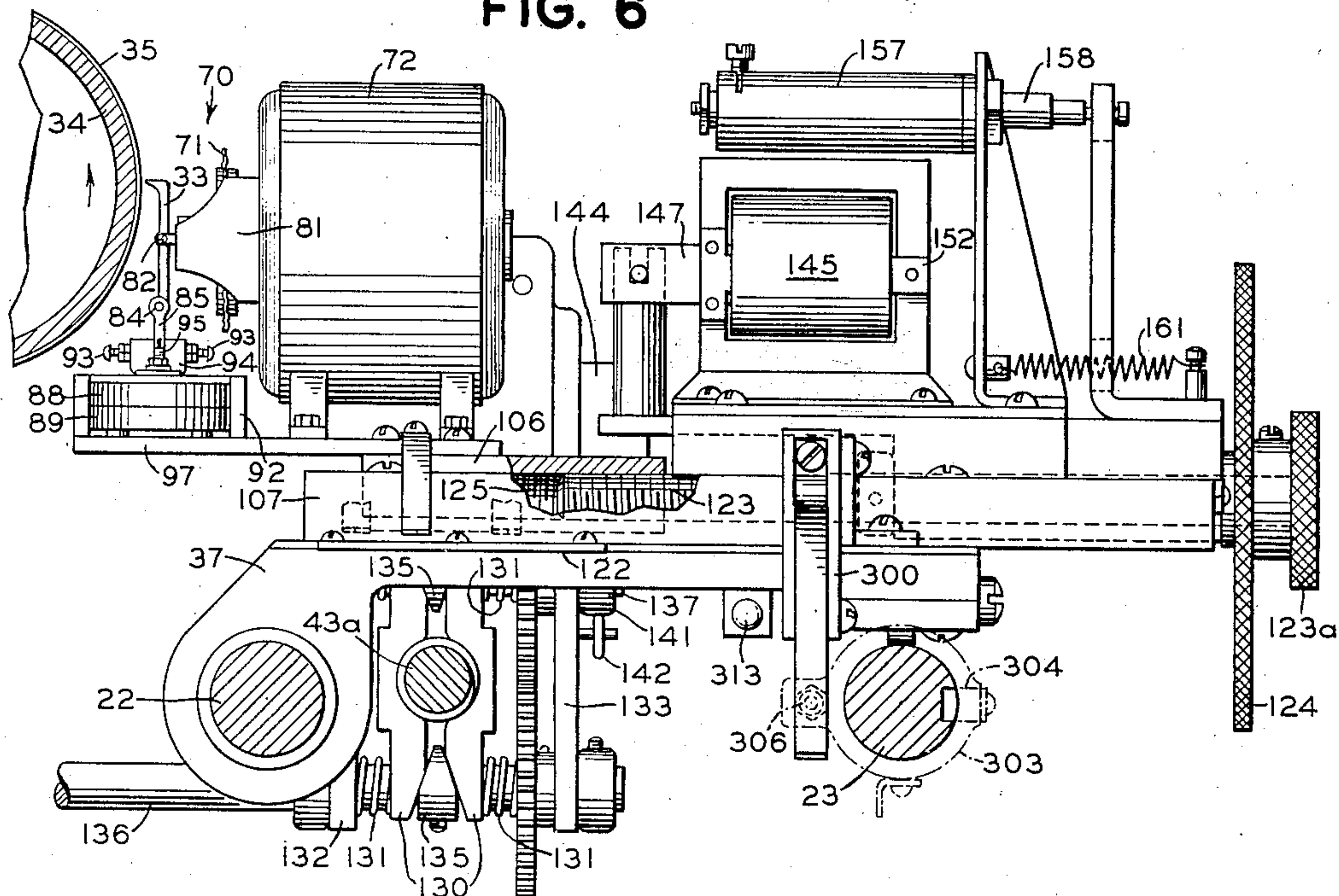
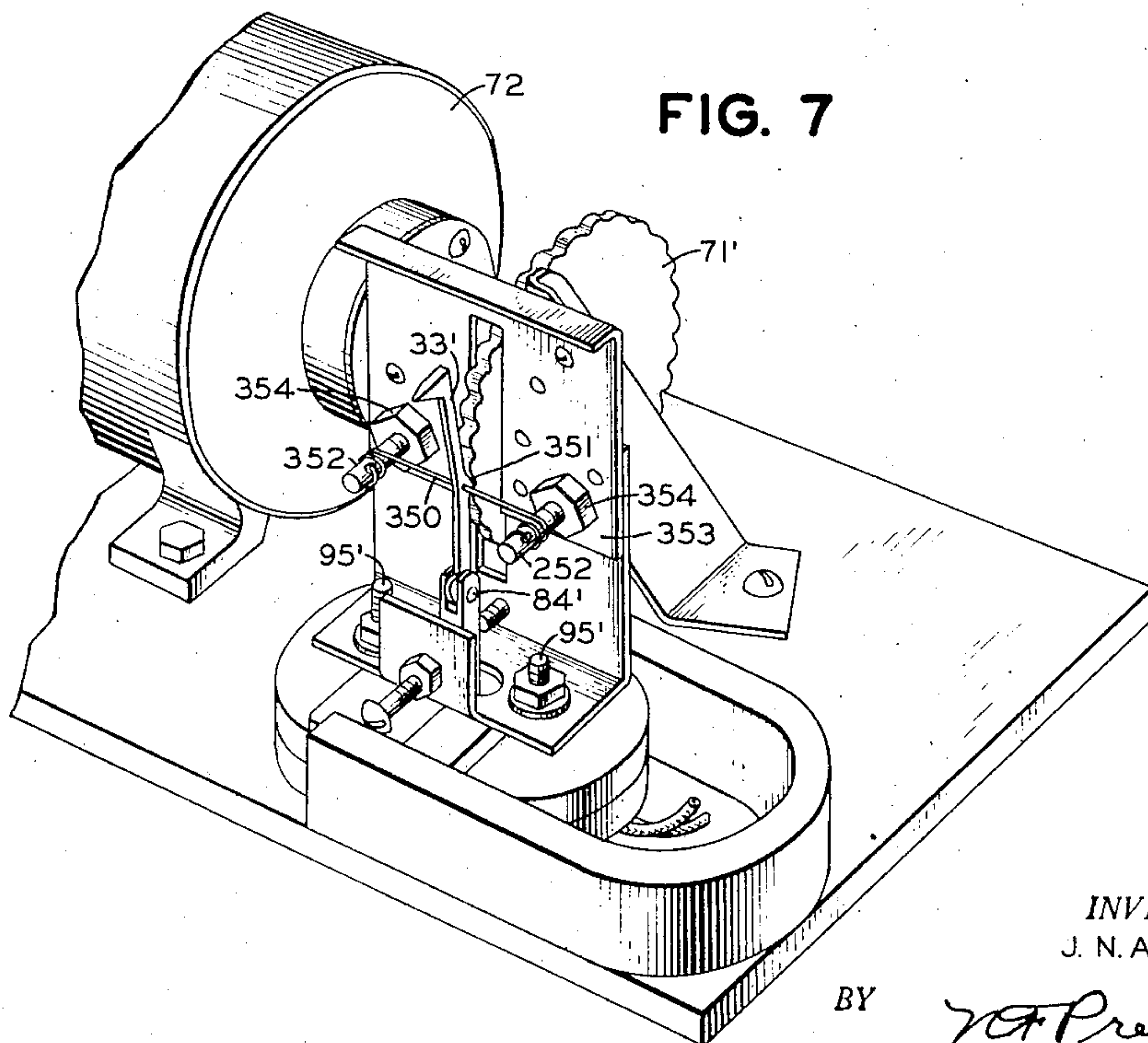


FIG. 7



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2,403,472

APPARATUS FOR RECORDING ELECTRICAL SIGNALS

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Application October 2, 1942, Serial No. 460,530

7 Claims. (Cl. 234—70)

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This invention relates generally to an improved apparatus for recording electrical signals, and more particularly to the recordation and reproduction of pictures, drawings, writing and other subject matter, in facsimile or otherwise, by means of a stylus which causes marking impacts to be applied to a record receiving medium to delineate a record thereon in accordance with received electrical signals. The invention is particularly adapted, although not limited, to the facsimile production of a master copy of an original from which numerous other copies may be made by the mimeograph, hectograph and other printing processes.

In accordance with the present invention the subject matter may be transmitted by facsimile or other signals generated in accordance with the subject matter to be recorded or reproduced, and in the case of subject matter appearing on an original sheet or blank, this may be reproduced in facsimile upon a record receiving blank. The record receiving blank may, if desired, comprise a stencil or other master blank from which a large number of copies may be made by various known printing or other duplicating processes, or the recording may be effected upon a single blank or simultaneously upon a number of blanks by means of carbon paper or other transfer media, thereby to produce multiple copies.

In the production of facsimile copies the record receiving blanks usually are carried by copyholders such as rotatable cylinders or drums or other forms of platens that are scanned by the recording apparatus during the reproducing operation, and these copyholders may be interchangeable in the apparatus so that they can readily be placed into operative position in the recording apparatus and can readily be removed therefrom either manually or automatically. The recording operation is effected by means of a recording stylus which is continuously vibrated at a high speed and intermittently contacts, or causes marking impacts to be applied to, the record receiving sheet at intervals in accordance with the transmitted subject matter, thereby to change or mark the surface of the sheet to record the subject matter thereon in facsimile or otherwise.

In recorders of the character heretofore employed for producing records or facsimile stencils by means of a percussion recording stylus, the stylus generally has been energized or driven by an electromagnet, the incoming electrical signals being applied to the magnet winding, the magnet being energized by the direct current components of the received signals. In such devices, however,

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it has been found difficult to control the degree of pressure with which the stylus engages or impacts the record sheet, the pressure exerted by the stylus often varying in accordance with variations in the signal strength of the received marking currents. Moreover, in prior devices it has been difficult to obtain the desired power necessary for cutting stencils or producing multiple copies without undesirably increasing the levels of the signal currents transmitted, and also difficult to provide a desired uniform power level of the currents which actuate the recording devices, and the amplitude of the stylus swing and the frequency response characteristic of the units were not uniform, particularly when producing stencils or multiple copies of the received subject matter.

One of the objects of the present invention is to provide a suitable recording unit in which the force of the impacts imparted by the stylus to the record receiving sheet is maintained constant, irrespective of variations in the signal level or amplitude of the received marking currents, thereby to produce uniform density and sharp definition of the recorded subject matter.

Another object of the invention is percussion recording apparatus of the character disclosed in which highly satisfactory recording is obtainable with low levels of the signal currents, and in which the amplitude of swing of the stylus and the frequency of its vibration are independent of the amplitude and frequency of the received marking currents.

A further object is a recording unit in which the power for driving the stylus is not derived from the received signals, and in which the amount of power applied to the vibrating stylus may be maintained as high as desired and kept constant at all times during recording operations.

A further object is a percussion type recording apparatus in which the movement of the stylus toward and from the record sheet is positively controlled and limited at all times and in which the limits of this movement may accurately be adjusted and maintained.

Still another object is a percussion recording unit which may easily be adjusted with respect to the record blank upon which it operates, and in which high stability of adjustment of the recording unit and greater uniformity in results are obtained.

A still further object is a recording unit of the character described which permits of greater tolerances in the manufacture of the recording drums or other platens employed, and in which

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variation in uniformity of thickness of the stencils or other record receiving blanks, or irregularities in the stencil or other blank surfaces, do not deleteriously affect the record.

The foregoing and other objects and advantages of the invention will be apparent from the following detailed description of the illustrative embodiments of the invention, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a view of a combined facsimile transmitter and recording apparatus in which the recording apparatus is constructed in accordance with the present invention;

Fig. 2 is a perspective view showing certain details of the recording device removed from its scanning carriage;

Fig. 3 is a fragmentary sectional view taken along the line 3—3 of Fig. 2, and including a recording drum for the device;

Fig. 4 is a fragmentary plan view showing certain details of the electromagnetic unit of the device of Fig. 2, with its upper protective cover removed;

Fig. 5 is a detail taken along the line 5—5 of Fig. 3;

Fig. 6 is a view, in elevation, taken along the line 6—6 of Fig. 1;

Fig. 7 is a perspective view of a modified form of the recording device; and

Fig. 8 illustrates diagrammatically a circuit arrangement which may be employed with the transmitter and recording apparatus.

Referring to the drawings, and particularly to Fig. 1 thereof, a base 20 forms the principal support for the apparatus and the driving and control mechanism therefor, which base is adapted to rest upon an apparatus table or cabinet or other convenient support, and a cabinet preferably being employed so that certain of the power unit and amplifier devices used may be embodied therein.

Secured to plates 20a and 20b on the base 20 are brackets 21 in which are mounted a front track or guide rail 22 and a rear track or guide rail 23 which slidably support the longitudinally movable transmitting scanning assembly 25 and the recording scanning assembly 26. Preferably, the transmitting scanning unit 25 comprises an optical pickup system for deriving facsimile signals from an original blank 29 which carries the subject matter to be reproduced or duplicated, the blank being secured upon a cylindrical drum portion 30 of a copyholder which is indicated in its entirety by the reference numeral 31. The copyholder 31 includes a cylindrical drum portion 34 adapted to support a record receiving blank 35 which is acted upon by the percussion stylus 33 of the recording unit 26.

In general, any suitable means for scanning the transmitting and record receiving blanks may be employed, for example, as disclosed in Patent No. 2,301,024, issued November 3, 1942, or in Patent No. 2,260,862, issued October 28, 1941. Also, any suitable type of transmitter may be employed for generating the facsimile signals supplied to the recording unit, such of example as illustrated in the foregoing patents and in Patent No. 2,158,391, issued May 16, 1939, and Patent No. 2,176,442, issued October 17, 1939.

The transmitting scanning assembly 25 and the recording assembly 26 are respectively mounted on traveling bases or carriage members 36 and 37, which latter members are each provided with guide blocks 38 and 39 slidably mounted on a front guide rail 22. The carriage

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members have rollers 40, one of which is shown in Fig. 6, that cooperate with the rear guide rail 23 to facilitate travel of the units 25 and 26 along the guide rails. The carriage member 37 of the recording unit is connected to the carriage member 36 of the transmitting unit, as by a carriage link 42 firmly secured to portions 36a and 37a of these units, so that any movement of the recording unit 26 longitudinally along the guide rods 22 and 23 will impart a similar movement to the transmitting unit 25, and vice versa. The various mechanical details for thus interconnecting the transmitting and recording units so as to cause them to operate in synchronism with respect to the line feeds thereof are disclosed in detail in the aforesaid d'Humy et al. Patent No. 2,301,024, and for the sake of brevity certain of these details are not illustrated in the drawings herein.

Power for operating the apparatus is supplied by a motor contained within a casing 40, the motor preferably being of the synchronous alternating current type, although if desired may be of the direct current type, it being understood that the speed of the motor for any given operation may be adjusted and maintained constant by any of the various suitable means known in the art for this purpose. The power is applied by the motor through the medium of reducing gear mechanism in known manner, which gear mechanism is also contained within the casing 40, the motor and gear mechanism causing rotation of a driven shaft 41 which rotates the transmitting and recording drums 30 and 34 in the direction indicated by the arrow on drum 30 during the scanning operations. The gear mechanism also drives a line feed shaft 43 which has a threaded portion 43a that directly drives the recording unit 26, and through the medium of the carriage link 42 also drives the transmitting unit 25 to cause line feed scanning movement of the units with respect to the transmitting and recording drums 30 and 34.

Preferably, and as disclosed in the aforesaid d'Humy et al. patent, the apparatus is arranged to accommodate transmitting and record receiving drums of different diameters in order to accommodate transmitting and recording blanks of different sizes, and for this reason the gear mechanism within the casing 40 is adapted to be shifted, as by the gear shift lever 42, in order to provide different driving speeds for the drums and therefore change at will the peripheral speed of rotation of the drums 30 and 34. With the drum speed shift arrangement the linear scanning speed for the drums 30 and 34 may be changed if desired, or when drums of different diameters are used in place of the drums shown the number of revolutions per minute of the drums may be either reduced or increased to an extent such that the peripheral speed of rotation and hence the linear scanning speed will remain approximately the same irrespective of the size of drums employed. Also, the driving ratio of the gears which cause rotation of the line feed shaft 43 may be changed, as by a shift lever 45, so that the speed of rotation of the feed screw 43a and hence the number of scanning lines per inch may be varied. For example, when the shift lever 45 is in its right hand position, as shown in Fig. 1, the gear ratio may be such that the transmitting and recording units scan at the rate of 100 lines per inch, and if the lever 45 is shifted to the left the gear ratio may be such that the number of scanning lines may be increased to 120 lines per inch, the arrangement enabling the

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number of scanning lines per inch to be made such as to give the most desirable results depending upon the subject matter and the kind of service for which it is used.

If desired, and as described in detail in the aforesaid d'Humy et al. patent, two line feed shaft members similar to the member 43, and which may be caused to operate at different speeds respectively, may be employed, one of which shafts produces the line feed scanning movement of the transmitter unit and the other of which produces the line feed scanning movement of the recorder unit, whereby when transmitting and recording drums of different diameters respectively are concurrently employed, the reproduced record may be enlarged or reduced with respect to the subject matter on the transmitting blank without causing distortion of the recorded subject matter. The foregoing various features of variable speed of the transmitting and recording cylinders and their respective line feed scanning means comprise subject matter claimed in the aforesaid d'Humy et al. patent, and for the sake of simplicity such arrangements are not disclosed herein in detail.

The cylinder 31 has reduced ends 46 and 47 formed with internal tapered surfaces which receive complementary bearing members 48 and 49. The bearing member 48 is secured to and driven by the shaft 41 hereinbefore referred to, and serves to drive the cylinder 31. The member 49 is secured to a shaft 51 journaled in fixed upright bearing members 52 and 53 so as to be freely rotatable and also slidably movable longitudinally within the bearings to permit entry and withdrawal of the member 49 from the recessed portion of the end 47 of the cylinder 31, and thereby permit ready insertion and removal of the cylinder 31 and drums 30 and 34.

To facilitate the insertion and withdrawal of the member 49, preferably there is provided a tapered cam member 55 fixedly secured to the bearing support 52, and coacting with this cam member is a second tapered cam member 56 which is secured, as by a set screw, to the shaft 51. Secured to the cam member 56 is a handle 57, and when the handle is raised upwardly as viewed in Fig. 1, this causes rotation of the cam 56 relative to the fixed cam 55, the adjacent tapered camming surfaces of these members coacting to cause the member 56 to be shifted to the right as viewed in the figure and thereby cause longitudinal movement of the shaft 51 and withdrawal of the bearing member 49 from the recessed end 47 of the cylinder 31, after which the cylinder may be slid to the right a distance sufficient to release the opposite end 46 from its associated drive member 48. A compression spring 58 which loosely surrounds the outer end of the shaft 51, causes the member 56 to return to the working position when the handle is turned downwardly, the spring also causing the bearing member 49 to enter the end 47 of the cylinder thereby to insure that the cylinder is properly supported during rotation thereof and to maintain a proper driving connection between the members 46 and 48. Instead of employing a cylinder 31 having the transmitting and recording drums formed or mounted thereon, separate transmitting and recording drums may be employed and maintained in proper driving relation in the manner disclosed in the aforesaid d'Humy et al. patent.

Fixed bracket members 60 and 61 are provided, each of the bracket members comprising two

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arcuate supports or saddles, the inner pair of these saddles preventing the cylinder 31 from dropping when it is released from the bearings 48 and 49 and the outer pair of saddles providing a convenient rest for the cylinder 31 to enable the blanks to be applied to and removed from the drums 30 and 34 at the beginning and termination of a reproducing operation.

As hereinbefore stated, any suitable transmitting unit may be employed. In general, in an optical pickup system such a transmitting unit employs a lens tube 66 containing lenses and an apertured plate aligned in position with respect to each other so that light from an exciter lamp is concentrated on a minute spot on the periphery of the drum 30 and consequently on elemental areas successively of the subject matter sheet 29 thereon during scanning. Another lens tube 67 contains lenses for directing the beam of light reflected from the elemental area of the record sheet 29 at the time being scanned onto an aperture and thence to a photocell, a light chopper in the form of a perforated disc being interposed between the photocell and the aperture in known manner, the number of perforations or notches in the disc and the speed of rotation thereof depending upon the desired rate of scanning, the frequency of the signal carrier current employed, and other factors. Preferably, and as disclosed in said Patents 2,158,391 and 2,176,442, the transmitter employs two light sensitive cells associated with the light chopper disc or discs in such manner that the signals produced by the transmitter need not be inverted before application to the recorder in order to provide a positive record from a positive original blank or a negative record from a negative original blank, although if desired one light sensitive cell may be employed and the signals inverted either in the transmitting or recording circuits by means of a reversing switch such as hereinafter described or by other suitable signal inverters of a type well known in the communication art.

The recording stylus actuating device, which is embodied within the recording assembly 26, is shown in detail in Figs. 2 to 6 of the drawings, and is indicated in its entirety by reference numeral 70. Referring particularly to Figs. 2 and 3, the device comprises a circular ripple or flutter cam 71 which during recording operations is continuously rotated at a constant speed by means of a motor 72, the cam being secured to the motor driving shaft by means of a collar 73 which is secured directly to the shaft in suitable manner, as by a set screw 74, the collar also being secured to a plate 75 which in turn is secured to the ripple cam 71 in suitable manner, as by rivets or machine screws 76. When the cam 71 is revolved by the motor 72 at a suitable speed, a cam follower 78 which has two camming portions 79 is rapidly vibrated or oscillated towards and from the surface of the sheet 35, Fig. 3, the cam follower being slidably mounted within guideways in a casing 80. The casing 80 is secured to a plate member 81 which in turn is rigidly secured to the housing of the motor 72.

The stylus 33 is pivotally connected at 82 to the forward portion of the cam follower 78 so that oscillation of the cam follower 78 by the ripple cam 71 causes the point of the stylus 33 to oscillate rapidly in a direction towards and from the blank 35 to apply marking impacts to the blank in selected elemental areas thereof, the stylus pivoting about the point 84. The rate of vibration or frequency of the percussion stylus

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33 may be varied within wide limits, depending upon the type of subject matter to be recorded and the degree of definition desired. When recording facsimile signals, the speed of the motor 72 and the number of lobes or ripples on the ripple cam 71 preferably are such that the stylus will oscillate at a high frequency, for example, of the order of 1,800 cycles, thereby to produce exceedingly fine definition of the recorded subject matter.

The lower end of the stylus 33 is pivotally mounted at 84 to the upper end of an extension or leg 85 which is integral with and projects upwardly from an armature 86 of the electromagnetic control unit. In the illustrative embodiment shown the armature 86 is pivotally mounted by means of two flat, flexible, phosphor-bronze spring members 87 each of which is received at one end within a side of the armature 86, as seen more clearly in Fig. 5, and are firmly secured to the armature, as by brazing or in other suitable manner. The spring members 87 are secured at their other ends between the opposite halves 88 and 89 of a casing which surrounds an energizing coil 90 of a polarized electromagnetic relay structure. The pole pieces 91 of the electromagnet preferably are composed of laminated strips, seen more clearly in Fig. 4, the laminated structure 91 in turn being supported between the legs of a permanent horseshoe magnet 92. The pole pieces are so arranged and the energizing winding is in a direction such that, when the coil 90 is energized by current of a given polarity, electromagnetic fields will be set up which causes rotation of the armature 86 about its axis 87 in one direction, and when the coil 90 is energized by current of opposite polarity, the armature 86 is rotated in the opposite direction.

It will be noted from Fig. 3 that, when the armature 86 and its extension 85 have been attracted to the position shown in the figure, this has moved the pivotal point 84 of the stylus to the right, in which position the stylus 33 has been rotated, in a counter-clockwise direction as viewed in the figure, to a position such that even though it is vibrated by the ripple cam 71 it does not contact the blank 35. If, however, the electromagnet is energized by a current of opposite polarity to attract the armature 86 and its extension 85 in the opposite direction, as toward the left in Fig. 3, this will shift the pivotal point 84 of the stylus 33 to the left and, consequently, will rotate the stylus 33 in a clockwise direction to a position such that when vibrating it will engage the sheet 35 and mark the same. In other words, when marking signals are received by the electromagnetic unit, the armature 86 will be moved to a position such as to cause the stylus 33 rapidly to impact the sheet 35, and when spacing or non-marking signals are being received the armature will be moved in the opposite direction to shift the pivotal point 84 so that the stylus 33 will not engage the blank 35, thereby causing the stylus to delineate black and white, or marked and unmarked, elemental areas on the blank which correspond with similar elemental areas on the original blank from which the signals were generated by a transmitter such as the transmitting unit 25 shown in Fig. 1.

As shown in Figs. 1 and 3, the limits of travel of the armature 86 may accurately be determined by means of adjustable stop members 93 which are threaded into a U-shaped bracket member 94 secured to the upper cover 88 of the unit, as by means of machine screws 95, Fig. 5, which also

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serve to secure the portions 88 and 89 of the casing together, the screws also passing through eye portions in the phosphor-bronze spring members 87 to secure these members in place.

As seen more clearly in Fig. 2, the driving motor and electromagnetic unit are mounted on a plate 97 of non-magnetic material, for example, brass. The motor and electromagnetic unit are secured to the mounting plate in any suitable manner, as by the machine screws 99 shown in Fig. 5, the mounting plate being secured to the traveling scanning carriage of the recording apparatus, as shown in Fig. 6.

Various types of polar and non-polar electromagnetic relay structures, different than that shown, may be employed to control the marking and non-marking positions of the stylus 33, which relays may be controlled by received modulated or varying signals applied directly thereto, instead of through signal repeating relays, although the polarized structure shown is preferred since it is sufficiently sensitive and fast in its operation to permit the faithful reproduction of facsimile signals at a high scanning speed. For example, with transmitting and recording drums having a circumference of the order of eight and one-half inches and a drum speed of the order of one hundred eighty revolutions per minute, it is possible to obtain a linear scanning speed of approximately one thousand five hundred thirty inches per minute, and thus the transmitting and recording apparatus are adapted to operate at a sufficiently high speed as appreciably to reduce the time required for producing a stencil or otherwise recording a given piece of subject matter.

Fig. 6 shows various details of the manner in which the recording unit 70 is mounted on the recording scanning carriage 37, the base 97 of the unit being secured, as by screws 105, to a block 106 that is slidably mounted within guide structure 107, the block 106 being internally threaded and receiving a threaded adjusting shaft 123. The recording unit is thereby made adjustable towards and from the blank 35 to accommodate recording cylinders of different diameters, by means of the rotatable shaft 123, which is rotated by a knurled knob 123a to adjust the recording unit to the desired positions, such as indicated by the indicia A, B and C (Fig. 1) that appear on a plate member 122 secured to the carriage of the recording unit, the indicia respectively corresponding to three different sizes of recording drums that may be employed. A graduated dial or vernier 124 secured to the rod 123 enables a very accurate adjustment of the recording stylus 33 relative to the stencil or other blank. A pointer 125 carried by the plate member 98 coacts with the plate 122 bearing the indicia to indicate when the recording unit is adjusted for the size of drum to be employed. The method of thus adjusting the recording unit is described in detail in the aforesaid d'Humy et al. patent, and for this reason it is not described in greater detail here.

The line feed of the transmitting and recording units is effected by means of a split block assembly comprising identical opposed split halves 130, Fig. 6, which members are internally threaded to receive the feed screw 43a, the members being spring-pressed into engagement with the threads of the feed screws 43a by means of four compression springs 131 which act between support members 132 and 133 and the upper and lower portions of the members 130. The members 132 and 133 comprise the legs of a U-shaped

bracket which is secured to the recording scanning carriage. Interposed between the inner surfaces of the opposite ends of members 130 are two wedge-shaped members 135, the lower member 135 being secured to a split-nut release lever rock shaft 136, and the upper wedge-shaped member 135 being mounted on a rock shaft 137. When the handle 136a, Fig. 1, of the shaft 136 is rotated so as to turn the wedge-shaped members 135 from the positions in which they are shown in Fig. 6, the split-nut halves 130 are forced to part a sufficient distance to effect their release from the threaded rod 43a and thus enable both the transmitting and receiving units to be moved longitudinally to any position, such as their initial starting positions, after which the shaft 136 is turned in a direction such that the wedge-shaped members 135 again assume their positions shown in Fig. 6 and make the feed screw 43a effective.

In order that there may be no likelihood of injury to the stencil or other blank by the stylus 33 or injury to the point of the stylus when a recording operation has been completed, and particularly when the transmitting and recording units are to be moved to their initial starting positions, a collar 141, Fig. 6, is secured to the rock shaft 137, the collar carrying a pin 142 which is adapted to control a stylus retracting switch 144 that in turn controls the energizing circuit of a solenoid 145, as explained in detail in the d'Humy et al. patent. When the solenoid 145 is energized, this causes retraction of its core 147 and effects withdrawal of the stylus a predetermined distance from the recording drum when the solenoid 145 is energized, the limit of this retractile movement being determined by the core 147 striking a stop member 152 on the frame of the solenoid when the stylus is in its proper retracted position. A dashpot 157 having a plunger 158 received therein eases the impact of the return of the recording unit to recording position under the action of a retractile spring 161 when the solenoid 145 is deenergized.

The original copy sheet 29 is wrapped around the transmitting drum 30, Fig. 1, preferably in such manner that the top of the copy is at the left hand end of the drum when facing the machine, the right hand edge of the copy overlapping the left hand edge by a slight margin. The copy may be held in position by any suitable means, such as elastic bands or garters 175, each of which preferably comprises a helical spring in the form of an annulus, such as disclosed in Patent No. 2,255,868, or in Patent No. 2,301,024. As shown in the figure, the leading garter member is advanced axially along the drum 30 from the left to right as scanning proceeds by a garter pushing plate member 176 secured to the supporting frame 36, and the trailing garter member is advanced by a second pusher plate 177 on the transmitting unit. The two elastic bands 175 are thus kept within a predetermined distance of each other and are kept immediately adjacent to the place where scanning is being effected, the bands rolling along on the copy sheet as the scanning proceeds and holding the copy sheet tightly against the drum and preventing distortion in the optical scanning system which otherwise might occur if the copy was not held tightly against the drum. Two similar garter members 175 are employed to hold the blank or stencil 35 on the recording drum 34, and usually these members may be placed adjacent to the ends of the blank 35, as indicated in Fig. 1.

Referring to Fig. 8, there is shown a circuit arrangement suitable for interconnecting the transmitting and recording apparatus in accordance with the present invention, although other known electrical systems suitable for transmitting and recording in facsimile may be employed, depending upon the purpose for which the apparatus is to be used. At the transmitting end a scanning photoelectric cell 200 and a balancing photoelectric cell 201 preferably are employed in the manner set forth in the aforesaid Patents Nos. 2,158,391 and 2,176,442, and controlling the light applied to the cells is a light chopper 202 which is rotated at a constant predetermined speed by a motor in a manner well-known in the art. In the embodiment shown the speed of the light chopper preferably is of the order of 3300 R. P. M. so that the apertured portions thereof will produce a signal frequency of the order of 2500 cycles. When light is falling on both photocells, the signal amplitude is at a minimum due to the balanced arrangement of the cells, and no signal is transmitted at this time. When a black mark appears under the scanning ray, however, the two photocells become unbalanced relative to each other, and at this time there is transmitted a carrier frequency of 2500 cycles, which carrier is modulated by the appearance or non-appearance of a mark on the original copy. This modulating frequency depends upon the speed at which the white and black elemental areas pass by the scanning light. For example, with an elemental area of approximately eight circular mills where the scanning ray impinges on the subject matter appearing on the transmitting blank, and a drum of eight and one-half inches in circumference and a speed of 180 R. P. M., the carrier frequency will thus be modulated by a signal frequency of the order of 1400 cycles. In the circuit of the balancing photocell is an adjustable impedance or resistance 204 which enables the photocells to be accurately balanced with respect to each other so that each one puts out the same amplitude of signal. It will be understood that the phase relationship between the two light beams for each of these photocells will be so adjusted as to most effectively balance when the scanning light is on the white background, as described in detail in the aforesaid patents.

The signal output from the photocells is connected to a thermionic preamplifier 203 of known type, and the transfer of signals from this amplifier to the succeeding similar amplifier stages is controlled by a gain control device 206. Connected to the gain control device 206 is a second amplifier 207 which preferably comprises two amplification stages. In both the preamplifier 203 and the amplifier 207 the constants of the circuits preferably are made such that the amplifiers will not pass low disturbing frequencies caused by undesired pickup from interfering stray fields. All stages of the amplifiers preferably are of class A amplification whereby each of the amplifiers has a constant average plate current output regardless of the amplitude of the marking signal applied.

The output of amplifier 207 is applied by means of a double pole switch 232 to the primary of a transformer 233. However, when the recorder is to be used for receiving signals from a remote point over the line L, the switch 232 will be thrown upwardly to connect the line L to the primary of the transformer 233.

The secondary 234 of this transformer is connected to the grids 236 of a pair of similar elec-

tronic devices 237, and the midpoint of the secondary is connected to a suitable source of negative biasing potential 238. The electronic tubes 237 preferably have a high amplification factor and a large mutual conductivity. The type 48 or the type 616 tube are examples of tubes suitable for the purpose. The anodes 239 of the tubes are connected to a relay 241 in series with a milliammeter 242 and a resistance 243. The other end of the winding of relay 241 is connected to a source of positive potential whereby the relay will be energized when the tubes 237 are passing plate current in response to received signals. The series circuit which includes the resistance 243 and the relay 241 is by-passed by a condenser 244.

The resistance 243 and condenser 244 operate to limit the maximum power input from the electronic tubes 237 to prevent excessive current from being applied to relay 241. The resistance and condenser coact to cause the anode voltage on the electronic tubes 237 to drop to a low value when a predetermined input level is reached, thus holding the anode current constant for higher values. The current applied to the relay 241 is, therefore, substantially uniform for the duration of a marking signal regardless of the signal level or intensity. It is also desirable that the anode current change from the full steady state to zero be accomplished within a relatively small input level change. The large amplification factor and the large value of mutual conductivity of the tubes 237 assist in obtaining this result, the relatively high value of biasing voltage which is applied to the tubes assisting in effecting this result.

The repeating relay 241 selectively controls the application of energizing current from the source 249 to the coil 90 of the electromagnet unit of the recorder. When the relay 241 is not energized, as shown in Fig. 8, current of a given characteristic or polarity, for example, negative current, is supplied from the source 249, through conductor 250, switch 251, break contact 252 and armature 253 of relay 241, and conductor 254 to the energized winding 90 of the electromagnetic relay structure, thereby maintaining the stylus 33 out of engagement with the blank 35, notwithstanding that the stylus may be oscillating by reason of rotation of the motor 72. In this position of the stylus, white or unmarked areas are produced on the record blank 35.

When the tubes 237 are passing plate current, in response to received marking signals, the relay 241 is energized, and through its armature 253, make contact 257, switch 251 and conductor 256 causes current of a different characteristic or opposite polarity, for example, positive current, to be supplied from the source 249 to the electromagnet winding 90, thereby actuating the armature of the electromagnetic structure and rotating the stylus 33, in a counterclockwise direction as viewed in Fig. 8, to cause the vibrating stylus to impinge upon the surface of the blank 35 and produce black or marked elemental areas thereon.

The switch 251 is a reversing switch which enables the polarity of the current applied to the contacts 252 and 257 to be reversed, thereby providing for signal inversion whenever this is desirable. With the switch thrown to its upper position, shown in Fig. 8, a positive original copy at the transmitter will be reproduced on the stencil or other blank as a positive, and a negative original will be reproduced as a negative copy, due to the balanced photocell arrangement. With the

switch thrown to its lower position, the reverse operation will occur, and a positive original will be reproduced as a negative copy, or a negative original will be reproduced as a positive copy. This enables the recorded copy to be reproduced in whichever form may be desirable. Other means known in the art for producing signal inversion may, of course, be employed.

The driving motor 72 for the stylus may be controlled locally by means of a manually operable switch 275, which either supplies or disconnects its supply current from the source 261, or the recording apparatus may be operated by signals from a distant point transmitted over the line L, as stated hereinbefore, and when this is done it may be desirable to also provide separate control for the energizing circuit of the motor 72. For this purpose a distinctive signal, for example, a steady tone of predetermined frequency, may be transmitted over the line L prior to a recording operation, and this tone will be received by an amplifier 281 which is connected by conductors 282 and 283 to the line switch 232. This tone will be selected by a filter or tuner 285, which may include amplifying and detecting stages and which causes energizing current to be applied to the winding 286 of a relay that controls through its armatures 287 and 288 energizing current for the motor 72. The relay 286 upon operating also closes a holding circuit for itself, through its armature 288 and make contact 289, and break contact 292 and armature 291 of a relay 293, to a source of holding current 290. Relay 286 will, therefore, remain energized so long as it is desired to transmit signals to the recording unit, and the motor 72 will be caused to run continuously during this period. When the recording has been completed, another distinctive tone or signal may be transmitted over the line L, which tone will be selected by a filter or tuner 294, which may include amplifying and detecting stages and which will supply energizing current to the relay 293. Energization of this relay attracts its armature 291, thereby breaking the holding circuit for relay 286 and stopping the motor 72.

Various other control circuits for enabling operation of the recording unit over the line L may be employed such, for example, as various of the control circuits disclosed in the aforesaid Patent 2,260,862, or as disclosed in Patent 2,255,868, issued September 16, 1941, and Patent 2,262,715, issued November 11, 1941. Other remote control circuits known in the art and suitable for controlling the various functions of the recording apparatus from a distant point may be employed. Also, if desired, the control of the stylus actuating motor 72 may be associated with the control of the driving motor for the scanning mechanism shown in Fig. 1 so that, upon energization of the motor which drives the recording scanning unit, the motor 72 will simultaneously be energized.

Where the signals for operating the recorder are received from an incoming line which may represent a circuit originating in another city or different locality from that of the recording unit, it will be understood that the incoming signals are suitably amplified prior to their application to the amplifier stages shown, and that these signals may be amplified either at the place of origin, at the receiving end, or intermediate these points.

The photoelectric transmitter shown in Figs. 1 and 8 may be balanced on a selected portion of the original blank 29 by closing a switch 245, Fig. 8, and manipulating the control 204 which is connected to the balancing photocell 201, correct balance being indicated by a minimum de-

lection of the milliammeter 242. The switch 245 is employed because the electronic devices 237 are heavily biased negatively for class C operation, and if this bias is not reduced in some manner the small output from the photoelectric pickup device when it is nearly balanced may not be indicated by the milliammeter 242. A modification of the foregoing balancing procedure is to direct the beam which is projected into the photocell 200 upon the lightest portion of the original which is to be reproduced, for example, a pencil mark, and adjusting the amplifier control so that the stylus will just mark the recording sheet 35. With this setting anything lighter in shade than the portion of the original selected for the balancing operation will not cause energization of relay 241, and hence will not cause the stylus to mark the sheet. The adjustment of the pickup by balancing it on a selected portion of a given shade on the original in conjunction with the resistance and condenser combination illustrated provides a definite working range between light and heavy marks on the original which is desirable in the case of "mark" and "no-mark" characteristics of a coated stencil sheet on which recording may be effected, that is, a minimum threshold value of stylus marking action at any desired density of shade on the original.

In order to save operating time and cause the scanning operation by the transmitter of the transmitter-recorder of Fig. 1 to stop approximately as soon as the subject matter on the original blank 29 has been scanned, irrespective of the length of the blank as measured longitudinally along the transmitting cylinder, a switch 300 is provided, which switch may be mounted on the traveling carriage of the recording unit 70, the switch being connected, as by a flexible cord, in series with a carriage limit switch 301. Either of the switches when operated to open circuit position will cause the driving motor and hence the scanning units to stop. Coacting with the switch 300 is an actuating unit 302 therefor, which as shown in Fig. 1 may comprise a collar or sleeve member 303 that has a relatively close fit with the guide rod 23 on which it is mounted, the member 303 being slidable longitudinally along the guide rod and thus readily settable to different machine stopping positions corresponding to various positions of the transmitter at the time the subject matter on the transmitting blank has been completely scanned. As shown, the adjustable unit 303 has a spring member 304 carried thereby, which spring member resiliently engages in a spline 305 in the guide rod 23, thereby to prevent rotation of the unit about the guide rod and also to frictionally engage the guide rod so that the unit will remain in any adjusted position. The portion 302 of the unit 303 carries an adjustable switch-actuating pin 306 which is in the path of travel of the switch 300 and which operates to open the normally closed contacts of the switch when the line feed movement of the transmitting carriage has caused the latter to completely scan the subject matter on the transmitting blank, thereby automatically stopping the transmitting and recording operations.

The unit 303 is manually set by the operator prior to the scanning operation of any given subject matter, and to determine readily the setting to which the unit should be placed there are provided corresponding calibrated scales 310 and 311 whereby the operator may place the subject matter sheet on the transmitting drum and visually discern the proper mark on the scales 310 and

then set the unit 303 to the corresponding scale setting. In the event that the unit is not initially set or is improperly set, a rod 313 secured to the recording carriage unit will engage the carriage limit switch 310 and automatically stop the driving motor and the transmitting and recording apparatus so that no injury can occur either to the scanning apparatus or to the sheet or stencil by reason of overtravel of the scanning units.

In order to prevent injury or shock to the transmitting and recording units when they are moved to their initial starting positions, either manually or automatically, there is provided a buffer in the form of a dashpot 314, Fig. 1, mounted on the frame structure 20a, the dashpot having a plunger 315 which is held in its extended position by a compression spring within the dashpot cylinder. When the transmitting and receiving carriages are returned to the left, a stop member on the transmitting carriage engages the end of the piston 315, and as this movement of the units toward the left is continued the spring within the dashpot 314 is compressed so that it prevents undue shock to the units, the structure also providing a suitable means for limiting the extent of movement of the units toward the left and determining the desired initial starting position of the units.

Other and additional control circuits and devices for controlling the operation of the recorder, particularly when it is connected to an incoming line instead of to the transmitter as shown in Fig. 8, and for maintaining a distant transmitter and the local recorder in proper phase relation, may of course be employed, various kinds of which circuits and devices suitable for the purpose are known in the facsimile recording art, for example, as shown in Patents Nos. 2,260,862, 2,255,868, 2,262,715 and 2,301,024.

Fig. 7 of the drawings shows a modified form of the recording unit in which the stylus 33' is held against the teeth of a ripple cam 71' by means of a taut wire preferably composed of steel piano wire, the wire 350 acting as a return spring for the stylus 33'. The stylus or hammer 33' is vibrated at a high frequency by means of the cam 71' and a cam follower portion 351 formed on the stylus. The wire 350 is maintained taut by means of two studs 352 which are threaded into a bracket member 353 and maintained in their adjusted positions by lock nuts 354, the studs 353 being rotatably adjustable to give the desired tension to the wire 350. The bracket 353 may be firmly mounted on the unit by means of the machine screws or bolts 95' which also serve as clamping members of the electromagnetic relay structure. The manner of controlling the marking and non-marking positions of the stylus 33' is essentially the same as that employed in connection with the form shown in Figs. 2 to 5 hereinbefore referred to.

Marking may be effected by the recorder upon various types of stencil sheets and printing plates known in the art, including mimeograph, hectograph and other forms of stencils, and planographic aluminum or similar printing sheets. In the case of such printing plates or sheets it will be understood that a transfer medium such as a sheet, ribbon or other carrier for a marking or image-forming substance is interposed between the stylus and the printing sheet or plate. Also, records may be made upon the surface of one or more sheets of paper or other record receiving sheets by means of carbon paper, ribbons or other transfer sheets in contact with the record receiv-

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ing sheets, the uncoated side of the carbon paper or other transfer sheet ordinarily being exposed to the action of the stylus, although for certain purposes the carbon or other transfer sheet may be placed beneath the sheet or sheets on which the record is produced, thereby to mark the underside of the record sheets.

The invention has been illustrated and described in connection with facsimile recording apparatus, but it is to be understood that the recorder may be employed to record various types of signals other than facsimile signals, for example, to produce charts, graphs or other records by signals generated in accordance with various conditions to be recorded. Various other forms, modifications and uses will suggest themselves to those skilled in the art without departing from the spirit of the invention, and therefore the invention is not to be regarded as limited except as indicated by the scope of the appended claims.

I claim:

1. Apparatus for recording on a record sheet, comprising a platen for supporting said sheet during recording operations, means including a recording stylus for causing marking impacts intermittently to be applied to said record sheet to mark the same in accordance with received marking and spacing signals representative of the subject matter to be recorded, said platen and stylus being mounted so as to enable relative movement between them alternatively to position them into marking position and out of marking position with respect to the record sheet, mechanical driving means for vibrating said stylus in a direction towards and from the record sheet to cause the same to impinge upon the record sheet with a predetermined constant pressure which is independent of the signal level of the received marking signals, and means responsive to said received marking and spacing signals for effecting said relative movement between the platen and the oscillating stylus selectively to position at least one of them into and out of marking position to produce a record corresponding to said received signals.

2. Apparatus for recording on a record sheet, comprising means including a recording stylus for causing marking impacts intermittently to be applied to said record sheet to mark the same in accordance with received signals representative of the subject matter to be recorded, said stylus being mounted so as to be alternatively movable into marking position and out of marking position with respect to the record sheet, means including a rotating cam having a plurality of lobes thereon and a cam follower engaging said lobes for mechanically vibrating said stylus at a predetermined rate, and means responsive to said received signals for causing the vibrating stylus selectively to be actuated into and out of marking position to produce a record corresponding to said received signals.

3. Apparatus for recording on a record sheet, comprising means including a recording stylus for causing marking impacts intermittently to be applied to said record sheet to mark the same in accordance with received signals representative of the subject matter to be recorded, said stylus being mounted so as to be alternatively movable into marking position and out of marking position with respect to the record sheet, a rotatable flutter cam having a series of cam surfaces thereon, a motor for rotating said cam at a constant speed, a cam follower engaging said cam surfaces, means for causing said rotating cam

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and cam follower to vibrate said stylus at a predetermined rate, and means responsive to said received signals for causing the vibrating stylus selectively to be actuated into and out of marking position to produce a record corresponding to said received signals.

4. Apparatus for recording on a record sheet, comprising means including a recording stylus for causing marking impacts to be applied to said record sheet to mark the same in accordance with received marking and spacing signals representative of the subject matter to be recorded, said stylus being mounted so as to be alternatively movable into marking position and out of marking position with respect to the record sheet, mechanical driving means for vibrating said stylus in a direction towards and from the record sheet to cause the same to impinge upon the record sheet with a predetermined constant pressure which is independent of the signal level of the received marking signals, means responsive to said received marking and spacing signals for producing signals of different polarity respectively corresponding to said marking and spacing signals, and means including an electromagnet responsive to said signals of different polarity for causing the vibrating stylus selectively to be actuated into and out of marking position to produce a record corresponding to said received marking and spacing signals.

5. Apparatus for recording on a record sheet, comprising means including a recording stylus for causing marking impacts to be applied to said record sheet to mark the same in accordance with received signals representative of the subject matter to be recorded, said stylus being pivotally mounted so as to be alternatively rotatable into marking position and out of marking position with respect to the record sheet, mechanical driving means for vibrating said stylus at a predetermined rate, and means including an electromagnet and an associated armature responsive to said received signals for causing the armature to move to one position when marking signals are being received and to another position when spacing signals are being received, said armature providing said pivotal mounting for said stylus and rotating the stylus selectively.

6. Apparatus for producing in facsimile on a record sheet a copy of a picture, drawing, writing or other subject matter, comprising a travelling scanning carriage, a percussive recording stylus mounted on said carriage for causing marking impacts intermittently to be applied to said record sheet in accordance with received facsimile signals, means mounted on said travelling carriage for mechanically vibrating said recording stylus at a constant speed and at a constant amplitude irrespective of the amplitude of said signals, means including said carriage for causing the vibrating stylus to scan the record sheet, and means responsive to received facsimile signals for causing the vibrating stylus selectively to be actuated to a position for applying marking impacts to said record sheet and to a position to prevent the stylus from applying marking impacts to the record sheet in accordance with said received signals.

7. Apparatus for producing in facsimile on a record sheet a copy of a picture, drawing, writing or other subject matter, comprising a scanning carriage, a percussive recording stylus mounted on said carriage for causing marking impacts intermittently to be applied to said record sheet in accordance with received facsimile

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signals, means including motor driven cam members mounted on said carriage for vibrating said recording stylus at a constant speed and at a constant amplitude irrespective of the amplitude of said signals, means including said carriage for causing the vibrating stylus to scan the record sheet, and means responsive to received facsimile

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signals for causing the vibrating stylus selectively to be actuated to a position for applying marking impacts to said record sheet and to a position to prevent the stylus from applying marking impacts to the record sheet in accordance with said received signals.

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