C. Kirchhof.

Magnetic Telegraph.

No. 14,664. Patented Apr. 15, 1856.

Fig: 1.

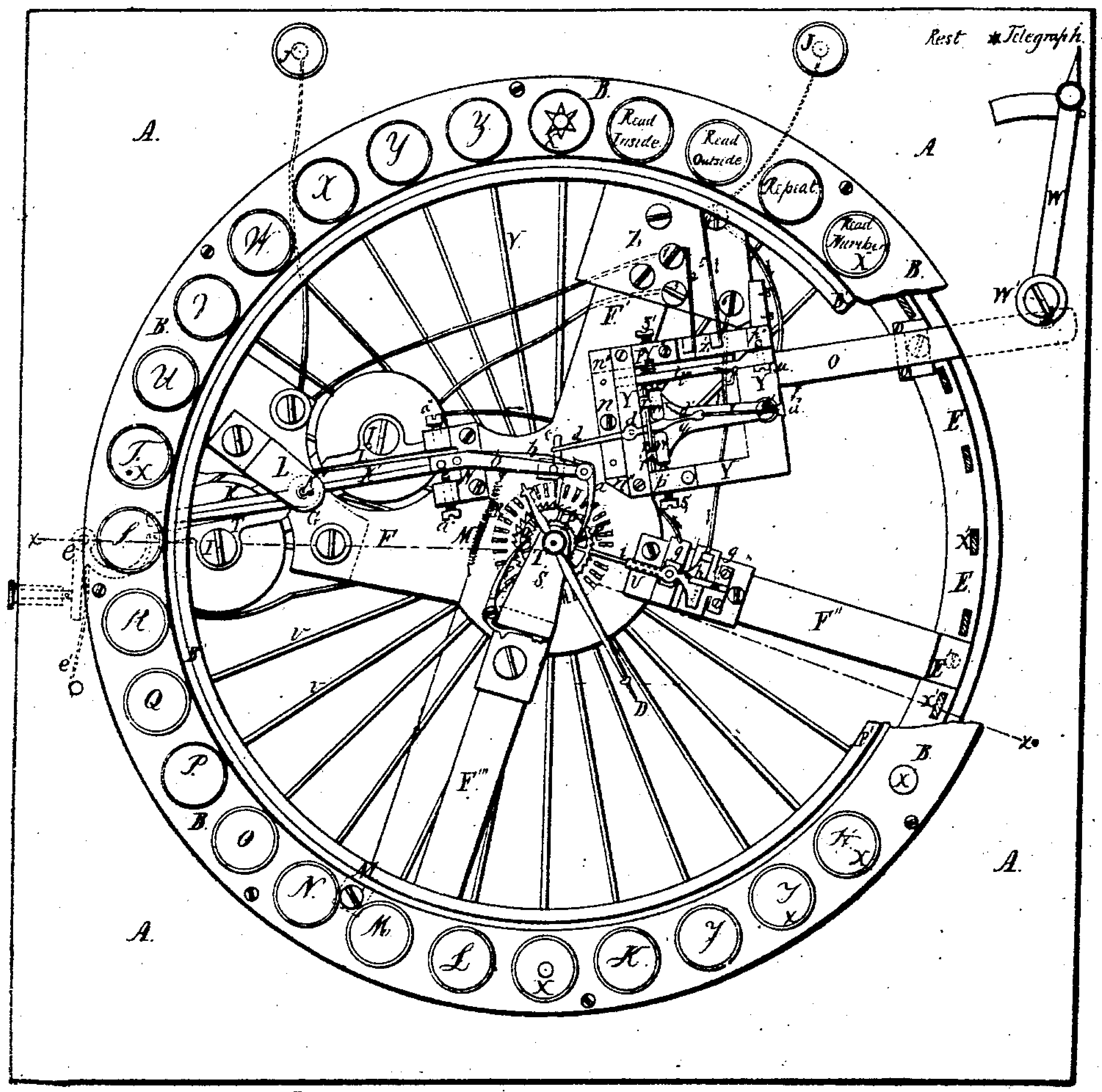

Fig: 7.

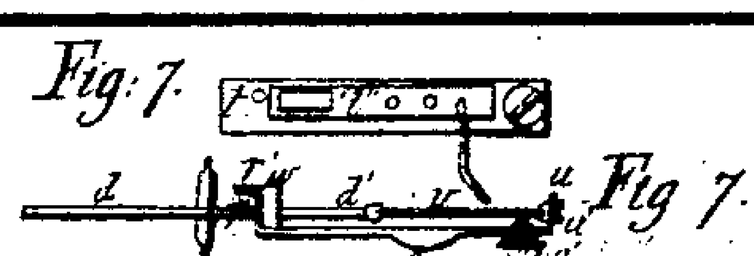

Fig: 7

Fig: 8.

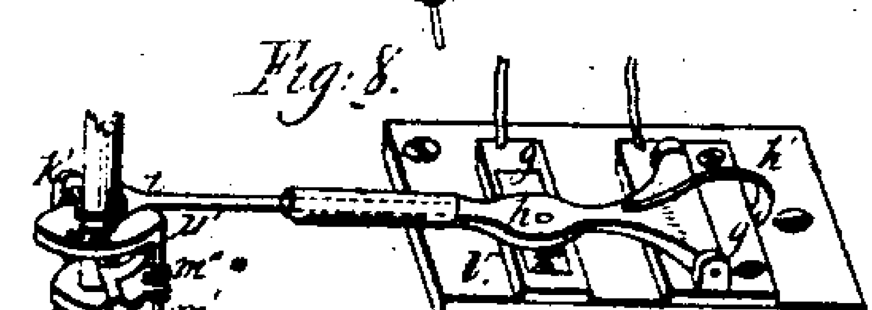

Fig: 11.

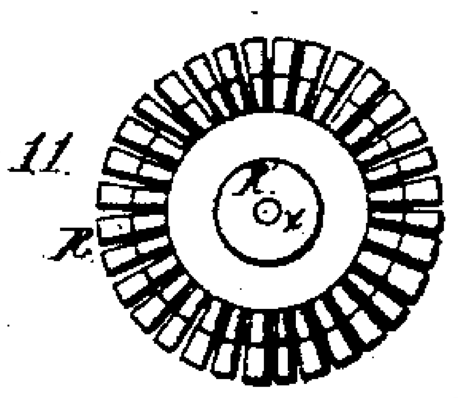

Fig: 12.

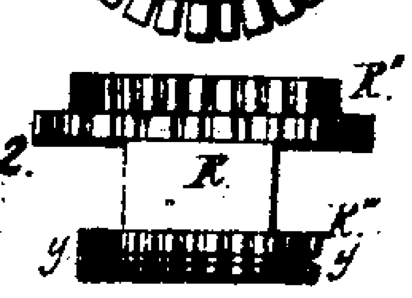

Fig: 10

Fig: 10

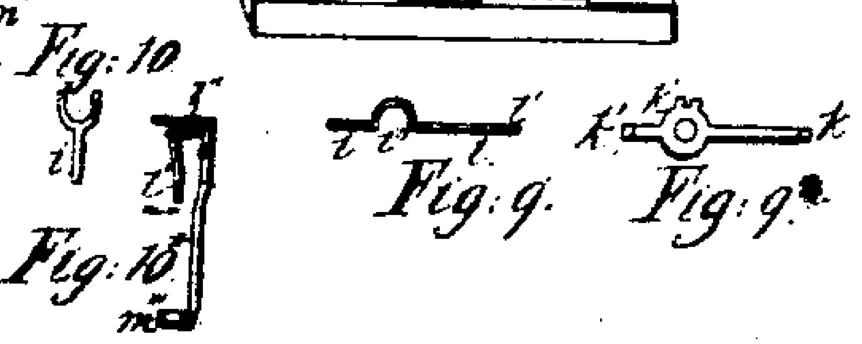

Fig: 9. Fig: 9*

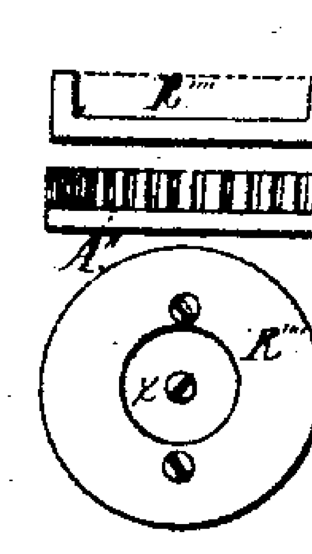

Fig: 13

Fig: 14

Fig: 15.

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Fig. 3.

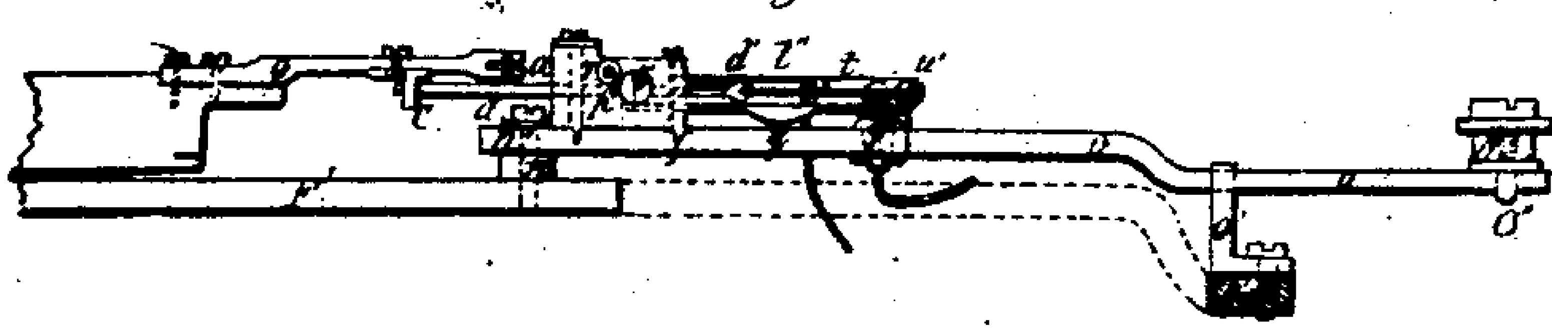


Fig. 4.

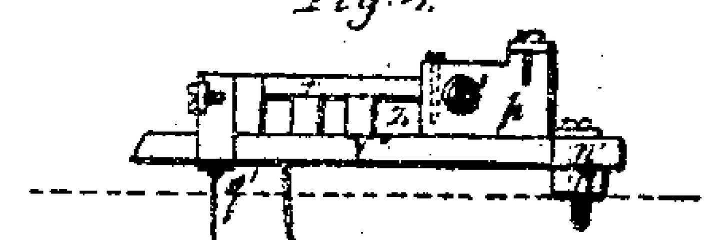


Fig. 5.

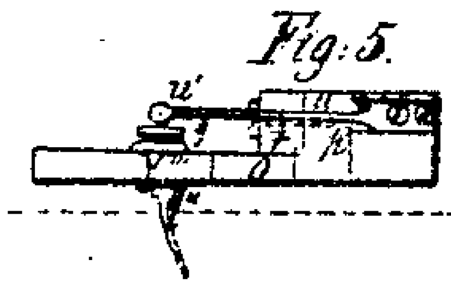


Fig. 6

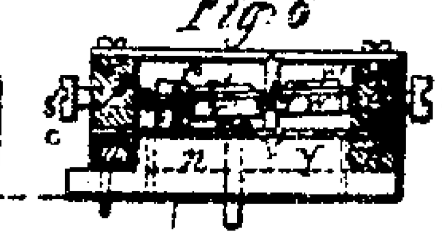
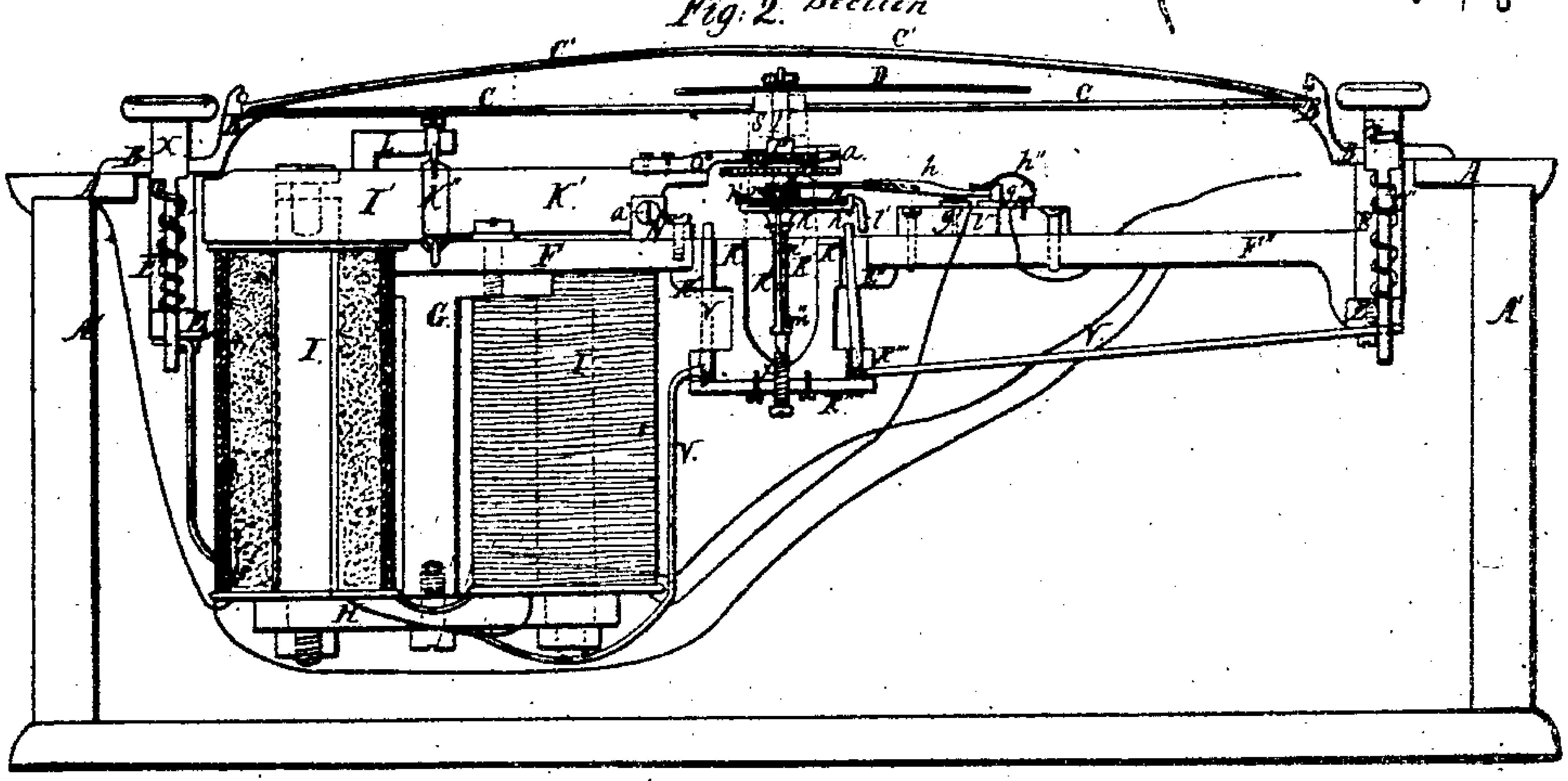
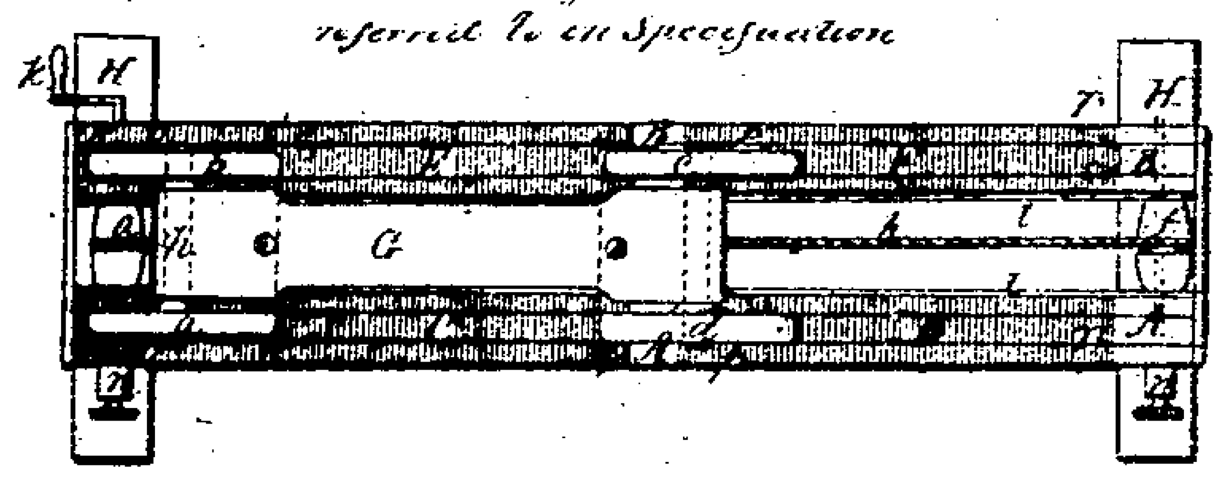
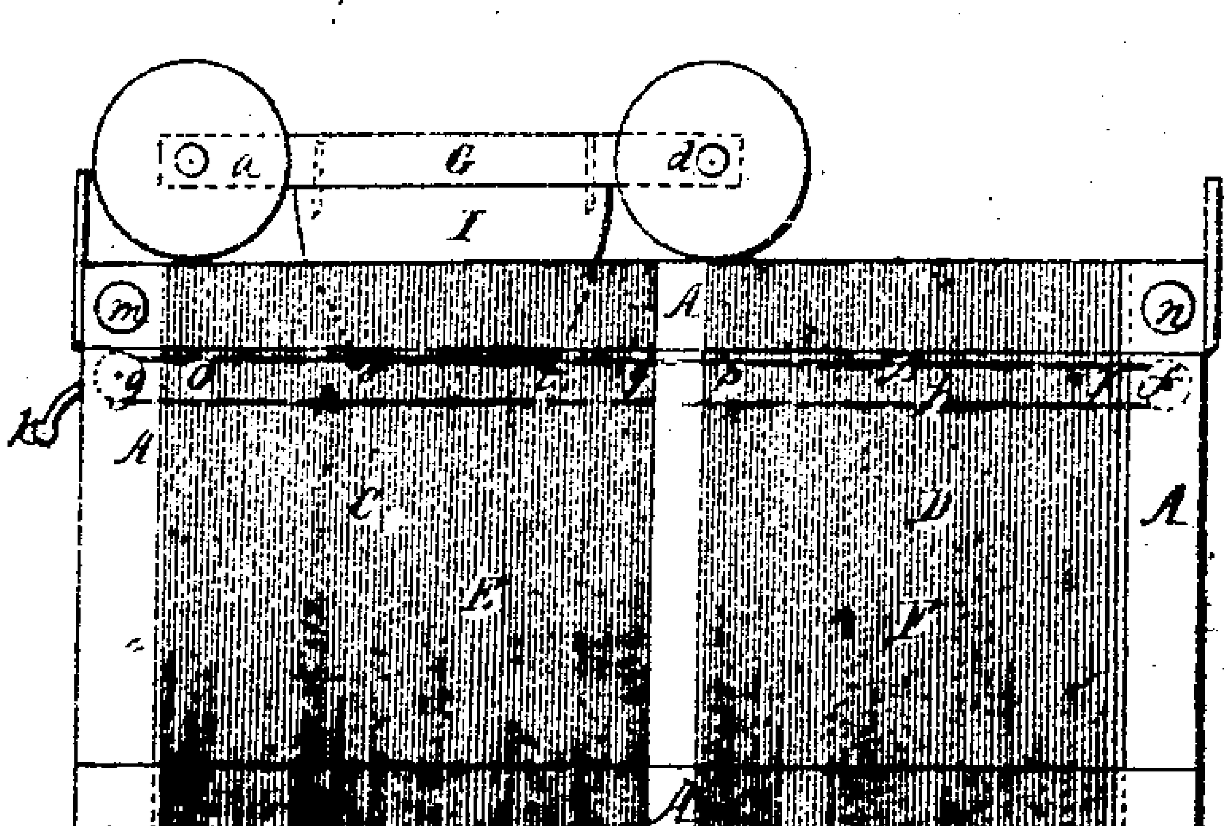


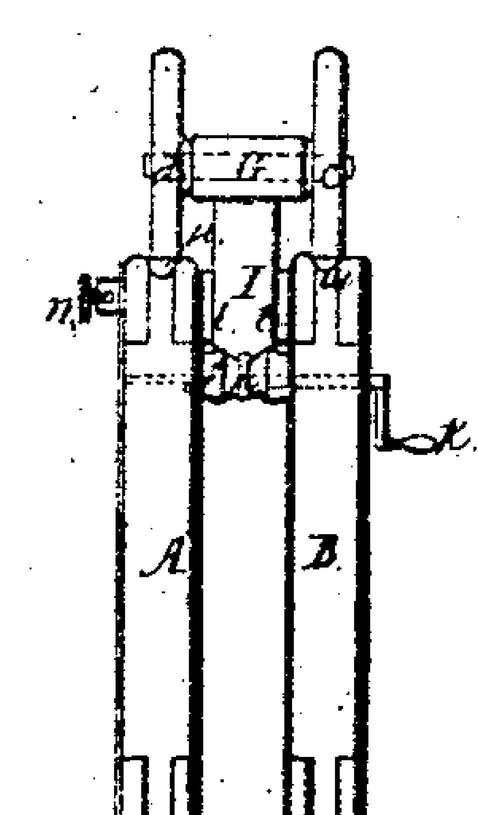
Fig. 2. Section



These three Figs are not referred to in Specification







UNITED STATES PATENT OFFICE.

CHARLES KIRCHHOF, OF NEW YORK, N. Y.

IMPROVEMENT IN ELECTRIC TELEGRAPHS.

Specification forming part of Letters Patent No. **14,664**, dated April 15, 1856.

To all whom it may concern:

Be it known that I, CHARLES KIRCHHOF, of the city, county, and State of New York, have invented certain new and useful Improvements in the Electro-Magnetic Telegraph; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a plan view, showing the interior of the instrument I employ for the dispatch and receipt of communications. Fig. II is a transverse section of the same in the line $x\ x$ of Fig. I. Fig. III is a side view of a portion of the instrument which I call the "self-breaker." Fig. IIII is a view of a portion of the self-breaker seen from the opposite side to Fig. III. Fig. V is a view at right angles to Fig. III, looking toward the right side thereof. Fig. VI is another view at right angles to Fig. III, but looking toward the left side thereof. Figs. VII and VII* are side views of detached portions of the self-breaker. Fig. VIII is a perspective view, on an enlarged scale, of what I term the "watcher" and "waker." Figs. IX, IX*, X, and X* are portions of the watcher and waker detached and separate. Figs. XI to XV are different representations of a brass center piece. Fig. XVI is a telegraph-circuit with a battery and the earth-plates, including two stations, and exhibiting the mere elements of the machine—viz., the electro-magnet and armature-lever, pawl-and-ratchet wheel and index, the shuttle and knee-lever, with the spring acting on the knee-lever, and the stop-screws and contact-point of the shuttle, and the course of the circuit through it, with exaggerated play of the shuttle.

Similar letters of reference indicate corresponding parts in the several figures.

My invention relates to that well-known electro-magnetic dial-telegraph which is generally called "self-rotating telegraph" or "index-telegraph by self-intermission;" and it consists in improvements of it. I found it, however, necessary to have a telegraph constructed which, after reading over a few lines of instruction, enables everybody to make a proper use of it, to make and receive every communication quickly and surely, and, if the communication is accidentally interrupted, to correct and restore it again. Therefore any number of instruments being in one circuit must be easily put in activity by a simple mechanism to answer for both purposes—to transmit and receive messages. The uniformity and regular motion must be regulated by the instrument itself without any forcing influence. The combination of several instruments or lines must be simple, and everything avoided which misleads the operator or requires a good knowledge of the telegraph.

To enable other skilled in the art to make and to use my invention, I will now proceed to describe the construction and operation of this improved telegraph.

The instrument is contained in a wooden case, A′, having an aperture in its cover A, which is surrounded by a ring, B, of brass or other metal, which has an elevated edge, B′, supporting a dial-plate, C, marked with the letters, characters, numbers, &c., and a glass cover, C′, for the said dial-plate. This dial-plate, with its cover, is shown in Fig. II in section, but in Fig. I is supposed to be removed to show the interior. In the ring B, around the dial-plate C, are the knobs or keys X X, opposite the corresponding letters, arranged for stopping the index at the desired letter. Below, but parallel and concentric with the ring B, a second ring, E, is supported within the case by pillars E′ hanging from the ring B. This ring E surrounds and supports a large brass cross, whose four arms are respectively marked F F′ F″ F‴, which supports most of the parts of the machine. The center of the large cross receives a brass boss, R, of which Fig. XI is a top view and Fig. XII a side view. This boss is secured firmly in its place. In its center is a cavity, R′, in the bottom of which is a steel screw, x, to support the index-spindle T, the upper part of which is supported by a cock, S.

The two ratchet-wheels P and Q, which are fastened to the index-spindle T, have their teeth inclined in opposite direction, and the number of teeth in each one is equal to the number of keys or knobs X X. The wheel P is engaged by a pawl, f, which is held in place by a spring, f', to prevent the index-spindle moving but in a right-hand direction. The index D is fastened above the dial-plate C upon the spindle T.

To the under side of the arm F of the cross is secured a stand, G, which carries an iron cross-piece, H, with the cores and helices of the vertical magnet I I. The cores of the magnet reach above the coil and the surface of the cross, to serve as pivots for the shoes I′ I′, whose faces form perpendicular planes opposite to the armature K K′. This armature is in the form of a two-armed lever, which oscillates horizontally to a limited extent on its vertical pivot or fulcrum K″, the lower end of which is supported in F, and the upper part in a cock, L.

The oscillation of the armature is limited by the two set-screws *a″ a″* in the fixed clamp N, so that it comes either in contact with the shoes I′ I′ or poles of the magnet, or is drawn back therefrom by a spiral spring, M, whose tension is regulated accordingly to the attraction of the magnet by a screw, M′.

The arm K′ of the armature is lengthened by an additional light arm, O, of brass or any not magnetic metal, to whose end is pivoted a click, *a*, which is held by a spring, *b*, always in contact with the small ratchet-wheel, P, so that it may be caused to turn the said wheel tooth by tooth by the swinging of the armature. To the same arm O is rigidly attached a catch, *c*, which engages in the notches of a larger ratchet-wheel, Q. A portion of the piece of which the catch *c* is formed extends backward from the arm O, or in the opposite direction to the catch, and has a notch (see Fig. I) to receive the end of a small lever, *d d′*, which has a certain amount of play allowed therein.

Opposite to the extremity of the arm K of the armature is a square hook, *e*, movable on a pin by *e*, and occupying such a position that it may come in contact with the armature. This hook is drawn back from the armature by a spring, *e′*, but by pressure of the finger of the operator on a knob, *e″*, at the side of the exterior of the box, movement may be given to the armature when the circuit is closed to adjust the index D to any point on the dial.

The instrument, as far as above described, contains nothing essentially new, for its leading features are the same as in every dial apparatus or spell telegraph which operates by the employment of mechanical motive power. Suppose, now, a shuttle or intermitter were to be connected underneath the armature or its lever permanent in such a manner on the cross-arm F, so that it had a thin projection between the armature and either set-screw, the armature would be obliged, after a certain distance of travel, to operate upon that shuttle which produces self-intermission, and after this moment of breaking circuit the armature with its lever would be obliged, by means of the inertia, to complete the rest of the travel and force the shuttle to the end of its course. This would be the construction of the self-intermitter which Siemens & Halske, the German inventors of the original instrument, have employed, and the faults of it are the too early intermission or restoration of the circuit and the employment of the inertia of the armature after the moment of breaking or restoring the circuit. Both show the great defectiveness of their invention, and has to be overcome by a great deal of unnecessary electric power.

The next fault of their invention is the troublesome arrangements which have to be made before a message can be transmitted, and, besides, this requires good and attentive operators, especially if more than two instruments are used. For example, before it can be telegraphed from station to station, the operator of the first station has to connect his battery and index apparatus with the circuit, disconnecting the alarm apparatus, before he can notice the second station; but still the current is too weak to operate his index apparatus, therefore station II has now to make the same preparations as station I before they can communicate together with their index apparatuses. Should it be necessary to communicate with a third station, station II is obliged to keep a second instrument for that purpose, which is connected with the instrument at station III, but cannot undertake a communication with station III before it has made the same arrangements as station I and station II did; also, should station I like to communicate direct with station III, above arrangements have also to be made, and, besides this, station II has to be noticed to use the "excluder," an instrument for the purpose to unite the two circuits of its two instruments, excluding the earth-plates, but leaving both batteries in the circuit; and after this is done the indices, spiral springs, &c., must be regulated before a direct communication can be made from station I to station III. Suppose, now, an order is to be given to six different stations. These six stations require five arrangements, four excluders, ten instruments, ten batteries to communicate together, and the circuit is intermitted at ten different places. How easily can it happen that a shuttle misses its service at one of those places, which breaks up all telegraphical communication till it is found out which shuttle refused its service, and at which station, which only can be done by breaking up the whole line in their different circuits.

A fourth fault is the arresting of the index during its motion by mechanical means, caused by pressing the key of a desired letter or character, in order to compel the armature to stop also in the middle of its travel, and hereby the operation upon the shuttle is prevented for restoring, in consequence of which the receiving-instrument can be stopped also. But this mechanical arresting causes a fifth fault—viz., that either the index of the transmitting or of the receiving instrument stands not right opposite the desired letter, but between this and the next one.

A sixth fault is the employment of the shuttle itself to stop the index at a desired letter. Suppose, now, the shuttle of the transmitting-instrument misses its service, which breaks the circuit, and this circuit would be closed by other means, the instrument is only enabled to receive, but not to transmit, a message; and this fault is the worst one of all rotating telegraph instruments. Then, for example, a fire-alarm is to be communicated, and the shuttle refuses its service. The fire will be over before the instrument is enabled to operate again; and still worse is the fault of the next-described construction.

Some years after Siemens's invention, Highton, in England, tried to construct a similar instrument, though he failed. He constructed the self-intermitter as follows: A slide or shuttle, connected with one end of the wire of the line and sliding upon a ground-plate, slides or touches with one end a little over a bed-piece, of brass, which is connected with the other end of the wire of the line. Consequently, by moving the slide forward or backward the circuit can be intermitted or restored, the lever of the armature having a certain distance to travel before it starts the slide; but when the armature has approached close to the magnet the slide is thrown from the bed-piece and the circuit broken, like by the original instrument; but, "in order to secure it for going home on either side when started by the arm of the armature, a spring is attached to the slide, that after it has moved half its distance the spring should push it home. This is, viz., accomplished by a spring rising over a projection in the center of the slide, but having an inclined surface on each side of the projection, so that after the slide has moved a little more than half the spring presses upon this inclined surface and forces the slide home; or the same can be accomplished by means of a weighted lever, which, being moved beyond the perpendicular on either side, falls over; or other arrangements, &c." Very little examination will show the absurdity of that. Suppose the slide may be moved forward till the moment of breaking and the spring may be on the left side behind the highest point of the projection, the spring has to be on the right side of the top of the projection in the moment of restoring the circuit again; but if the slide moves backward and arrives at that place on which it was in the moment of breaking, it will restore the circuit again. Consequently the spring is not beyond the top on the right-hand side, but before the top on the left side, and therefore the armature will be attracted and return again without having completed its travel, and the slide will go home, but on the wrong side, breaking the circuit again, and vice versa, which causes a permanent, quick vibration of the armature.

The armature must have a great deal of inertia, in order to enable it to overcome the attraction of the magnet to complete its travel and to start the slide to the required place, and also to raise the spring over the projection, which afterward forces the slide to go home. In relation to this, either the intermission or restoration, or both together, take place before the armature has completed its motion, and the motion of the slide after the moment of breaking or restoring is an unnecessary one. The reserved power is direct, detrimental, and must be reserved by the inertia again. No projection on the slide, but a level surface, is required. Even friction produced by its weight upon the plate is enough; but still worse would be the use of a weighted lever. This alone shows plainly that this construction requires still more waste of electric and magnetic power than Siemens's, without having any advantage whatever, as it is plainly shown hereinafter, not to mention the abrogation of the secondary batteries and the second magnet in the instrument, which he used as a substitute of the spiral spring. These were already abrogated by the original construction; but he says himself: "If desired at the receiving-stations, the slide may be entirely removed and the wires of the line joined. The removal of such slide-pieces at those stations will cause the armatures to work more rapidly, and hence cause the work to be done by them before the same work is accomplished at the transmitting-station, and hence security of action may be obtained also in this way." By this he confesses plainly that the construction of his intermitter has far more disadvantages than Siemens's, and that he could not depend upon his, because his intermitter requires too much unnecessary power, and is liable to undergo many changes, brought on by friction, &c., and therefore the intermitters of several instruments are not always able to make them work in unison, which obliges him to throw off the intermitters of the receiving-instruments entirely to aim a more rapid motion and to enable them to follow the transmitting-instrument, in consequence of which the operators are troubled and detained by the displacing and placing of the intermitter. For example, station I sends a message to station II, and station II is obliged to ask them to repeat. It must open the circuit anyhow, to connect his slide, else it has to expect a difference of the stand of the indices. It is now a question if both instruments will operate in unison without being regulated, and if they do not, station I has to remove its slide. Has the question at station I arrived, both stations have to change the position of their slides again, in order to continue the message, because the transmitting-instrument must always be the intermitting one, and here is it where the sixth fault occasionally happens, as mentioned before. Now, these are proofs enough of his retrogression, and the reason why Siemens's construction is adopted everywhere.

In order to overcome all these faults, as mentioned before, I constructed and combined the parts of my instrument entirely differently from theirs and used none but those parts of theirs in it which are well known and absolutely necessary to every self-rotating index apparatus. For instance, the key, called a "shuttle," "slide," or "bridge," which is influenced by a reserved power caused by earth-motion of the armature, for opening and closing the circuit, surrounding always one and the same magnet; second, the knobs or keys, with their spring either circular or in any other way arranged for resting the instrument. are the same as used in all instruments of the same class; but the principles, purposes, nature, and result of these parts in my instrument are altogether different from those mentioned above.

My first improvement consists in the prevention of the too early intermission or restoration of the circuit, which generally happens by the direct starting of the shuttle through the oscillating or pendulous arm of the armature and in the abrogation of that motion of a slide-shuttle, &c., which continues after the moment the circuit is broken or restored again, and in consequence of which the reservation of a power to use for this purpose after these moments is avoided. At the moment a circuit is closed and surrounds a good electro-magnet its magnetism begins to develop, affects and attracts the armature, causing a forward motion, (positive motion,) and at the moment the circuit is broken again the magnetism begins immediately to vanish, and the armature will be given free to any mechanical power to move it backward, (negative motion;) consequently the moments of breaking or closing the circuit are the precise limits between which either the existence of magnetism effects a positive motion, or the non-existence of the magnetism permits a negative motion of the armature, and every mechanical part partaking one or both of these motions must be in readiness at this moment to obey the same law immediately, and dare not transgress these limits, else they will be detrimental, and operate longer than the determinated time and purpose requires, and these important principles have not been thrown in consideration by any inventor before. Now, if there is used a reserved power of moving some of these mechanical parts—like the shuttle or the armature and its lever—to continue and complete the adopted motion after the moment of breaking circuit, it would operate against the original negative power, and an increase of inertia, spring-power, time, and expenses for so much more battery will be the consequence, and which has been also referred to and clearly proved by experience. In order to avoid the disturbing influence of the inertia and gravitation of the armature and its lever, it is necessary to throw away this lever and all unnecessary parts and concentrate the greatest part of the iron mass toward the axle and construct the ends of the arms of the armature as thin as possible, and counterbalance it like a magnet-needle. Only the arm K′ of the armature must be lengthened, by a light arm of brass or of non-magnetic metal, to prevent a magnetic communication and an attraction of the movable parts.

My self-breaker or self-intermitter is described as follows:

On the arm F′ of the large cross is secured a piece, *n*, of brass, with rabbets in its ends, as shown in Fig. VI, to receive the side piece, *n′ n′*, of a sliding frame, Y, to which is rigidly attached a bar, *o*, which slides in a guide, *o′*, on the ring E. This arm *o* has near its extremity a notch to receive a stud, *o″*, secured to an upright axle, W′, which is supported in suitable bearings and furnished outside the case with a hand, W, having a pointer. By the movement of this hand and pointer the stud *o″* is caused to slide the frame Y longitudinally far enough to insert the small lever *d d′*, (which has been before mentioned, and is carried by the frame Y,) in the notch in the back part of the catch *c′*, or to withdraw it therefrom, at pleasure.

On the side piece, *n′ n′*, of the frame Y there are two stands, *p′* and *p*, supporting a bridge-piece, Y′, which supports the upper end of the vertical axle *d″*, which forms the fulcrum of the lever *d d′*. One end of the frame Y receives a shouldered upright pin, *q′*, which is insulated. This pin *q′* serves as a pivot for the shuttle *q* to vibrate horizontally upon. This shuttle is made of sheet-brass, and its vibrating end is furnished with two small loops, *r′ r′*, which fit to slide easily upon a rod, *r*, of metal or glass, one end of which is secured in the stand *p′*, and the other in an ivory strip, *t*, which is secured to a stand, *p″*, on the frame Y. If the rod *r* is of metal it should be insulated from the stand *p′*.

The shuttle carries two small blocks of ivory, *w w′*, between which the arm *d′* of the lever *d d′* is allowed a limited amount of play. One extremity of the shuttle *q* carries a platina point, *q″*, which stands opposite to a copper strip, *t′*, on the face of the ivory strip *t*, the said strip *t′* being faced with platina, as indicated in blue color in Fig. VII, opposite the said platina point. The vibration of the shuttle is limited by two set-screws, *s* and *s′*, in the stand *p′* and *p*, the former being opposite the ivory block *w*, and the latter bearing against the ivory strip *t*. The amount of vibration of the shuttle needs to be scarcely perceptible, and must be regulated before, only just sufficient to make or break contact between the point *q″* and the platina face of the copper strip *t′*.

To the stand *p″* there is secured a weak steel spring, *u*, at the extremity of which there is a knob, *u′*, with a cavity to receive one end of a light wire, *v*, the opposite end of which is pressed by the spring into a cavity in the end of the arm *d′* of the lever *d d′*, to constitute what is known as a "knee-lever," which causes the arm *d′*, when the lever is stationary, to bear against one of the ivory blocks *w* or *w′* and hold the shuttle, with its platina point *q″*, either in or out of contact with the platina face of the copper strip *t′*.

The arm *d* of the lever when entered in the notch in the catch *c′* partakes partially of the movement of the armature K K′, and by said movement, in either direction, the arm *d′* is caused to be withdrawn from contact with the ivory piece w w', as the case may be, and to carry the knee-lever past the line of culmination of the axle d'' and the point u', so that the power of the spring u may throw it against the block w or w' and reverse the position of the shuttle and hold it fast, the act of closing the armature being followed by the separation of the point q'' and copper strip t', and vice versa. If now, for example, the shuttle, with its pivot q', connected with one pole of a battery, and the copper strip t' with the magnet, and through it with the opposite pole, the instrument will rotate step by step in the well-known manner, but more easy, sure, and regular.

By the above-described self-breaker or self-intermitter the intermission or restoration of the circuit at the precise time required is just so perfectly secured and its taking place too early prevented, like the regulation of the steam of a steam-engine, which also moves its valve and turns the steam on after the completed stroke by means of the momentum of the fly-wheel or paddle-wheel. Besides that, are neither the contact-points worn out by their friction over each other, nor are they hurt by the hard blows of the armature against the shuttle and the set-screw.

It will be understood that the action of the armature does not carry the lever d d' much more than half the distance it has to move in order to make the shuttle intermit or restore the circuit, but that it cannot remain in this position, as it is beyond the line of culmination and between the ivory pieces w and w', and in the notch of the catch e' there is a certain amount of play. Therefore the spring u, which reserved a certain amount of power by this action, presses it sidewise and compels it to continue and to complete its motion also till it arrives at one of the ivory pieces w or w', and starts or moves the shuttle q this hardly-perceptible distance till to the moment of breaking or restoring the circuit, whereby both are stopped, and, though the reserved power is used up, but the weak original power of the spring u will be sufficient to restrain the shuttle from vibrating or moving again. Immediately after that the armature, and by this all oscillating mechanical parts, are obliged to reverse and to assume the corresponding course, but the shuttle q remains in its position until the knee-lever has completed its inverse motion and brings it in its former position again. In this manner the shuttle is not only stationary during the time of the travel of the armature, but also some time afterward, or during the vibrations of the armature, which may happen by its pushing against the set-screws a'' a''. Therefore the circuit remains all that time either permanently broken or permanently closed till the knee-lever d d' has completed its motion, in consequence of which the vibrations of the armature are scarcely perceptible, as either the positive or the negative power remains permanently in activity after the armature has completed its motion. Therefore the armature is attracted in the same direction against the set-screw, and the vibration cannot be also communicated to the shuttle, as during this time the knee-lever runs through this given amount of play and touches neither.

The time allowed between the completed action or travel of the armature and the moment of breaking or closing the circuit will be governed by the amount of play allowed for the lever d d' in the notch of the catch e', and between the ivory pieces w w'.

My next improvement consists in the method by which the index is stopped right opposite the desired letter by means of what I term a "watcher," in connection with a "waker" influenced by the knobs X X, which are mentioned before.

On the arm F'' of the large cross is fastened an ivory slab U, which is visible in Figs. I and II, and is also shown in the perspective view Fig. VIII. On this slab is secured a brass plate, g, partly covered with platina, which is represented in Fig. VIII, colored blue, and at a short distance from g another plate, g', is secured to the same slab, the second plate, g', supporting the lever or key h, which I call the "watcher," and which carries a platina point, h'', touching the platina face of the first plate, g, and is forced downward by a spring, h'. This watcher h can be raised by the fork i, which is secured to it, but well insulated, and which embraces the index-spindle.

Some distance below the fork i there is secured to the index-spindle a ring, k, having two arms, k' k'', whose ends are bent square upward and bored to serve as bearings for a wire, l, at one end of which there is a broad hook, l', hanging downward nearly to the face of the large cross. This wire, which I term the "waker," is bent in the form of a semicircle, l'', as shown in Fig. IX, to clear the index-spindle, and this semicircular part lies upon the ring k.

The waker l supports a sliding collar, m, which is capable of sliding up and down the index-spindle T. This collar m has a rod, m', attached to it passing downward through a notch, m'', in the ring k', and carrying another ring, m''', which surrounds the spindle, to guide the motion of m up and down. The waker constitutes an elbow-lever, with l' for one arm and l'' for the other. It rotates with the spindle and index, and if the hook l' meets with any obstruction it is swung sidewise and the semicircular part l'' is thrown upward and the collar m is thereby raised and caused to raise the fork i of the watcher-key h, and thus to break the circuit, which passes through the watcher, the pin h, and the plate g.

For the purpose of obstructing the hook l' at the proper point, a number of elbow-levers, V V, corresponding with the number of knobs X X, are fitted in a corresponding number of notches in collars R'' and R''' at the top and bottom of the boss R.

The elbow-levers have each its fulcrum-pin secured in it, and a groove, Y, is made in the outside of the lower collar, R''', to receive the said pins, which are confined by a notched collar, R'''', fitting over R'''. The upright or shorter arms of the lever V V protrude through openings in the large cross F to a short distance above the level of the lower end of the waker-hook l'. The longer arms of the said levers extend radially to the index-spindle and are connected with the knobs X X on the outside of the case. These knobs have springs X'' X'', which force them upward and hold the upper extremities of the upright arms of the levers V V just within the circle of the rotation of the waker-hook l'; but if either of the knobs X X is pressed down by the hand of the operator, its lever V will obstruct the waker-hook when it arrives in contact therewith in the course of its revolution, and the watcher will open, and either the pressure of the hand must be removed to allow the spring X'' to throw the lever clear of the waker-hook, or the index-spindle must be turned a step more, so that the waker-hook, if short enough, would slip over the end of that lever V before the watcher can close again. Suppose, now, the plate g is connected with a magnet, and through this with one pole of a battery, and the plate g' with any mechanical "interrupter," and through this with the other pole of the battery, the instrument will rotate, but if a knob be pressed down it will stop right opposite that letter, and neither this interrupter is hindered to continue its motion nor is the index mechanically arrested. It stops only because the circuit is broken and its magnet cannot draw. If, now, instead of a mechanical interrupter the self-cranker is employed, the instrument will rotate by its self-intermission, and if a knob is pressed down it must stop, also, opposite the desired letter, and at the time the index is advancing from the last letter before the desired one to the desired one the waker will be obstructed, which opens the watcher, and when the index stands right opposite the letter and the shuttle has operated for restoring the circuit again the current cannot circulate, because its course is through the watcher; but this is now open, hence the instrument must stop as long as the knob is not relieved from pressure, and as soon as the knob is relieved then the watcher is closed and the circuit restored again. Immediately after that the magnet attracts the armature and the rotation goes on again.

The superiorities of this method of stopping are as follows: The bad practice of mechanically arresting and the retardation by inertia of the second-hand underneath the index is avoided. The indices of all instruments stand right opposite the desired letter, so that no mistake can be made, and the arrangement has no connection with the shuttle whatever. Therefore, it is not at all necessary to have always the intermitter or self-breaker in operation in that instrument which is transmitting; and, also, the contact-points of the watcher can never be hurt by the opening-sparks, because it opens always when the index is advancing, and at that time no current exists and a quicksilver connection could be used just as well. The advantage of this arrangement will be shown by my fourth improvement.

My third improvement consists in the method by which I keep all instruments of a line working in unison or make sure that all have acted before the prime current is intermitted or restored again, but without the employment of local batteries and any mechanical arrangement as mentioned before. Then such arrangements operate by their own principles, and have to be always regulated to operate in accordance before a communication can be made. For this purpose I employ the galvanic induction or secondary current as the only means which is always itself regulating, corresponding, and nearly proportional to the variation of the prime current, and retards the motion of that instrument, in which the prime current is intermitted to give the others time to complete. The retarding influence of the induction is sufficiently proved by the failure of the electro-magnetic motive power, but I never perceived a useful practice of it.

I will now describe the manner to effect this: Each coil of the magnet is covered with a second coil of thicker copper wire, like the induction-coil which is shown colored green in Fig. II. In this coil two secondary currents are induced by the change of the prime electric current, as the winding is parallel with the winding of the prime coil; but as this is a coil for quantity, and the iron of the cores solid, it delays the magnetism at the close of the circuit and prolongs it at the opening, and thus the effect of the drawing power of the magnets is procrastinated and the motion of the instrument also.

By increasing or decreasing the number of windings the motion of the instrument is regulated to any degree (like a clock by its pendulum) to keep a certain measure of time, the greater the number of windings causing the more procrastination. If, now, in that instrument, which is intermitting, both induction-coils are connected with each other and the induction-circuit closed, it will operate slowly, according as it is regulated; and if in every other instrument in the same circuit the induction-circuit is open, it will operate much quicker, and in consequence of this their armatures will always have their action completed before the first instrument opens or closes the prime circuit again.

It is finally necessary to explain the means by which this opening and closing of the induction-circuit is effected, and the means by which an accommodation or side course of the prime current evading the self-intermitter and uniting afterward with the circuit again, is closed or opened for that purpose at the same time, and also the manner how both are used in connection with some suitable means for connecting and disconnecting the self-intermitter with the lever of the armature, in order to work as required, and in consequence of which, by turning the handle W of only one instrument from the word "rest" outside of the case to the word "telegraph," or inverse from "telegraph" to "rest," all instruments being in a circuit immediately can be brought in or out of operation, and how an accidental interruption of the communication, caused by the shuttle, could be corrected again by means of the accommodation course.

On the cross-arm F an ivory slab, Z, (see Fig. I,) is fastened, which contains four metal screws, 1 3 and 4 6. To the screws 1 and 4 brass springs 2 5 are soldered. The springs are faced with platina opposite the platina points on the sides of the screws 3 and 6 and operate like keys. A small piece of ivory, *z*, which is fastened to the frame Y, (shown in Fig. I and IIII,) and notched to receive the ends of the keys 2 and 5, closes either the key 2 and opens the key 5, or opens the former and closes the latter, even as the frame Y is moved forward or backward. Below the slab Z the screw 1 is connected with one end and the screw 3 with the other end of the induction-circuit. The prime current, which comes from the line outside of the box to the binding-screw J, runs from there below the slab Z to the screw 4, and has now the change of two directions—either in the direction of the red arrows, in Fig. I, through the spring 5 to the screw 6; thence under the breaker through the wire Z″ to the watcher *g′* and *g* and on the magnet, and leaves at the binding-screw J′ outside the box for connection with the line, or it runs in the direction of the black arrows, from the screw 4, through the pivot *q′* to the shuttle *q* and its platina point *q″* to the copper plate *t′*, from this through a perpendicular connecting-wire down in and through the wire Z″ under the breaker and through the watcher, &c., as before.

The connection of the two springs 2 and 5 with the screw 3 and 6 and the operation or non-operation of the instrument are regulated at once by the movable support or frame Y of the shuttle and the handle W outside of the box. If this handle stands at "rest" the support stands farther from the armature, the lever *d* is removed from the catch *c′* of the armature and cannot partake the motion of it, the spring 2 is separated from the screw 3, therefore the induction-circuit is open and the instrument will operate quickly, but the spring 5 lays on screw 6, therefore the prime-current has the change of both directions, as mentioned before, and remains permanently closed; then suppose one way should be obstructed, the other would be sufficient. In this condition the armature will be permanently attracted and the instrument is always in readiness immediately to rotate in unison with another such instrument, being in one circuit in which the intermitter is in activity, and the index of both can be stopped right opposite any desired letter by pressing down the knob of that letter on either of the instruments. But if the handle W is turned to the word "telegraph" the support is moved closer to the armature, the lever *d* is inserted in the notch of the catch *c′* and partakes the motion of the armature by breaking circuit. The spring 2 is in contact with screw 3, therefore the induction-circuit is closed and the instrument is obliged to take its regulated slower motion, and the spring 5 separated from screw 6; therefore the prime-current has no change and can only circulate through the self-breaker, in consequence of which the instrument rotates immediately by its self-intermission and regulates its oscillations itself, and any number of such instruments having their handle on "rest," being in circuit, will operate step-by-step in unison with it, and should it happen that by change one of these instruments should be made intermitting, too, it will make no change in their uniformity, as they are regulated to keep the same measure of time. By turning the handle back again all instruments will stop. It will clearly show that the spring 5 is made as a measure of precaution to prevent accidental interruption, which so often and easily happens by the former constructions.

The least obstruction or oxidation of the contact-points by the opening-spark is sufficient to make for a long time every communication impossible, and all instruments in that line useless for the purpose. Now, suppose the self-breaker of my transmitting instrument refuses its service, the operator will immediately know the cause of it and turns the handle W at the word "rest." The circuit is again permanently closed by means of that spring 5. The receiver immediately will know what happened, and will turn the handle of the receiving-instrument at the word "telegraph," and the communication can go on as before, and even if all the self-breakers but one of all the the instruments in the circuit refused their service, the only one will be sufficient to keep that line in useful activity, and besides this a notice could be given by means of the watcher.

It was before mentioned that the index could be regulated or moved by the little knob *e″* outside of the box from letter to letter, and the circuit can be broken by means of the watcher in connection with the knobs X X, therefore the indices of all instruments can be moved from letter to letter by successively applying the knob X of the next letter and moving the index to that letter, the circuit will always be broken, and the indices of all the other instruments will always sweep to that letter. A second use of this arrangement is as follows: If a line is badly insulated, or two lines connected with each other, what easily can be done by a switch which joins the lines, and the intermitting instrument is very far from the battery, it can happen, for example, at rainy time that the deviated amount of current which goes home without reaching the intermitter is strong enough to effect such an amount of permanent electro-magnetism by that instrument which is close to the battery that it works irregularly. The operator of this instrument immediately will see this by the shaking motion of the index, but has not the necessity to give a signal to regulate the instruments, as generally must be done. He only puts the intermitter in operation, in consequence of which both the deviated and the original current are intermitted, and the other operator can do with his instrument just as he pleases, as the induction will keep order and all instruments will operate perfectly.

It would be superfluous to repeat here the explanation about the management of the instrument, as it is clearly shown by the description itself.

Having thus described my invention, I will proceed to state what I disclaim therein. I do not claim any part or arrangement with the use and result thereof, as far as already well-known and clearly specified; but

What I do claim as my improvements, and desire to secure by Letters Patent, is—

1. The prevention of the too early intermission or restoration of the circuit in the use of self-intermission through the method, by which a key, shuttle, or its equivalent, is not only stationary during the whole travel of the armature, but also for a certain time afterward, so that the circuit during that time remains either permanently broken or closed, but afterward this shuttle is started and shoved by the indirect influence of the motion of the armature through some devices till to the moment of breaking or restoring the circuit and here stopped, and the armature, and by that all oscillating mechanical parts, are obliged to reverse immediately, substantially as described.

2. The manner of stopping the index of all instruments of a circuit right opposite the desired letter without disturbing or preventing the index armature or shuttle of any instrument to complete their adopted motion by means of a watcher and waker operated by the revolving hook l' and key-lever V, or its equivalents, in the manner specified, so that the watcher will keep open meanwhile the shuttle makes contact, whereby the indices stop until the key is relieved and the watcher closes again.

3. The method, as substantially specified, to keep all instruments of a circuit in unison working, and without any mechanical means, through employment of the induction-current, by retarding the influence of the electro-magnetic power at a certain degree upon that instrument which intermits the circuit, and whereby the other instruments of the circuit, not having their intermitters in activity, are governed by it and insured to complete their motion before the circuit of the prime current is intermitted or restored again, the said induction-current in each instrument being used in connection with some suitable means for connecting and disconnecting the self-intermitter with the armature-lever, and also with a means for closing and opening the induction-circuit, and for the opening and closing of the accommodation-course of the prime current, which act together at once, answering simultaneously their different purposes, as described.

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Witnesses:
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