5 Sheets--Sheet 1.

W. E. SAWYER.

Telegraph-Apparatus for Cable Use.

No. 149,252. Patented March 31, 1874.

Fig. 3.

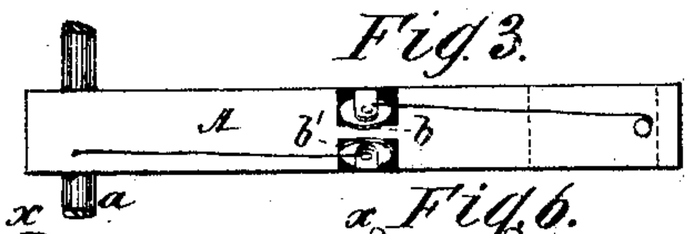


Fig. 5

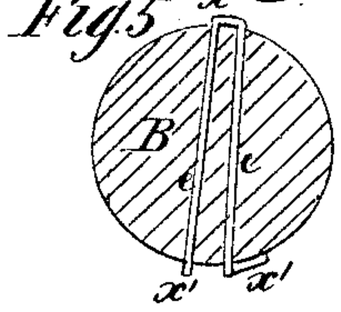


Fig. 6.

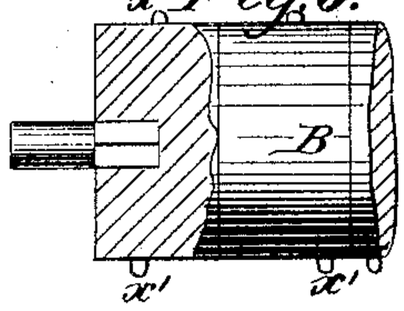


Fig. 4.

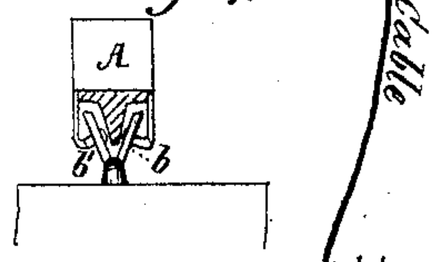
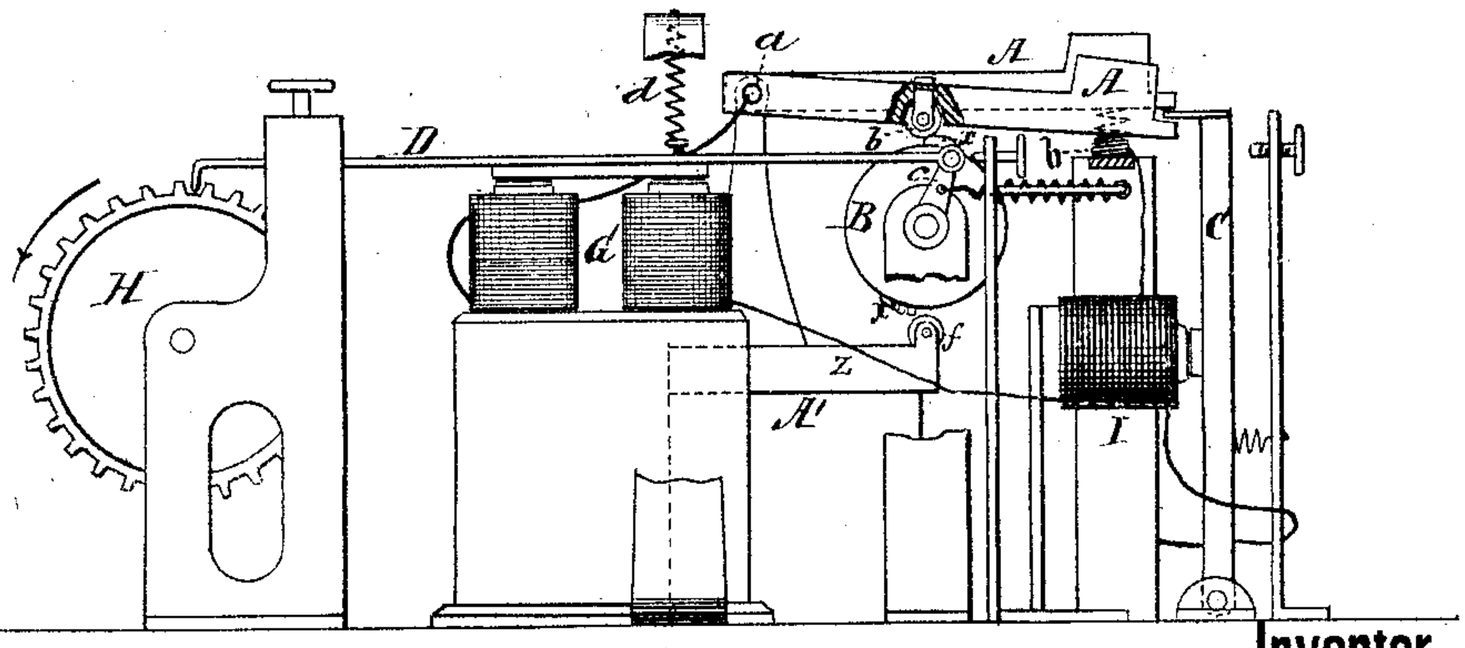


Fig. 1.

Fig. 2.



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5 Sheets--Sheet 2.

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Fig. 7.

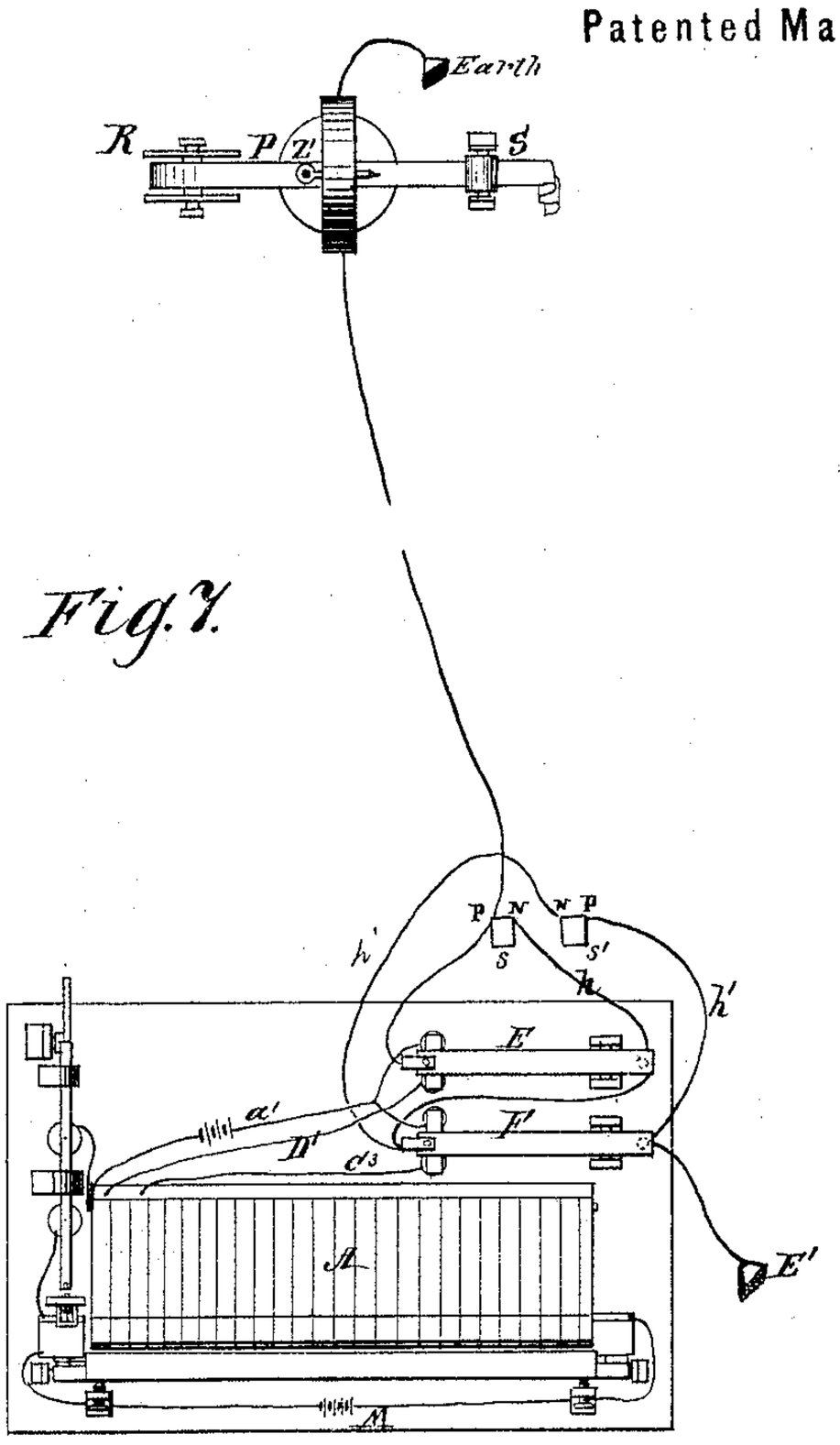
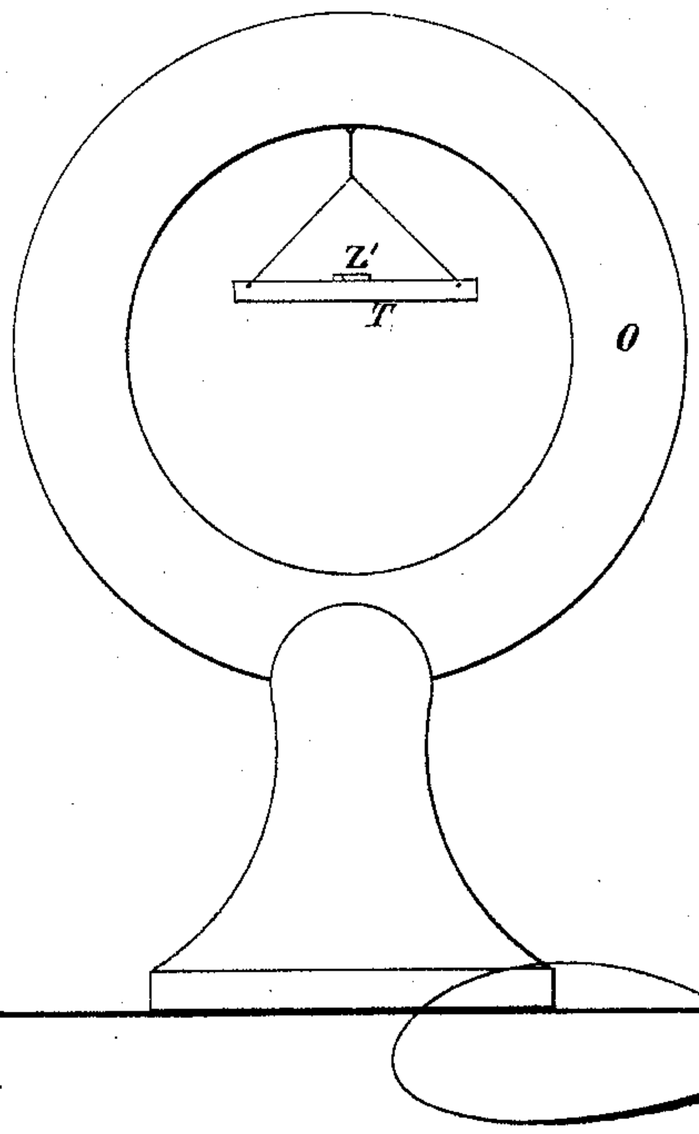


Fig. 8.



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5 Sheets--Sheet 3.

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Fig. 9.

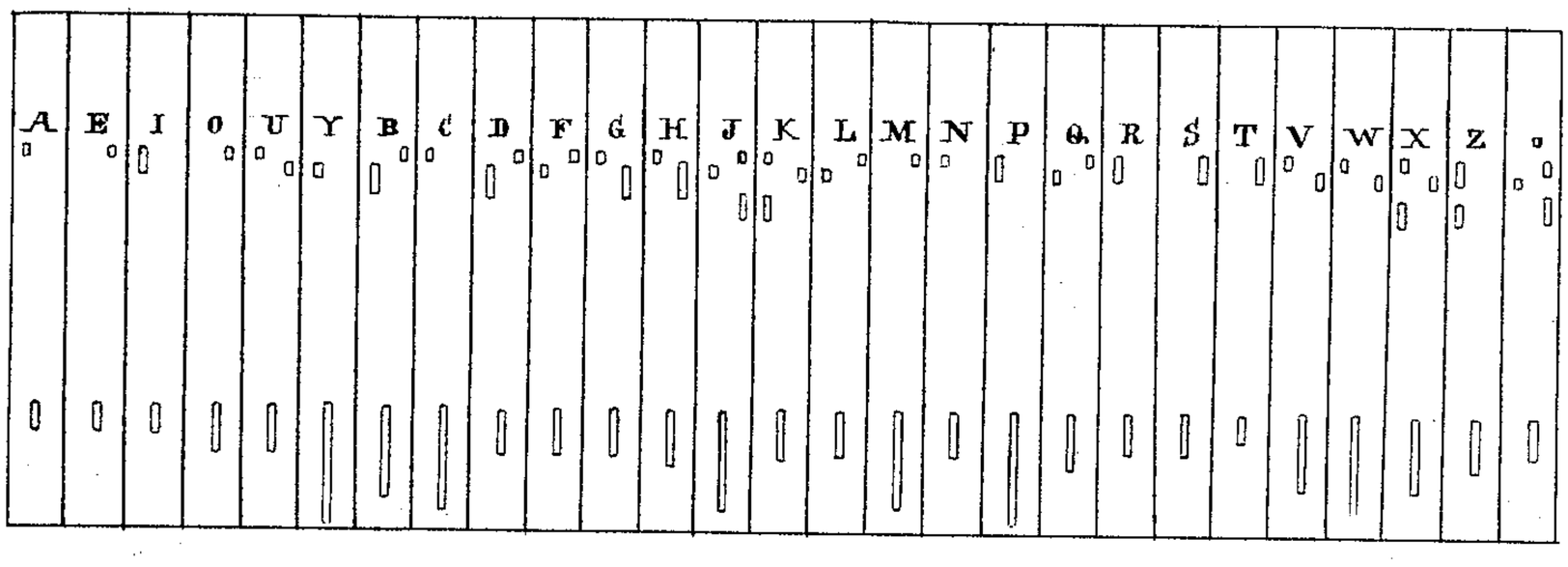

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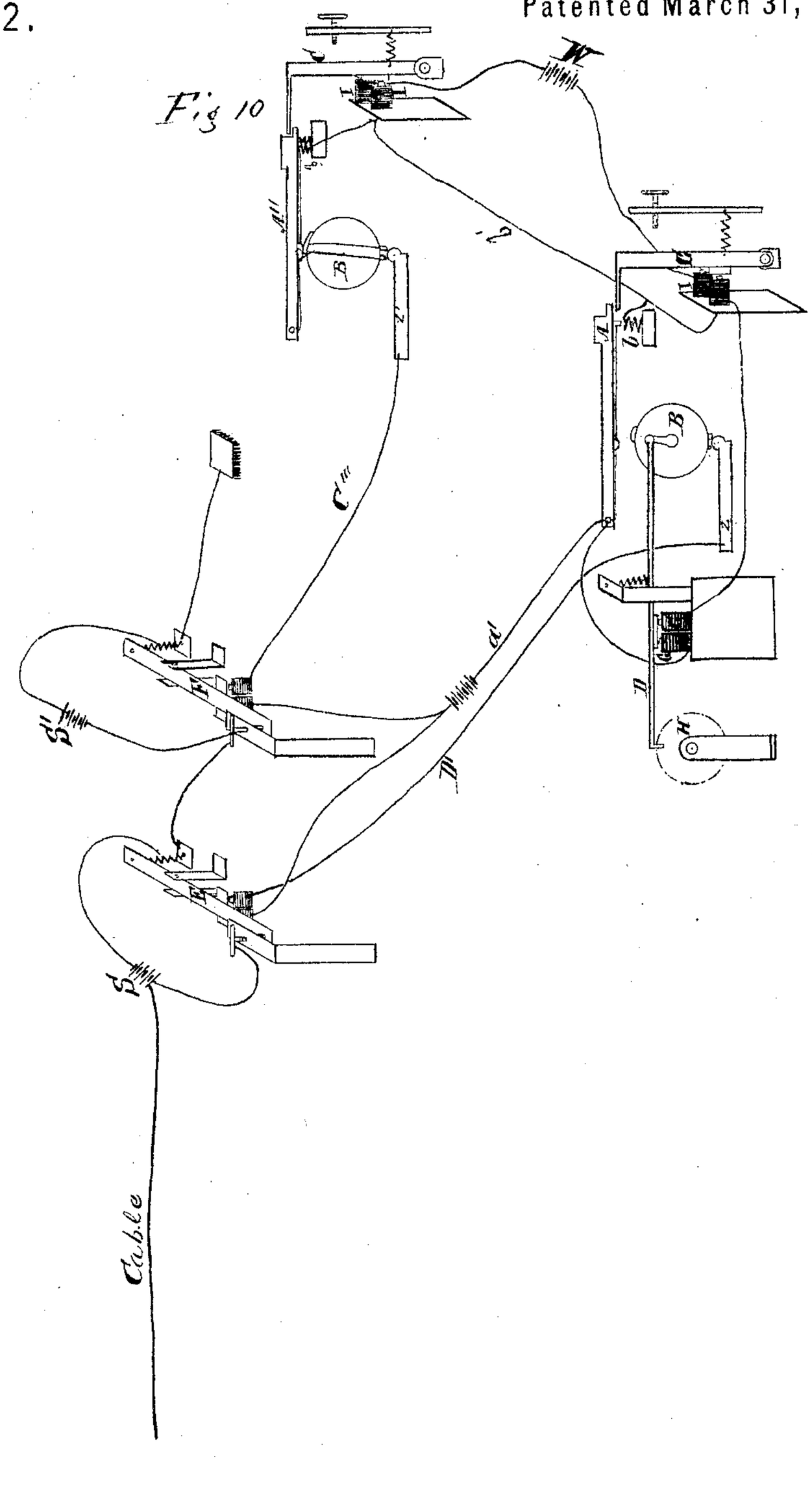
Fig 10



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5 Sheets--Sheet 5.

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Telegraph-Apparatus for Cable Use.

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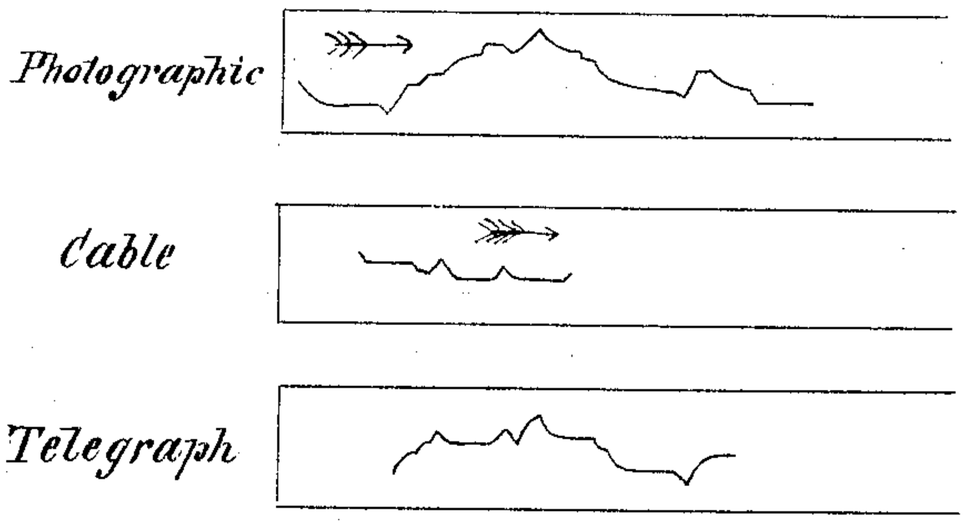

Fig. 12.

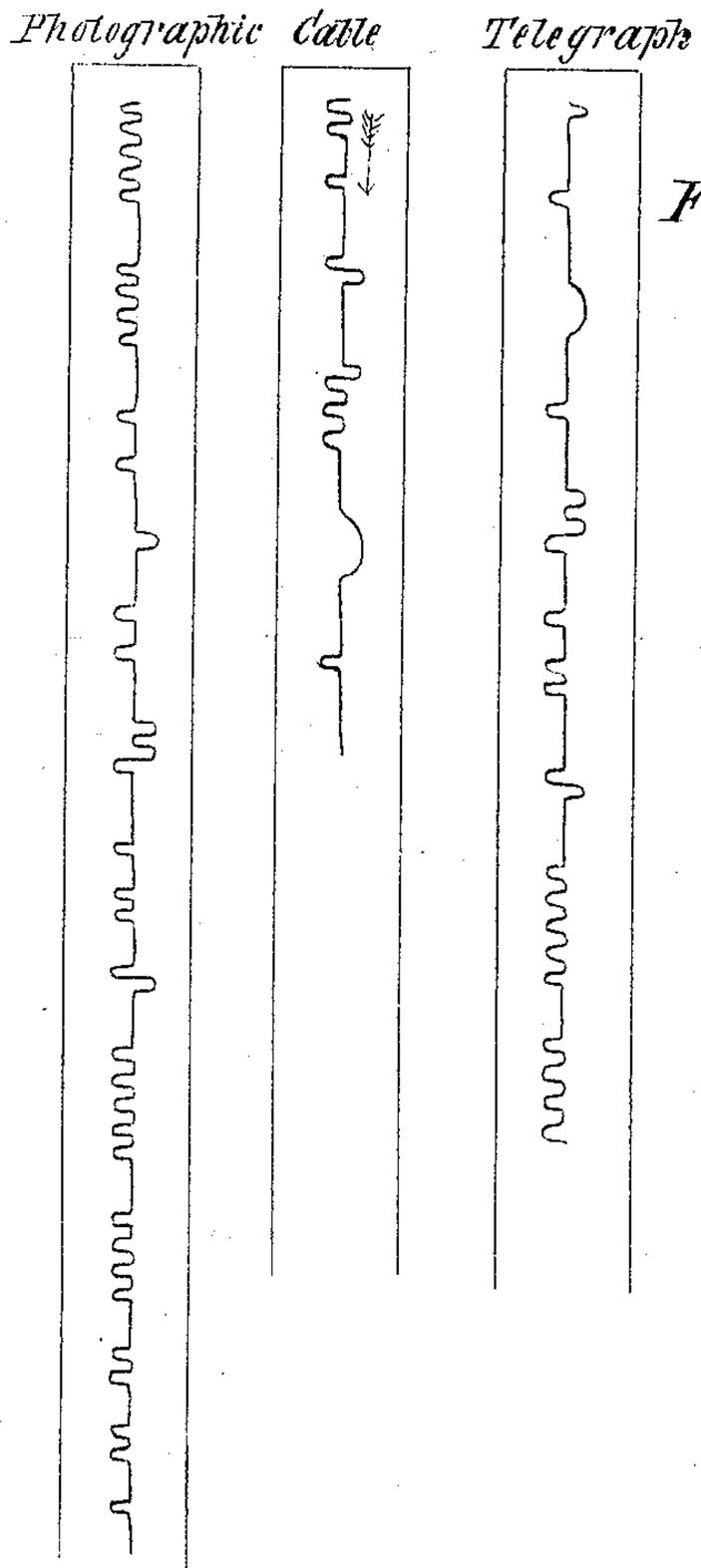

Fig. 13.

Fig. 11.

A	∖	G	∨
N	∖‾	H	∨‾
C	∖_	E	/
Y	∖‾‾	O	⌐
J	∖	M	⌐‾
R	∖_	T	/
P	∖‾‾	S	⌐
Z	∖	F	∧
U	∨	L	∧_
V	∨‾	O	∧‾‾
W	∨‾	I	∧
K	∧	.	∧‾
X	∧_	D	∧
		B	∧_

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AM. PHOTO-LITHOGRAPHIC Co. N. Y. (OSBORNE'S PROCESS.)

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, OF WASHINGTON, DISTRICT OF COLUMBIA.

IMPROVEMENT IN TELEGRAPH APPARATUS FOR CABLE USE.

Specification forming part of Letters Patent No. **149,252**, dated March 31, 1874; application filed February 12, 1874.

To all whom it may concern:

Be it known that I, WILLIAM EDWARD SAWYER, of Washington, in the District of Columbia, have invented a new and Improved Telegraphic Transmitting and Receiving Apparatus for Cable Use; 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 a part of this specification, in which—

On Sheet I, Figure 1 is a plan view of the transmitting apparatus, part being broken out. Fig. 2 is an end elevation, showing one of the lettered keys depressed, and the position of armatures which results from it. Fig. 3 is an under side view of one of the lettered keys. Fig. 4 is a cross-section of the same. Fig. 5 is a cross-section of the vibrating cylinder. Fig. 6 is a partly sectional view of a fragment of the cylinder. On Sheet II, Fig. 7 is a plan view of both the transmitting and receiving instruments suitably connected with the cable. Fig. 8 is an elevation or face view of the galvanometer and its attachment. On Sheet III, Fig. 9 is a plan of the surface of the cylinder as it would appear spread out or flat. On Sheet IV, Fig. 10 represents a diagram of the several connections and circuits of the apparatus. Sheet V shows the alphabet, and illustrates its practical application in formation of words.

In the cable transmitting-instruments heretofore used, in order to transmit signals, each time the operator depresses a key or other equivalent sending instrument three or more currents have been automatically sent into the line in rapid succession, and of unequal duration. The first current corresponds in sign with that which it is desired should arrive at the other end of the line; the second is of opposite sign, and the third is of the same sign as the first current. When these currents are employed to produce one signal, the duration of the second current exceeds that of the first, and the duration of the third current should be less than that of either the first or second. If more than three currents are employed to produce a single current and signal at the distant end of the line, the fourth current will be opposite in sign to the third, the fifth opposite the fourth, and so on. The first current sent causes a rapid change in the electrical condition of the conductor; but if it were alone and uncorrected, it would, on arriving at the distant station, occupy the receiving instrument for a considerable time, and produce on it a stranger effect than is desired; therefore, to cut it off and leave only the effect required, electricity of opposite sign is thrown into the wire, and in order that this second current may have power to operate as rapidly as possible in overcoming the first current, the second current is continued on so long that if uncorrected it would produce an effect beyond that required of it in checking the first current; and so the second current is in turn corrected by a third current, and this again may be corrected by a fourth, and so on theoretically to any number, although practically from five to seven currents will suffice. These alternating currents are thus employed to control the needle, and restrict it to its normal or static condition before commencing to form the sign of a second word or letter. Thus several movements of the needle are made each time a word, sign, or signal is formed, which have no value as part of the sign or signal.

The chief object or effect of the present invention is to greatly lessen the number of electrical impulses or currents necessary to make the sign of a word, so that the time and expense of cable transmission may be correspondingly diminished.

By the apparatus hereinafter described, each movement of the needle is utilized in forming a signal, or part of a word, sign, or signal.

In carrying out my invention, I employ in the receiving-instrument a suspended galvanometer needle-bar, having a perforation at one end through which a ray of light is directed upon a photographically-sensitized traveling paper strip, thus chemically tracing an irregular path thereon, whose variations from a straight line are greater or less, corresponding to the oscillatory movements of the needle. The length and direction and combination of short lines which make up the irregular, but continuous, path or line on said paper-strip, are the indexes by which letters and words are indicated, and messages thereby deciphered.

To control the movements of the galvanom-

eter-needle, I employ as one of the chief mediums a cylinder which is adapted for reciprocating rotary movement, and provided with projecting metal strips and teeth applied to its periphery. When one of the keys of the lettered key-board is pressed down on the cylinder, a metallic and electrical connection is formed, which not only throws on the cable a current from the positive or negative pole of the battery through the action of a local current upon the electro-magnetic keys; but also causes an armature to engage the key, and hold it in the depressed position until the rotation of the cylinder, by means of a peculiar arrangement of sliding-pawl armature, carries it round sufficiently far to destroy the metallic connection, when the locking armature instantly releases the key to engage with another that will be similarly depressed. The length of time of engagement of the keys and cylinder is the perfect measure of the time during which the letter is formed. The deflection is of course changed from right to left, and vice versa, as the current is changed from positive to negative, or vice versa.

From this general reference to the nature and operation of the apparatus, I will proceed to describe its construction in detail, so far as necessary to an understanding of the same by those skilled in the art.

I will first describe the receiving-instrument. The principal elements of the same are the galvanometer O, and the sensitized paper strip P, which is wound on a reel, R, and passes through the galvanometer to the drawing-rolls S. The needle T is suspended by strands of unspun silk, as usual. A plate or bar, Z′, having an aperture in one end, is attached to, and supported on, the needle, at right angles to it and parallel to the paper strip. The actinic ray of light, from any suitable source, passes through the aperture in the needle-bar Z′ onto the paper, and, by a well-known chemical effect, traces the movement of the needle with entire accuracy. The paper strip being constantly drawn from the spool or reel, the path traced by the ray of light is a continuous one, although irregular.

A is the key-board; B, the cylinder; C, the key-locking apparatus; D, the sliding-pawl armature for imparting reciprocating movement to the cylinder, and E F the sending-levers or electro-magnetic keys, connected with the cable and with two local batteries, with which said keys are normally in circuit. This circuit is broken, and the battery of either key thrown on the cable when one of the lettered keys is depressed, as hereinafter more fully described.

The battery M is in the circuit formed through the lettered keys, magnets G I, armature C, and springs *b*. (For full illustration of connections and circuits, see Sheet IV.)

The spring-supported keys of board A are all pivoted on a rod, *a*, which is connected to the magnets of levers E F by wire *a′*, and each is provided, on the under side, with two small friction-wheels, *b*, set at an angle to each other, and from one of which a wire passes to the rod *a*, and from the other of which a wire passes to the spiral springs *b*, supporting the key. The springs are connected by a wire, *b′*, and supported on a cross-bar arranged beneath the keys. The cylinder B is mounted in suitable standards or bearings, and has a crank-arm, *c*, to which are applied an adjusting-screw and retracting-spring, after the same manner as to armatures of electro-magnets. The long armature D is hinged to the crank-arm *c*, and, traversing the cores of magnets G, is supported at its hooked and free end over the toothed wheel H by a coiled spring, *d*, as shown.

When a key is depressed and electrical connection made through the magnets G, the armature D is necessarily attracted, which causes its hook end to engage the toothed wheel. Said wheel being constantly rotated in the direction of the arrow by spring-power or other medium, the armature is thus caused to slide over the magnets G, which carries the cylinder through an arc of greater or less length, according to the time the key remains in contact with it. When the circuit is broken by the strips *x* on the cylinder passing out of contact with the wheels *b*, the armature is released from the wheel H, and the cylinder returned to its former position. Simultaneously with the attraction of the armature D to magnets G, is the attraction of the locking-armatures C to its magnets I, which causes said bar to engage the rabbeted end of the depressed key, and hold it in that position till the metallic and electrical connection between the cylinder and key is broken, as before described.

It will be observed, from Fig. 2, that the bar C, when swung forward to lock the depressed key, passes under all the other keys, and prevents their being also depressed till it moves back. Thus there is a simultaneity of action of the armatures D and C, although for entirely different purposes. (It will be observed the locking apparatus C is furnished with an adjusting-screw and retracting-spring, in the usual way.)

The series of metallic strips *x*, of varying length, are applied to the cylinder B on the upper side, and connected by wires *e* with studs, or elongated strips, or projections, *x′*, on the opposite or under side of the cylinder. The cylinder is marked off, by grooves or otherwise, into cylindrical sections of equal diameter transversely, and one or two wires, *e*, and studs or strips, *x′*, as the case may be, are appropriated to each section. The latter, *x′*, come in contact, at each movement of the cylinder, with friction-rollers *f*, which are mounted on projections of metal plates Z, set in a table, A′, that extends beneath the roller B, and parallel to the key-board. These plates correspond to the studs and strips *x′*, or the groups thereof, in both number and position, and each of them which corresponds in posi-

tion to the right-hand wire *e* of a cylinder section is connected by wire C‴ with the magnet which operates the sending-lever F, and similarly, all on the left hand with the magnet operating the lever E by wires D′. Thus, when a key is depressed, not only is a circuit formed through D, G, I, and *b*, but through one of the wires of the cylinder, stud, or strips *x x′*, a corresponding plate, Z, and the sending-lever connected therewith.

The keys or levers E F stand each normally in a local circuit with their respective batteries S S′, by means of wires *h h′*, arranged as shown. Each lever is also connected with the cable, and a wire goes to earth E′ at each end of the line or cable. When the lever E is depressed by formation of the key-board circuit with the magnet of said lever, its battery S is thrown on the cable. A key-board circuit is always formed through E or F when one of the lettered keys is depressed, as shown in Fig. 2, Sheet 1, and through which of the two keys it shall be is always determined by the connection of the wires *a′* D′ and the studs or strips *x′* on the under side of the cylinder.

I will now describe the electrical connections and circuits of the apparatus, as illustrated in a general way in Fig. 10, on Sheet IV. When the key A is depressed the current flows to sending-lever E, since a circuit is formed through the plate Z, wheel *f*, and points or studs of the cylinder B, and battery S is thrown on the cable, its local circuit with lever E being broken. But when key A″ is depressed the battery S′ is thrown on the cable by like formation of a current through sending-lever F and plate Z′. The battery S sends a positive and battery S′ a negative current.

When either key A or A″ is depressed, a circuit is always formed through pawl-armature D, magnets G I, battery M, locking-armature C, and springs *b*, so that the key is locked.

I have shown in Fig. 11, Sheet V, the signs indicating the letters of the alphabet as formed by the movements of the needle by my method. In practice, the dashes are curved somewhat, owing to the paper strip continuously moving.

In Fig. 12 I have represented sign equivalents of the words "photographic cable-telegraph," the signs forming one continuous line and one letter following another without separating or distinguishing sign. The dashes or short lines, which are inclined laterally indicate electrical impulses, and the whole is to be read from left to right on the strip, as per arrow. The result is that, while some one hundred and thirty-six electrical impulses or movements of the needle are requisite, under the old method, to transmit the words "photographic cable-telegraph," as shown in Fig. 13, only thirty-four impulses or movements are requisite by my method.

It is evident that the deflection of the needle-bar will continue as long as a key-board circuit exists through one of the levers E or F, and that this circuit depends, in turn, for its duration, on the time during which metallic contact exists between the wheels *f* of plates Z and the studs or strips *x′* on under side of the cylinder. If the contact be with a stud, of course the needle will be affected but an instant. If it be with a strip, it will necessarily be larger, but will vary with the length of the strip. Thus the studs and strips *x′* determine absolutely the length of time or extent of deflection of the needle. The strips *x* on the upper side of the cylinder have a different function, which is to determine or regulate the time during which a key is held locked by armature C, and thereby determine the length of the dashes formed on the paper strips or tape, which are not formed by electrical currents, but by the forward movement of the strip or tape.

The dash is always part of a letter, and the length of a dash, in connection with the oblique movement caused by the galvanometer-needle, determines the letter, as, for instance, a short positive movement of needle, to which is added a brief dash, means one letter, and a longer dash another letter, and, with a still longer dash, another letter. In other words, the circuit, through a lettered key and the cylinder-strip beneath it, through pawl-armature D, magnets G I, locking-armature C, and battery M, exists independently of, and continues after, the circuit formed through the same key and one of the keys E F, and prevents, for the time being, the release of armature C and depression of another lettered key.

What I claim is—

1. The combination, with the lettered keys, having an end shoulder or rabbet, as shown, of the vibrating locking-armature C, the same being suitably connected electrically, whereby the armature holds one of the keys depressed, but prevents depression of the others till the circuit is broken, as and for the purpose specified.

2. The cylinder B, having strips *x* on its upper side and studs and strips *x′* on its opposite side, in combination with keys A having metallic connecting-points, and the plates Z, sending-instruments E F, combined as shown and described.

3. The combination, in a receiving-instrument, of the bar Z attached to needle T and having aperture *o*, with the traveling sensitized strip to direct a ray of light thereon, as and for the purpose described.

4. The mode of signaling or recording signals through a submarine line or cable, by utilizing all electrical impulses, or each movement of the galvanometer-needle or needle-bar, to form on the sensitized strip a positive sign, or part of a complete sign, of a word or letter, as set forth.

5. The alphabet, as shown and described.

6. The combination of the cylinder, having metallic projections on its periphery, keys having corresponding projections, plates Z, sending-instruments E and F, the cable or wire

connection, the galvanometer, the bar T having an eye, A, and the traveling sensitized strip, as shown and described, whereby dashes or curves are formed lengthwise of the strip and sidewise or oblique to the line of motion, to be read from left to right instead of from top to bottom, in reference to an imaginary zero-point, as at present, the same being connected in a continuous line, as specified.

7. The combination of the detent-armature, revolving spur-wheel, magnets G, cylinder B, having metallic projections, the keys having metallic projections on the under side, and wire, as shown and described.

The above specification of my invention signed by me this 10th day of February, 1874.

W. E. SAWYER.

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