No. 755,646. PATENTED MAR. 29, 1904.

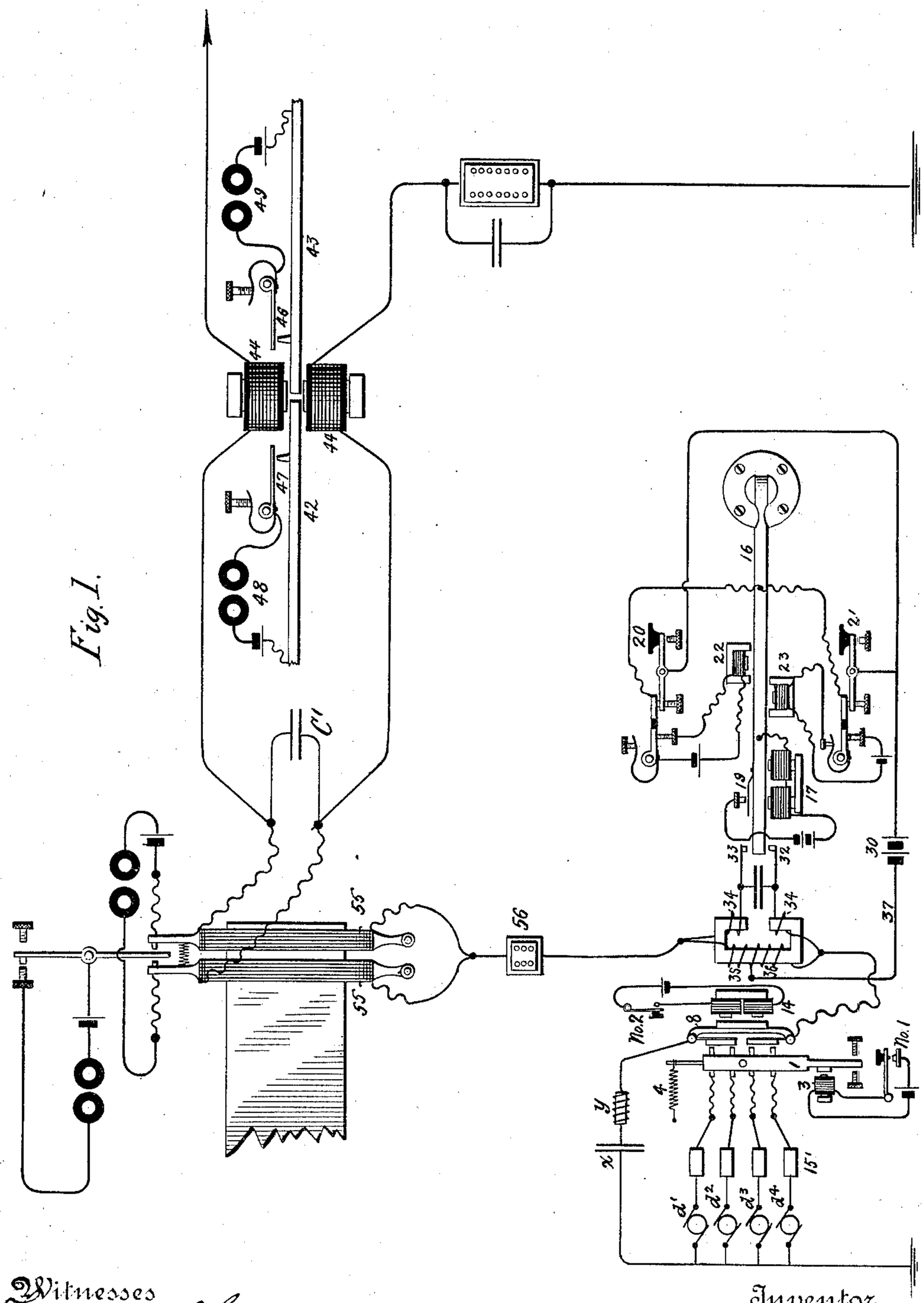
S. D. FIELD.

MULTIPLEX TELEGRAPHY.

APPLICATION FILED MAR. 5, 1903.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.



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MULTIPLEX TELEGRAPHY.

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NO MODEL. 5 SHEETS—SHEET 2.

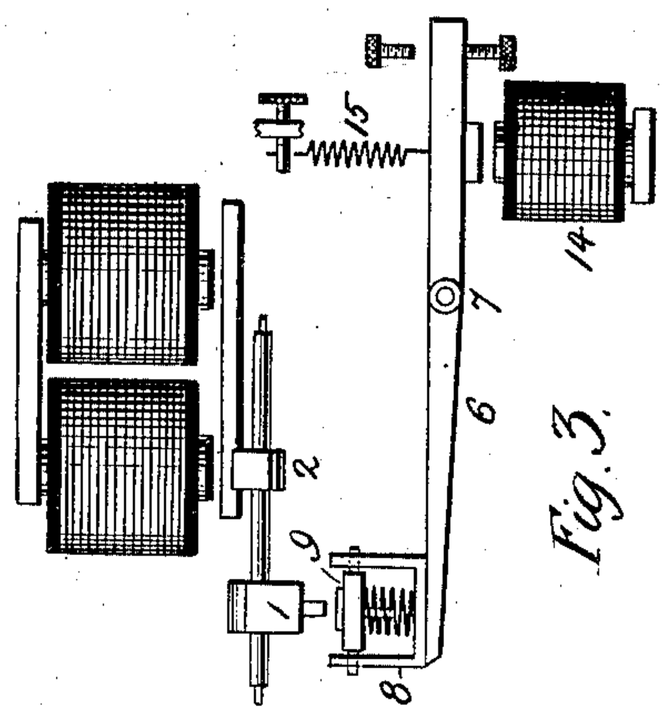

Fig. 3.

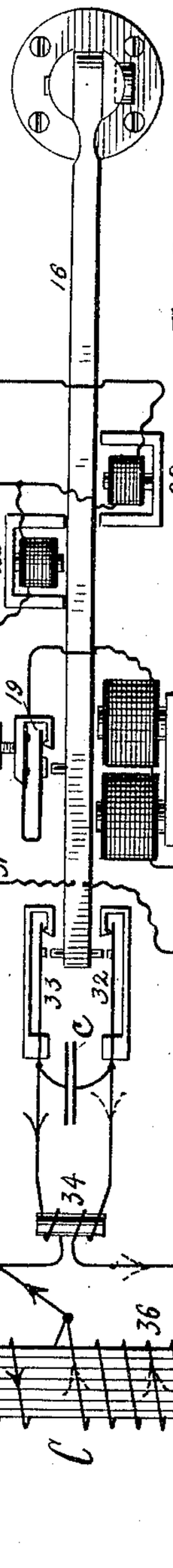

Fig. 4.

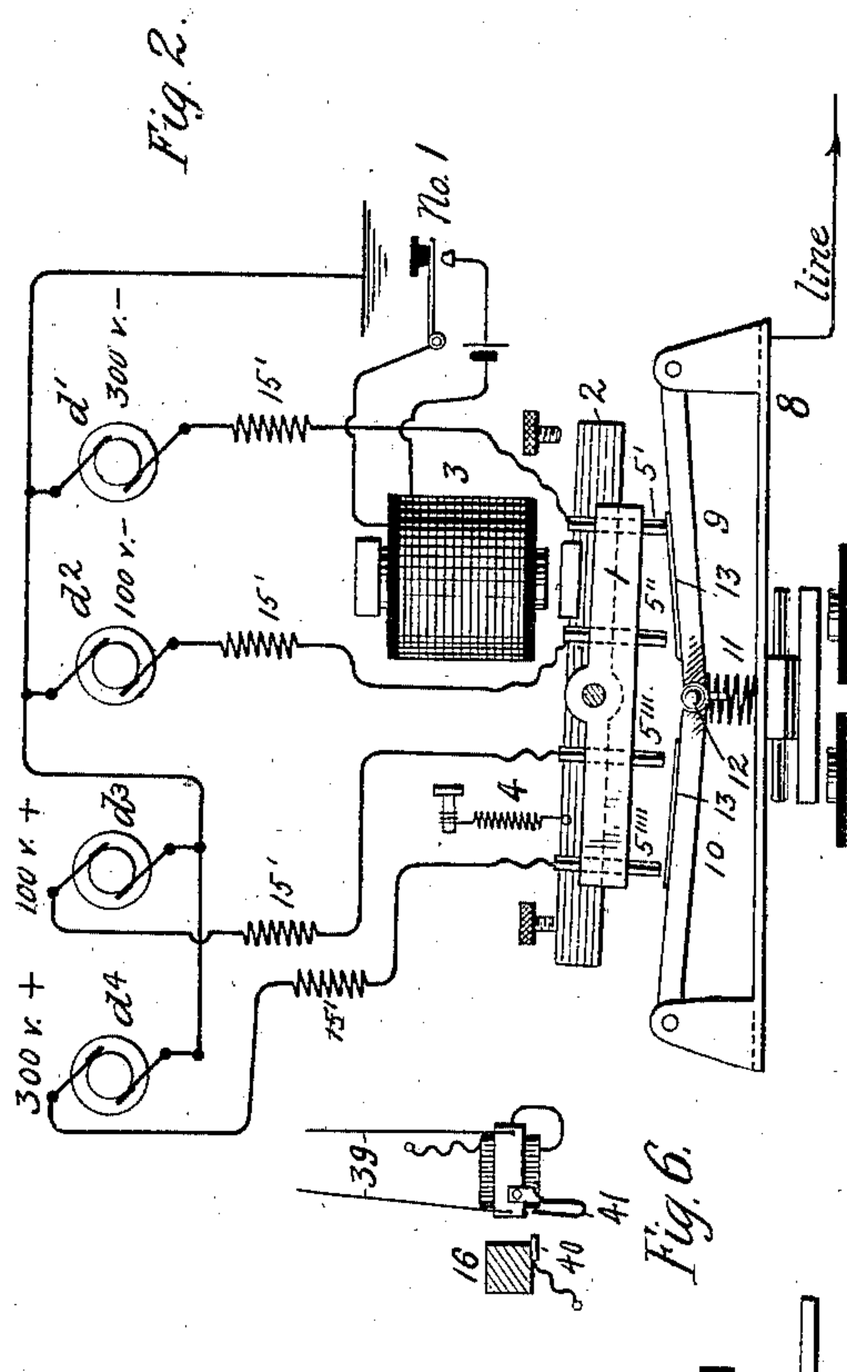

Fig. 6.

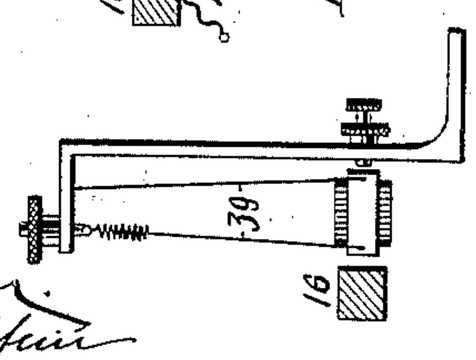

Fig. 5.

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NO MODEL. 5 SHEETS—SHEET 3.

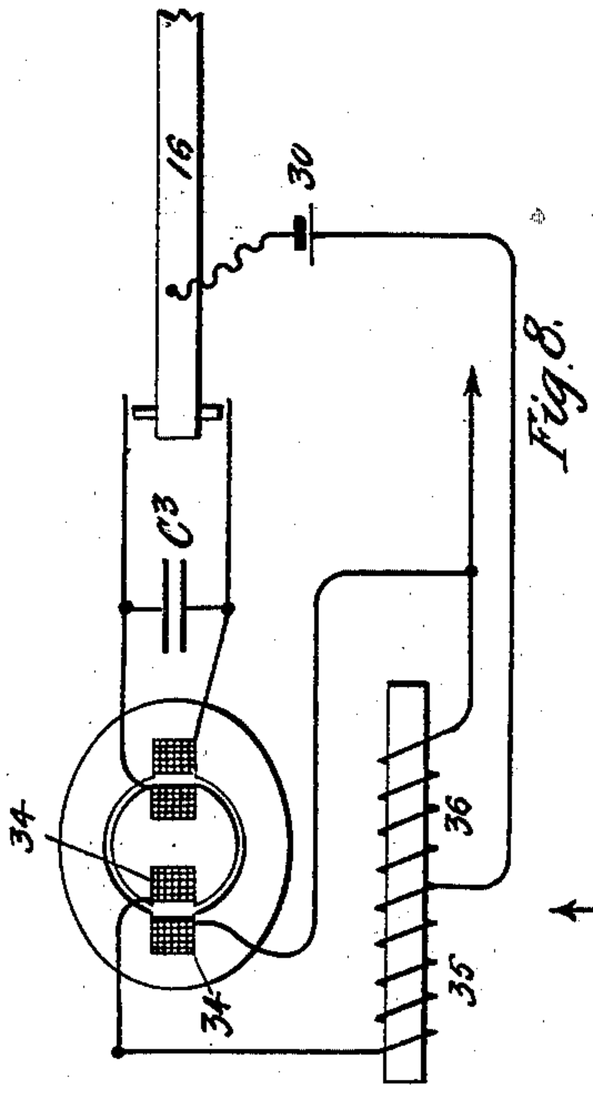

Fig. 8.

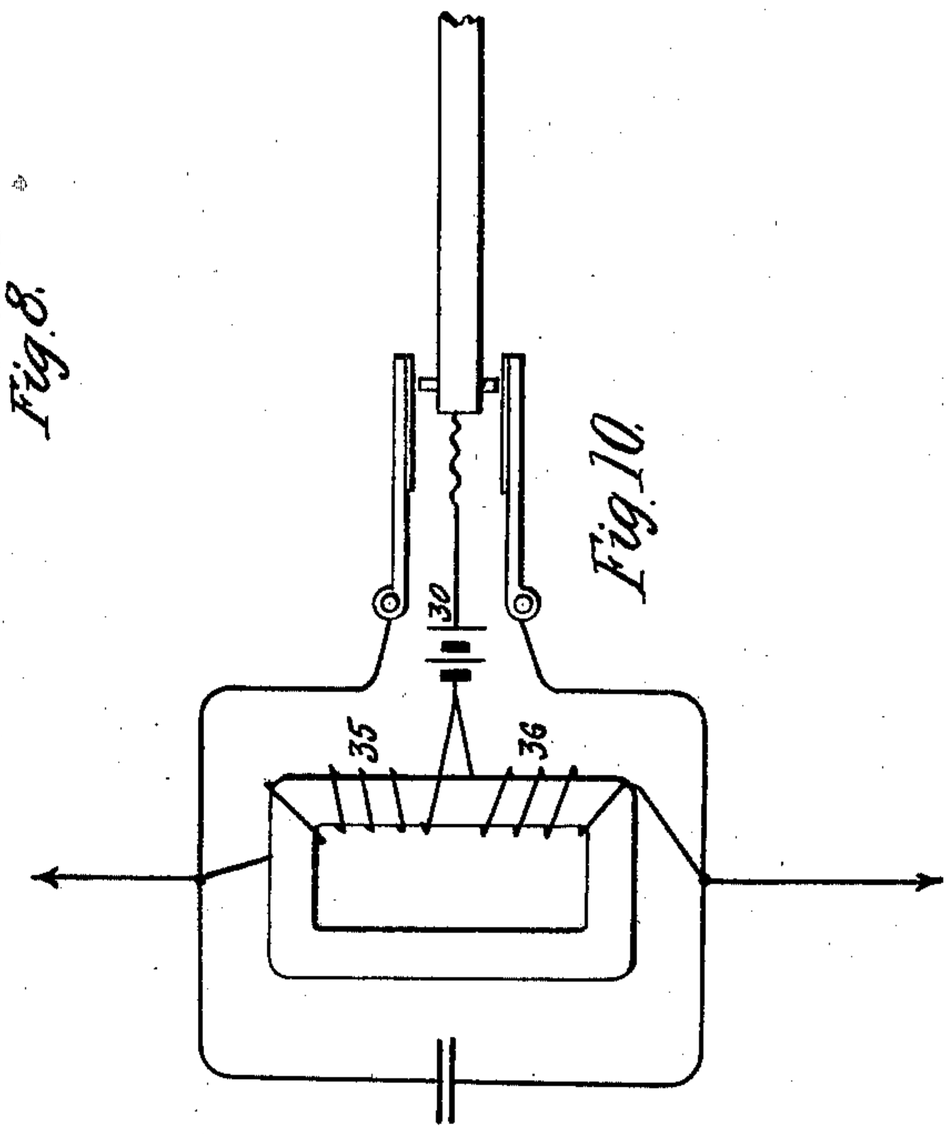

Fig. 10.

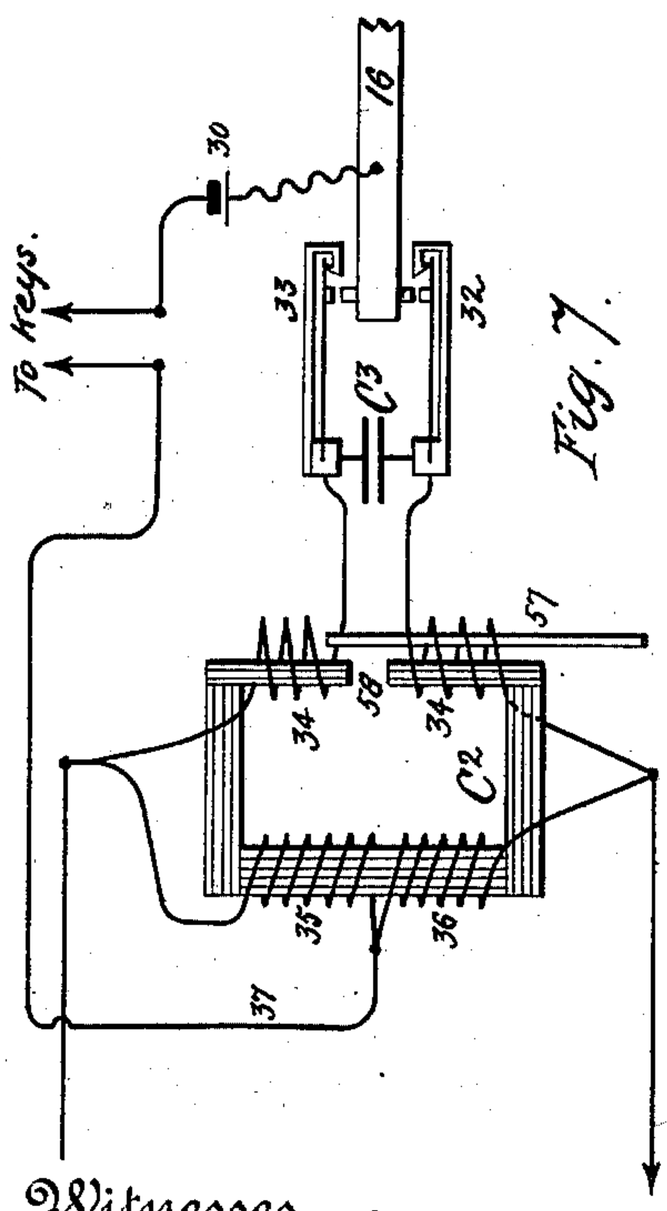

Fig. 7.

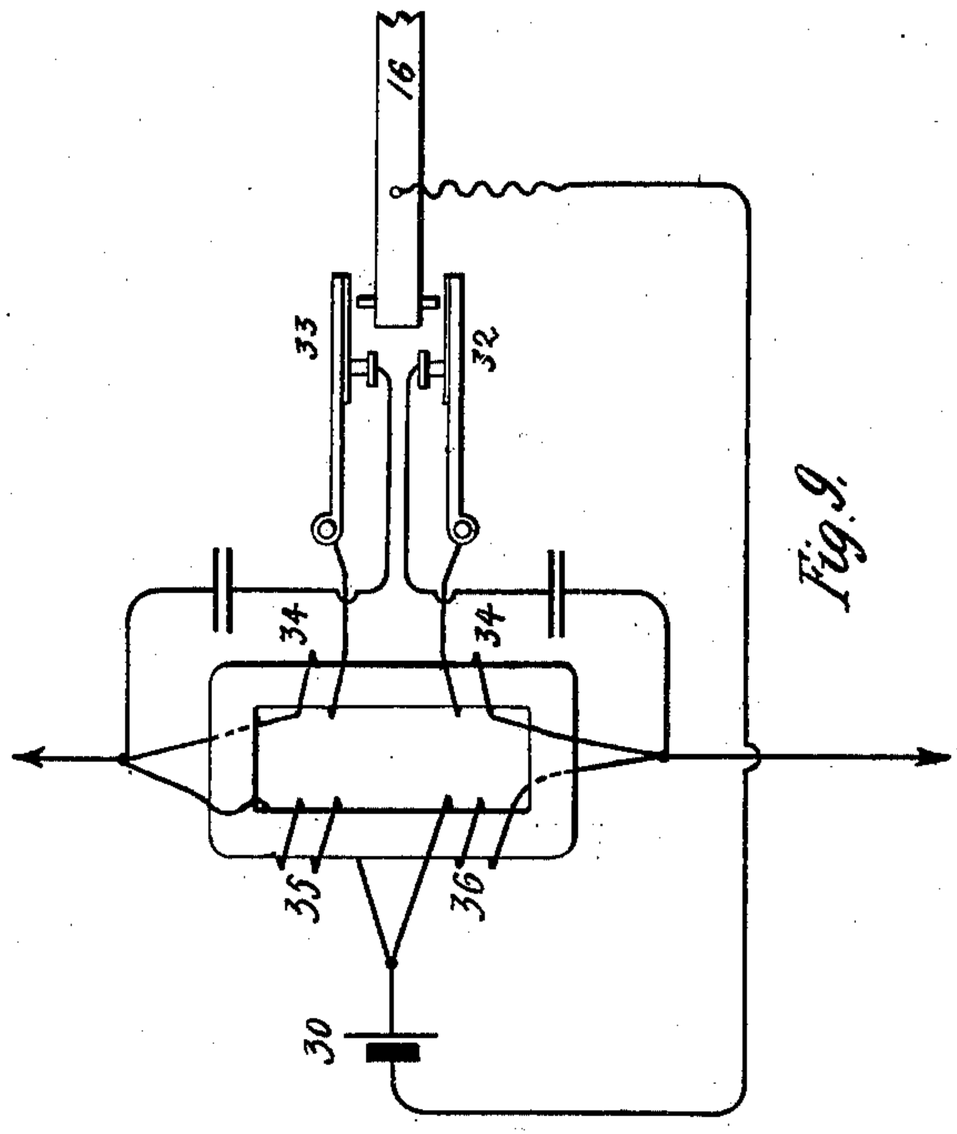

Fig. 9.

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MULTIPLEX TELEGRAPHY.

APPLICATION FILED MAR. 5, 1903.

NO MODEL. 5 SHEETS—SHEET 4.

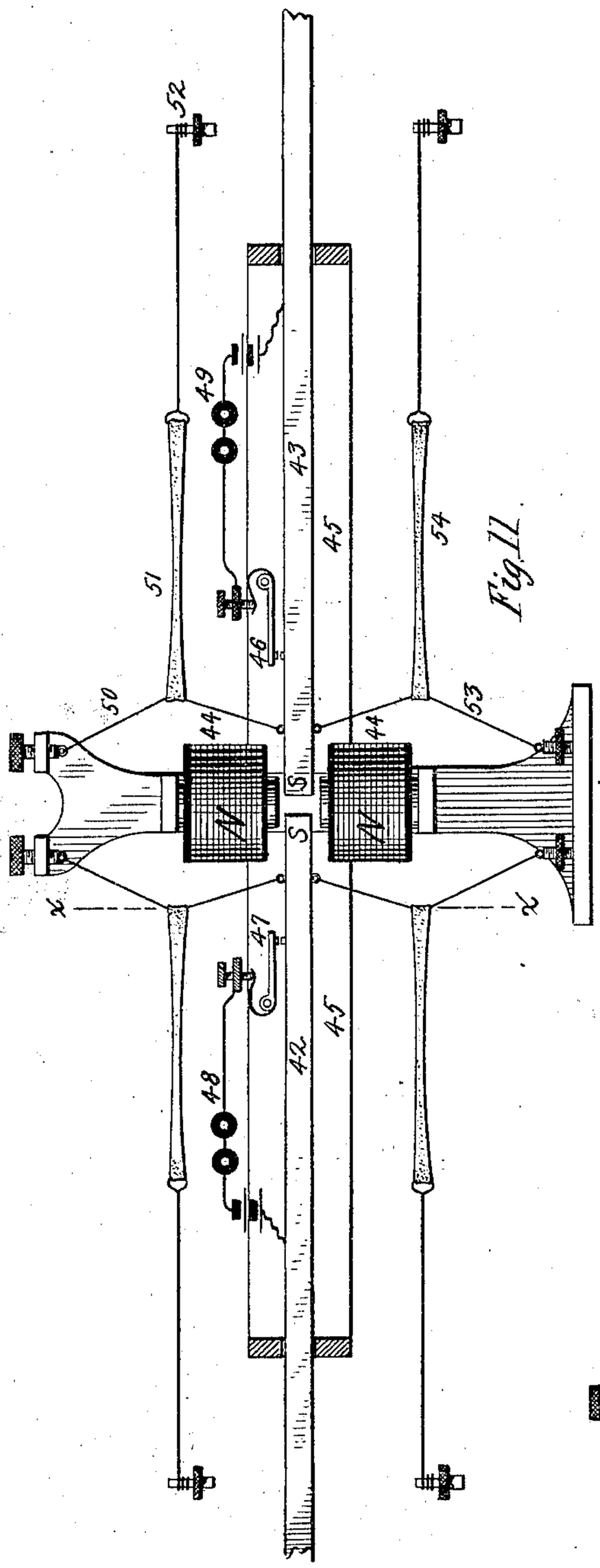

Fig. 11.

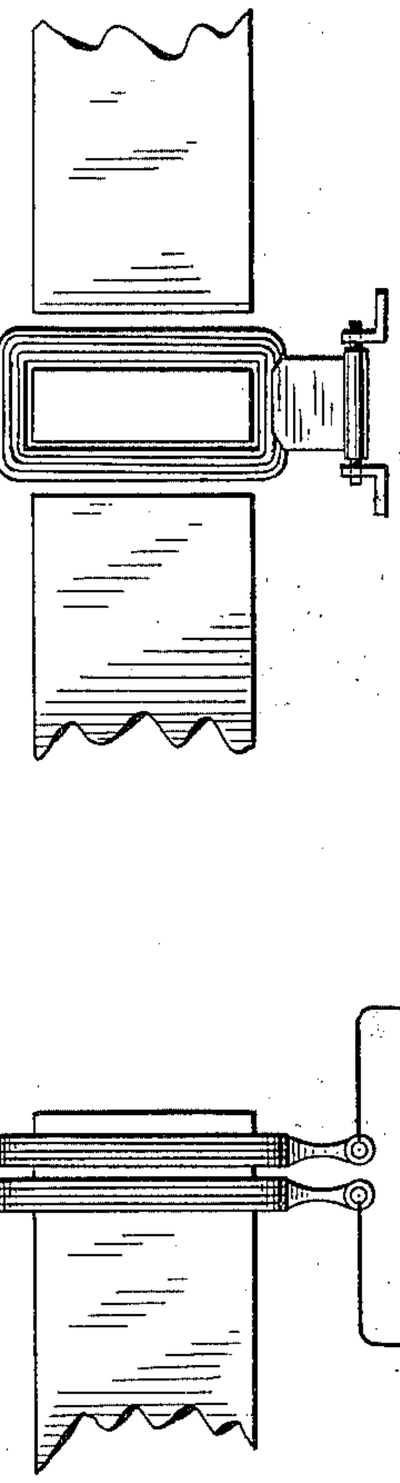

Fig. 15.

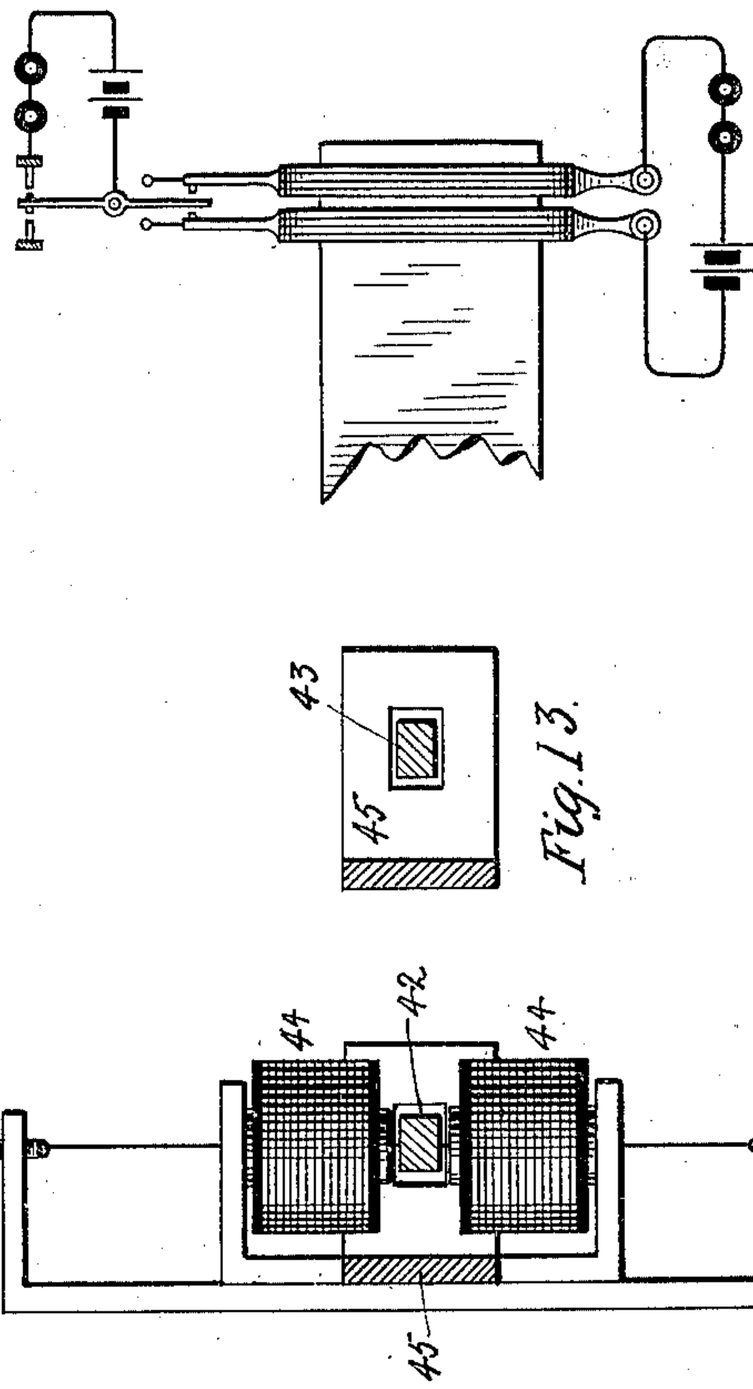

Fig. 14.

Fig. 13.

Fig. 12.

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MULTIPLEX TELEGRAPHY.

APPLICATION FILED MAR. 5, 1903.

NO MODEL. 5 SHEETS—SHEET 5.

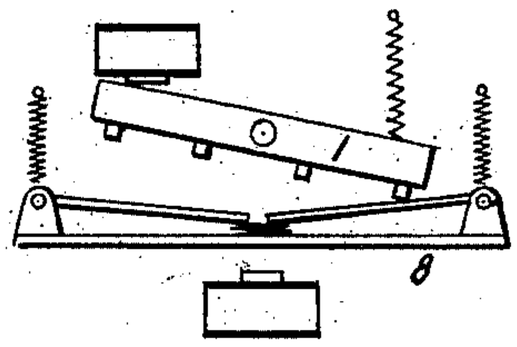

Fig 16

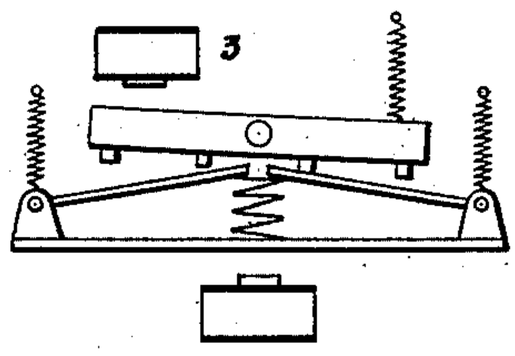

Fig 17.

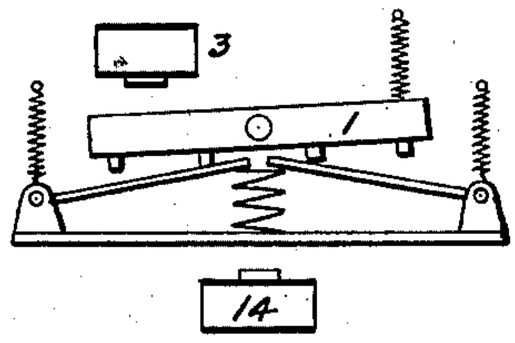

Fig 18.

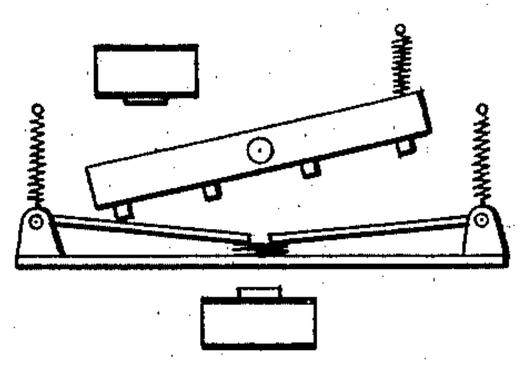

Fig 19.

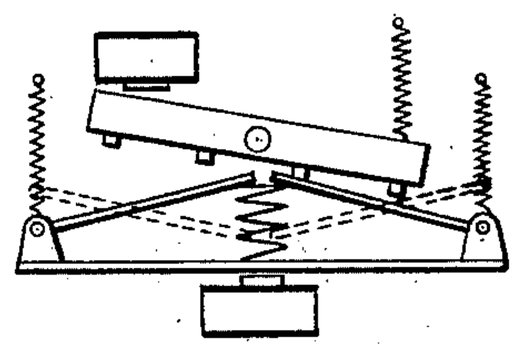

Fig 20.

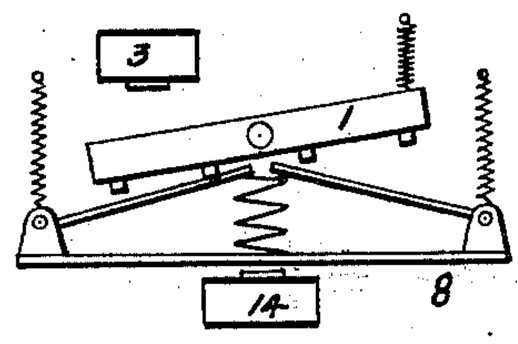

Fig 21.

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No. 755,646. Patented March 29, 1904.

UNITED STATES PATENT OFFICE.

STEPHEN DUDLEY FIELD, OF STOCKBRIDGE, MASSACHUSETTS.

MULTIPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 755,646, dated March 29, 1904.

Application filed March 5, 1903. Serial No. 146,313. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN DUDLEY FIELD, a citizen of the United States, residing at Stockbridge, in the county of Berkshire and State of Massachusetts, have invented certain new and useful Improvements in Multiplex Telegraphy, of which the following is a full, clear, and exact description.

The object of this invention is to improve multiplex telegraphic apparatus, this specification describing means whereby a multiplicity of separate messages can be transmitted simultaneously upon a single telegraphic circuit.

The novelty of the herein-described system consists in certain improvements in the key system of what is known as the "dynamo quadruplex," first invented and introduced by me, and various improvements upon certain subsequent patents granted me which render this combination possible, in a new circuit and mechanical arrangement of the apparatus described in my Patent No. 403,258, and in certain improvements in receiving apparatus to be used therewith. To avoid repetition and for accurate description, attention is called to my United States Patents Nos. 389,883 and 503,590 for description of certain portions of the herein-described receiving mechanism.

In the operation of quadruplex apparatus, wherein one message is sent by current reversals while another is transmitted by variations in current strength irrespective of polarity, it has been customary to use two separate keys respectively devoted to the two transmissions outlined above. Such organization of apparatus brings in more or less irregularity of action, principally for the reason that changes of circuit resistance are experienced during the time of passing contacts on the keys, while the abrupt change of potential occurring when the keys combine to change from a weak positive to a strong negative, or vice versa, makes a condition of current change extremely difficult to balance.

My improvement in the first key system consists in combining the two keys into one mechanism so arranged that all parts work in unison with each other; also, to so arrange such action that abrupt reversals are avoided, all current reversals being made by a series of steps instead of the abrupt transition at present employed.

In the second key system, whereby I impose two or more additional transmissions upon the two already effected, I make use of a principle first enunciated in my Patent No. 403,258; but the mechanical details herein shown are so widely different as to make the present a substantially new invention.

In the receiving mechanism I employ as a receiving agency for the first two transmissions the relay shown and described in my Patent No. 389,883. For receiving the two superimposed transmissions described ordinary tuned reeds are employed, which in themselves are very old in the art. I have, however, added to these reeds certain devices to render them less responsive to non-related currents, the principles of which are shown in my Patent No. 503,590, Sheet 5, Figs. 8 and 9, the specific arrangement herein shown being of different mechanical construction and somewhat dissimilar action.

As has been stated, the two first transmissions are produced, as usual, by reversals and varying strength of current; the next two by vibrations of a certain individual frequency when working singly, but of a frequency common to both receiving-reeds when the two are jointly actuated. The tuning of these transmissions may be considered as a refinement leading to still further additions, for the apparatus can be arranged to work by impulses of different polarity, so far as the two described transmissions are concerned, without departing from the novely of the present arrangement.

In the accompanying drawings the apparatus is shown more or less conventionally.

Figure 1 shows the general assemblage of transmitting and receiving apparatus at one terminal station. Figs. 2 and 3 are two views of a key apparatus for transmitting signals by current reversals. Fig. 4 is a view of a key apparatus for transmitting signals by vibratory currents of different periodicities.

Figs. 5 and 6 are details of portions of the apparatus shown in Fig. 4. Figs, 7, 8, 9, and 10 are modifications of features of the vibratory-current transmitter. Figs. 11, 12, and 13 are views of the vibratory-current-receiving apparatus. Figs. 14 and 15 are views of the relay responsive to current reversals. Figs. 16 to 21 illustrate the operation of the first and second transmission keys.

Referring to Figs. 2 and 3, 1 is a rocking bar on the same axis with a lever 2, which is actuated by a magnet 3 and spring 4, the magnet being controlled by finger-key No. 1 of the first transmission. The rocking bar is provided with the usual limit-stops and spring adjustments. Bar 1 carries contact-pins arranged in succession two on each side of the fulcrum and lettered, respectively, 5′, 5″, 5‴, and 5⁗. These pins are connected with sources of electricity d', d^2, d^3, and d^4, respectively, ranging from a maximum negative voltage to a maximum positive voltage, substantially as follows: Pin 5′ is connected, say, with three hundred volts negative; pin 5″ with one hundred volts negative; pin 5‴ with one hundred volts positive, and pin 5⁗ with three hundred volts positive, the opposite poles of all sources being grounded. 6 is a lever pivoted at 7 and carrying at one end a frame 8 to the extremities of which are pivoted lever-contacts 9 and 10, supported at their adjoining ends by a spring 11, which acts upon a loose ball-joint 12 between the ends of the levers. Each lever carries a contact-plate 13, one of which is adapted to collide with the pins 5′ and 5″ and the other with the pins 5‴ and 5⁗. Lever 6 is controlled by finger-key No. 2 of the second transmission, which controls a circuit containing magnet 14, acting upon an armature attached to the end of the lever. The spring 15 opposes the magnet, and the usual limiting-stops and adjustments are provided. Frame 8 is connected to line.

The operation of the apparatus so far described is as follows: Referring to Figs. 16 to 21, wherein the position of magnet 3 and spring 4 are reversed with respect to Fig. 2 and magnet 14 is directly beneath frame 8, so that when energized it will pull said frame down, let us assume that magnet 3 is energized and key No. 1 is operating, while magnet 14 is idle. Under these conditions a current of three hundred negative will pass to line via contact 5′ and lever 9, the contact position being as shown in Fig. 16. Opening the circuit of magnet 3 will shift the position of bar 1 and send to line the following sequence of currents: first, contact 5″ and lever 9 collide, separating 5′ from lever 9 and diminishing current on line to one hundred negative, as seen in Fig. 17; second, immediately succeeding this contact 10 engages 5‴, separating 9 from 5″ and changing line potential from one hundred negative to one hundred positive, as seen in Fig. 18; third, upon the completion of the excursion of the rocking bar contact 5⁗ collides with lever 10, separating it from contact 5‴ and bringing to line a potential of three hundred positive, as seen in Fig. 19. A reversal has now been accomplished on the line by a series of steps, each of the value of two hundred volts, instead of a sharp reversal of three hundred negative to three hundred positive, as with the practice heretofore.

It is the common practice to incorporate two ohms per volt as battery resistance, with the consequence that a disturbance of three hundred ohms occurs at the time of passing contacts, caused by the paralleling of the two battery resistances of six hundred ohms to each potential of three hundred volts. In my arrangement above described but two hundred ohms, (indicated at 15′,) are employed between each contact-point and its attached dynamo. Consequently the simultaneous closing of any two points produces a circuit irregularity due to the paralleling of two hundred volts or one hundred volts only. Besides, this short-circuiting is of but half the duration of the present system, as here both contacts are in motion, the one advancing and the other receding from the contact-lever.

The operation of the No. 2 key can best be considered by regarding key No. 1 as idle with circuit closed and key No. 2 as open, in fact, as indicated in Fig. 16, full negative current being on the line. The closure of No. 2 key lowers frame 8, carrying the two lever-contacts, which causes the latter to assume the position shown in full lines in Fig. 20, where the line potential has been reduced from three hundred volts negative to one hundred volts negative, a difference that would be responded to by the No. 2 receiving apparatus to be referred to hereinafter. If key No. 1 remains inactive, the opening of No. 2 would return the contacts to the position of Fig. 16, giving another change of strength of potential to line—to wit, three hundred negative; but if key No. 1 should become active in the position Fig. 20 the current will change from one hundred negative to one hundred positive, as seen in Fig. 21. If now No. 2 should open the current, change will be from one hundred positive to three hundred positive, as seen in Fig. 19. We therefore have a single key capable of four different positions without any possibility of conflicting action. The step-by-step changes of polarity, as well as the changes in strength of current, are effected as regularly as the finger-keys are operated. Again, we have all the safeguards of two ohms per volt at all times of the operation, while at all times this resistance is the same for both high and low currents, although the high potential of three hundred volts positive or negative when on line has but two hundred ohms resistance in its path. The receiving part of these first two transmissions is adapted to the relay shown by me in Patent No. 389,883 and needs

no further description, save that the usual electrical balance with rheostat and condenser is employed.

Coming now to the key system devoted to the two or more superposed transmissions, we have a form of tuned reed or other harmonious vibrating agent which can be kept in continuous rythmical vibration by a magnet with an ordinary make-and-break attachment. Attached to this fork are two contacts with spring-points opposing them. Parallel to the fork are two small magnets so arranged that when energized they will attach themselves to the fork and by their weight and relative point of attachment more or less govern the periodicity of the fork. Two tuned reeds, to be hereinafter described, are provided at the distant station to act as a receiving medium. The fork being in continuous vibration its action on the distant reeds is governed in three different ways. Thus when vibrating freely its rate is such that it becomes a multiple or submultiple of both of the distant reeds. Consequently both will respond. With one magnet attached as weight its rate will be changed, so that but one distant reed acts, while the other magnet-weight is so positioned that when brought into action alone it will govern the remaining reed. Therefore it is only necessary to so arrange the parts that one key will send vibrations governed by one magnet-weight, the other by its mate, while in the event of a simultaneous depression of both keys the transmitting-reed will run free, the consequent line impulses catching both distant reeds. It will be seen that a single pair of contact-points at the home station will suffice for the dual transmission, and since they are in continuous operation they present a uniform and different resistance to line from that of contacts normally at rest.

In Fig. 4, 16 is the vibrating reed kept constantly in motion by magnet 17, actuated by battery 18 under control of contacts 19. When in a state of inoperation, keys 20 and 21 are open, magnets 22 and 23 firmly attached to the reed, which then is vibrating at its lowest possible rate. Assuming key 20 to be closed, contacts 24 and 25 separate, magnet 22 is disengaged from the reed, which latter now instantly takes up a higher rate of vibration, which has been regulated to be in accord with the distant reed tuned to be in touch with key 20. If now key 21 be depressed, key 20 remaining in action, contacts 26 and 27 will separate, magnet 23 will be detached, and the reed will take up a very much more rapid vibration—in fact, a vibratory rate which has been primarily adjusted to harmonize with both of the distant reeds. Releasing key 20 by reverse action causes magnet 22 to attach itself to the reed, thus bringing its rate of vibration down instantly to coincide with the frequency devoted to key 21. Releasing key 21, magnet 23 attaches itself to the reed, which at once assumes a slow rate of vibration, to which neither of the distant reeds need be subject. The various ramifications incident to this method of working are endless, they being in the general line of Patent No. 403,258. Continuing in the same manner, as many separate transmissions can be attached to a single fork or vibrating medium as are possible within the range of non-conflicting harmonious tones. The closure of the key 20 also closes a pair of contacts 28 29 simultaneously with the opening of 24 and 25. When 28 29 collide, current flows from battery 30, via wire 31, to reed 16. The circuit thence is completed either through contact 32 or contact 33, coil 34 to winding 35 or 36 of coil C, returning via wire 37 from the center of coil C to contact 28 of key 20. The reed being now under vibration comes in contact alternately with 32 or 33, the effect being to turn coil C into a divided coil, in which branches 35 and 36 make rapid exchange of relations as regards the line and the currents induced within the coil. These contact-points 32 and 33 are in direct connection, as seen, with the terminals of the simple coil C, wound around a well-laminated core. At or about the exact middle of this coil-winding the tap 37 is taken off which leads to the contacts on both of the transmitting-keys. From the opposing contacts on these keys the circuit leads to the reed through battery 30, where it finds its home in two platinum contacts, which engage during the reed's vibration with the pair of contact-points 32 and 33 above mentioned. The subsidiary induction-coil 34, inserted between the reed-contacts and the simple coil C in the line-circuit, is so wound and connected that the battery emanating from the reed is caused to pass alternately through the windings in opposite directions. Its core is laminated and adjustable. This coil has a dual use, first, to prevent sparking at the reed's contacts (the spark mainly coming from the line;) secondly, to eliminate the crest of the induced current proceeding from the line-coil when energized by the current.

Assuming that at the instant the contacts 33 are closed the course of the battery-current is indicated on the figure by full-line arrows, while that of the consequent induced currents relied upon for work at the distant station by dotted arrows, Fig. 4, the return vibration of the reed effects an equal and opposite action, giving true reversals on the line which are tempered and deprived of their crests by the action of the differentially-wound intermediate coil 34.

The extra or induced current indicated by dotted arrows exists only at the instants of separation of contact-points. It is usually evidenced by a spark and is in the same direction as the magnetizing-currents. After the points 32 separate there will be no induced current on that side, as there is no circuit for such.

An extra current also proceeds from the coil 36; but its effect on the line is offset largely by the value of the contrary potential delivered by core 34. The snap or jerk or false impulse due to the spark does not get to line. On the other hand, coil 34 by its retarding capacity delays the energizing of coil 35, and thus still further rounds off the induced current delivered to line by coil 36. In dealing with high vibrations this crest of current is of extreme embarrassment, it being of high and abnormal potential, wanders in every direction either by induction or direct leakage, and has hitherto been one of the most prominent bars to the utilization of harmonic vibratory telegraphy on a large scale. By my arrangement it is completely under control.

Fig. 5 shows the method of hanging the rate-regulating magnets, which consists of a suspension on fine wires or cords 39, too obvious in action to demand further description.

Fig. 6 shows a modification to be used when large rate-magnets are employed with comparatively feeble reeds. In such cases there is a tendency to mar the rythm of vibrations when the magnet contacts with the reed at a time when the reed is making its approach. The blow or impact will tend to halt the reed and for an instant interrupt the sequence of vibrations. The battery actuating the rate-magnet is caused to pass through a pair of minute contacts 40 and 41, which are only closed when the reed is in the immediate proximity of the magnet. Thus the magnet is made to collide and accompany the receding vibration of the reed instead of halting the same by meeting its approach. The cross-piece at the back of the rate-magnet is thinner than the pole-pieces extending from it, so that a slight spring tension will be stored in it to afford a prompt detachment of the magnet from the reed on the cessation of current.

Figs. 14 and 15 represent the apparatus described in my Patent No. 389,883, and further reference at this point is unnecessary.

Figs. 11, 12, and 13 represent the method employed in mounting the tuned reeds utilized as a receiving agency for the vibrations. I will here remark that the tuned or harmonic effect is only requisite when more than two vibratory transmissions are desired.

The reeds 42 and 43 are mounted to form two equally-polarized tongues or armatures of a polarized relay, both reeds or tongues being actuated by the same magnetic circuit as composed by electromagnets 44. Steel-bar magnets 45 are employed to polarize the system in the usual manner, the method of communicating polarity to the reeds being represented graphically in section, Fig. 13. Ordinary vibratory local contacts are represented by 46 47, which respectively control sounders 48 49. It is a well-known principle in mechanics that true pendulum vibrations are of the nature of a cycloidal curve. When the arc of vibration of a pendulum is very short, as in ordinary clocks, the partial similarity of movement obtained by the ordinary blade-spring suspension suffices. When an abnormal arc of vibration is found, it becomes necessary to incase the suspension-spring with cheeks shaped to a true cycloid. As a tuning-fork is similar in its action to a pendulum, it becomes necessary that any stop or device hampering its movements must partake of the nature of a cycloidal curve; otherwise a hampering of the normal rate of the fork or reed will ensue.

I have found that the following device acts in the above-described manner and performs its function without in any way hampering the normal rate to which the reed has been tuned. I obtain this effect by attaching to the free end of the reed fine wires, cords, or strings, which while acting in the above-described manner will also afford a soft or yielding stop, the object of which is to prevent a too free movement of the reeds when moved by steady impulses due to the two primary transmissions. In previous systems a regular Morse current traversing the circuit has a tendency to draw the reed out of line. On the cessation of this current the reed flies back with a snap, the jar of which causes the "floating" contacts 46 47 to bound apart, and thus make a false signal on their controlled sounder. When, however, the home of the reed is made against a medium which rapidly and uniformly increases its resistance at a rate much more rapid than the gain of the square of the distance, (due to magnetic approach,) it will be seen that a limit to the reed's excursion is afforded, which is never final, but at all times elastic. I have found such a device in the arrangement presented, wherein 50 is a string, wire, or pair of bars articulated to form a knee-lever. 51 is a rubber band strained by capstan 52 to cause cord 50 to be slightly out of perpendicular, or bowed. Should reed 43 be attracted downward, it will yield until the decreasing leverage of string 50 and increasing drag of spring 51 equals or exactly balances the attractive force to which it has been subjected. It will then halt, not abruptly, but with a perfectly smooth cessation of movement quite without disturbance to contacts 46. The reverse movement of the reed experiences a similar halt by means of cord 53 and spring 54. Both reeds are similarly equipped. Fig. 12 is a section on line *x x* of Fig. 11, showing the well-known arrangement of the polarized magnetic circuit.

Fig. 1 shows the assemblage of apparatus at one terminal station. It may be assumed that the coils of the receiving instruments are double-wound and adapted to be differentially balanced for working simultaneously in both directions in the manner well known in the art. The usual condenser C′ serves to carry the vibrations equally through both coils 55 of the relay, while the small rheostat 56 is for

the purpose of diverting a sufficient amount of arriving current through both coils of the receiving instrument to counterbalance the halting effect due to the mutual induction which said coils have on each other when subjected to such arriving currents.

For the purpose of eliminating the spark at the contact-points of the transmitter, also to provide a separate and independent path to earth for the vibratory currents, a condenser *x* and small—almost microscopic—retardation-coil *y* is placed in a shunt leading from a point in the line-circuit between the battery-keys and the vibrator. The office of the condenser is self-evident. The slight drag of the retardation-coil serves to keep the contact-points from welding by the rush of current from the home battery into the condenser.

A modification of the coil-circuits (and one which is generally to be employed) is represented in Fig. 7. Here all the coils are assembled on a single laminated core C^2. The influence of coils 34 on said core is adjusted by incorporating more or less iron, such as 57, within the coils, thus bridging gap 58. An adjustable condenser c^3 also bridges the interior terminals of coils 34, serving to still further temper the delivered currents.

Instead of graduating coil 34 by the insertion of more or less iron, as above described, I can obtain any amount of drag by the arrangement shown in Fig. 8. Here one of the coils 34 is placed upon a shuttle-shaped armature of finely-laminated iron, the coil being wound with wire to a given resistance and number of turns. The armature is surrounded by a finely-laminated iron case, into which the other coil 34 is set and which is wound with an equal resistance and number of turns. By altering the angular position of the coils with respect to each other any degree of retardation within the range of the apparatus can be obtained.

Fig. 9 represents a modification wherein a peculiar circuit arrangement of reactionary coils and condenser is employed. Aside from the fact that outside currents traverse two condensers to escape the coil-windings while the local coil-actuating currents act upon one condenser at a time I am unable to explain the phenomena connected with its working. The result has been obtained by experiment. It is advantageous in many instances. Assuming the condensers to be one microfarad each, extraneous currents traversing the line shunt the coils by a value of one-half, the condenser being in series, whereas the reed-contacts bring a full microfarad to bear alternately on but one-half of the windings, giving the local circuit four times the condenser effect experienced by the line-currents. It will be noted that the extra windings 34 34 are of fewer number and much less value than those pertaining to windings 36 35.

Fig. 10 shows the apparatus in its simplest form. Here two absolutely similar circuits are arranged from one winding, each circuit being alternately actuated by the reed. A simple condenser bridges the whole. I have found (as has been well known heretofore) that there is a fixed relation between induction drag and condenser acceleration when the maximum effect is to be obtained. Fig. 7, and more particularly 8, shows how the relation can be obtained.

Having described my invention, I claim—

1. A multiplex-telegraph system comprising a transmitter adapted to reverse the current on line and provided with means whereby such reversal will take place by a series of potential gradations from a maximum of one polarity to a maximum of the opposite polarity, in combination with receiving devices responsive to current reversals.

2. A multiplex-telegraph system, comprising a transmitter adapted to reverse the current on line and provided with means whereby such reversal will take place by a series of potential gradations from a maximum of one polarity to a maximum of the opposite polarity and means for changing the strength of current on the line, in combination with receiving devices responsive respectively to current reversals and currents varying in strength.

3. A multiplex-telegraph system, comprising a combination-key having a plurality of contacts connected respectively with sources of current of various potentials and polarities, in combination with two local-circuit keys adapted to singly or together actuate the combination-key to send circuits of one or two transmissions to line, one transmission consisting of graduated changes from one polarity to another and the other consisting of currents of different strength, and receiving devices responsive respectively to current-reversals and currents varying in strength.

4. A multiplex-telegraph system, comprising a transmitting-key consisting of a rocking bar having a plurality of contacts arranged on each side of its axis and connected respectively with sources of current of various potentials and polarities, two pivoted contact-levers adapted to engage respectively with the contacts on each side of the axis of said bar, in combination with two keys one of which is adapted to control the rocking of said bar, and the other to control the positions of the said contact-levers with respect to said bar, and a line-wire connected with said levers.

5. In multiplex telegraphy, a single key capable of simultaneously transmitting two different signals belonging to two different transmissions, one consisting of graduated current-reversals and the other of currents of different strength.

6. A multiplex-telegraph system, compris-

ing apparatus for transmitting to line-currents of different value by a series of steps, in combination with apparatus for impressing simultaneously on the same circuit rhythmic crestless impulses of different periodicities.

7. In a system of telegraphy, the combination of a source of current, a line, a continuously-operating vibratory key, a signaling-key, and means operated thereby for controlling the rate of vibration of said vibratory key.

8. In multiplex telegraphy, a transmitting device consisting of a continuously-operating vibratory element, a plurality of signaling-keys common to said element and each controlling devices for giving different periodicities to said element, in combination with a receiving apparatus consisting of a plurality of vibratory elements adapted to respond respectively to the various periodicities established by said controlling devices and all adapted to respond to the periodicity of said key when not controlled by any of said devices, substantially as described.

9. In multiplex telegraphy, the combination of a source of current, a line, a single main-line vibratory transmitting-key carrying contacts, a plurality of finger-keys in local circuits and a plurality of weights adapted to be affixed to the vibratory key through the agency of said finger-keys and local circuits respectively so that each finger-key will give a different rate of vibration to the transmission-key.

10. In multiplex telegraphy, the combination of a source of current, a line, a single main-line vibratory transmitting-key carrying contacts, a plurality of finger-keys in local circuits and a plurality of suspended electromagnets respectively included in said local circuits and adapted when energized to attach themselves to said vibratory key, for the purpose set forth.

11. In multiplex telegraphy, the combination of a source of current, a line, a single main-line vibratory transmitting-key carrying contacts, a plurality of finger-keys in local circuits and a plurality of weights adapted to be affixed to the vibratory key through the agency of said finger-keys and local circuits respectively, and a signaling-circuit including said contacts and controlled by each of said local-circuit keys.

12. In telegraphy, the combination of a vibratory element, a plurality of electromagnets adapted to be magnetically attached to different points on said element and normally closed local circuits including finger-keys and said electromagnets.

13. In multiplex telegraphy, the combination of a vibratory transmitting-key carrying two contacts, a divided main-line coil whose outer terminals are respectively connected with contacts opposing said key-contacts, a tap-circuit from the middle of said coil including a source of current and said key-contacts, and a finger-key adapted to control said tap-circuit.

14. In multiplex telegraphy, the combination of a vibratory transmitting-key carrying two contacts, a divided main-line coil whose outer terminals are respectively connected with contacts opposing said key-contacts, a tap-circuit from the middle of said coil including a source of current and said key-contacts, a plurality of local circuits adapted to impart different periodicities to said transmitting-key and a plurality of finger-keys each of which is adapted to simultaneously control said tap-circuit and one of said local circuits, substantially as described.

15. In multiplex telegraphy, the combination of a vibratory transmitting-key carrying two contacts, a divided main-line coil whose outer terminals are respectively connected with contacts opposing said key-contacts, a tap-circuit from the middle of said coil including a source of current and said key-contacts, a finger-key adapted to control said tap-circuit, and a condenser across the contacts to which said outer terminals are connected.

16. In multiplex telegraphy, the combination of a vibratory transmitting-key carrying two contacts, two corresponding contacts with which the first two alternately collide, a divided main-line coil the outer terminals of which lead to the respective corresponding contacts and include two other coils inductively related to each other, a local circuit leading from the middle of the divided coil to the transmitting-key and including a source of electricity and a finger-key for said local circuit, substantially as described.

17. In multiplex telegraphy, the combination of a vibratory transmitting-key carrying two contacts, two corresponding contacts with which the first two alternately collide, a condenser across said corresponding contacts, a divided main-line coil the outer terminals of which lead to the respective corresponding contacts and include two other coils inductively related to each other, a local circuit leading from the middle of the divided coil to the transmitting-key and including a source of electricity and a finger-key for said local circuit, substantially as described.

18. In multiplex telegraphy, the combination of a main-line coil through which primary impulses are directed, a secondary coil in which corresponding signal impulses are induced by those in the main-line coil, said secondary coil being in series with the line, another inductive coil in which currents are induced by the impulses flowing in the main-line coil, which currents are sent through said secondary coil in the same direction as the induced signal impulses therein, to thereby round off or obliterate the crests of said signal impulses, substantially as described.

19. In multiplex telegraphy, the combina-

tion of a main-line divided coil, two other coils of equal resistance and number of turns, in inductive relation with each other, and having one terminal connected with the outer terminals of the divided coil respectively, two contacts with which the other terminals of the inductively-related coils respectively connect, a vibratory contact playing between said two contacts and a local circuit leading from the middle of the divided coil to the vibratory contact and including a source of electricity, the windings being so arranged that the crests of the induced currents in each half of the divided coil will be obliterated.

20. In multiplex telegraphy, the combination of a main-line coil through which primary impulses are directed, a secondary coil in which corresponding signal impulses are induced by those in the main-line coil, said secondary coil being in series with the line, another inductive coil in which the inductive effect is adjustable and in which currents are induced by the impulses flowing in the main-line coil, which currents are sent through said secondary coil in the same direction as the induced signal impulses therein, to thereby round off or obliterate the crests of said signal impulses, substantially as described.

21. In telegraphy, a vibratory device having attached to its opposite sides flexible cords fastened at right angles thereto, in combination with elastic devices attached at intermediate points to said cords and exerting a tension thereon substantially parallel to the vibratory device.

22. In multiplex telegraphy, the combination of a vibratory transmitting-key carrying two contacts, a divided main-line coil whose outer terminals are respectively connected with contacts opposing said key-contacts, a tap-circuit from the middle of said coil including a source of current and said key-contacts, a finger-key adapted to control the said tap-circuit and a condenser across the outer terminals of the divided coil.

23. In multiplex telegraphy, two transmitting-keys, one of which is a vibratory key, a grounded line including said keys in series and a shunt to earth from a point in the line between the two keys and including a condenser and a small retardation-coil, for the purpose set forth.

In witness whereof I subscribe my signature in presence of two witnesses.

STEPHEN DUDLEY FIELD.

Witnesses:

D. D. FIELD,

W. W. MCKEE.