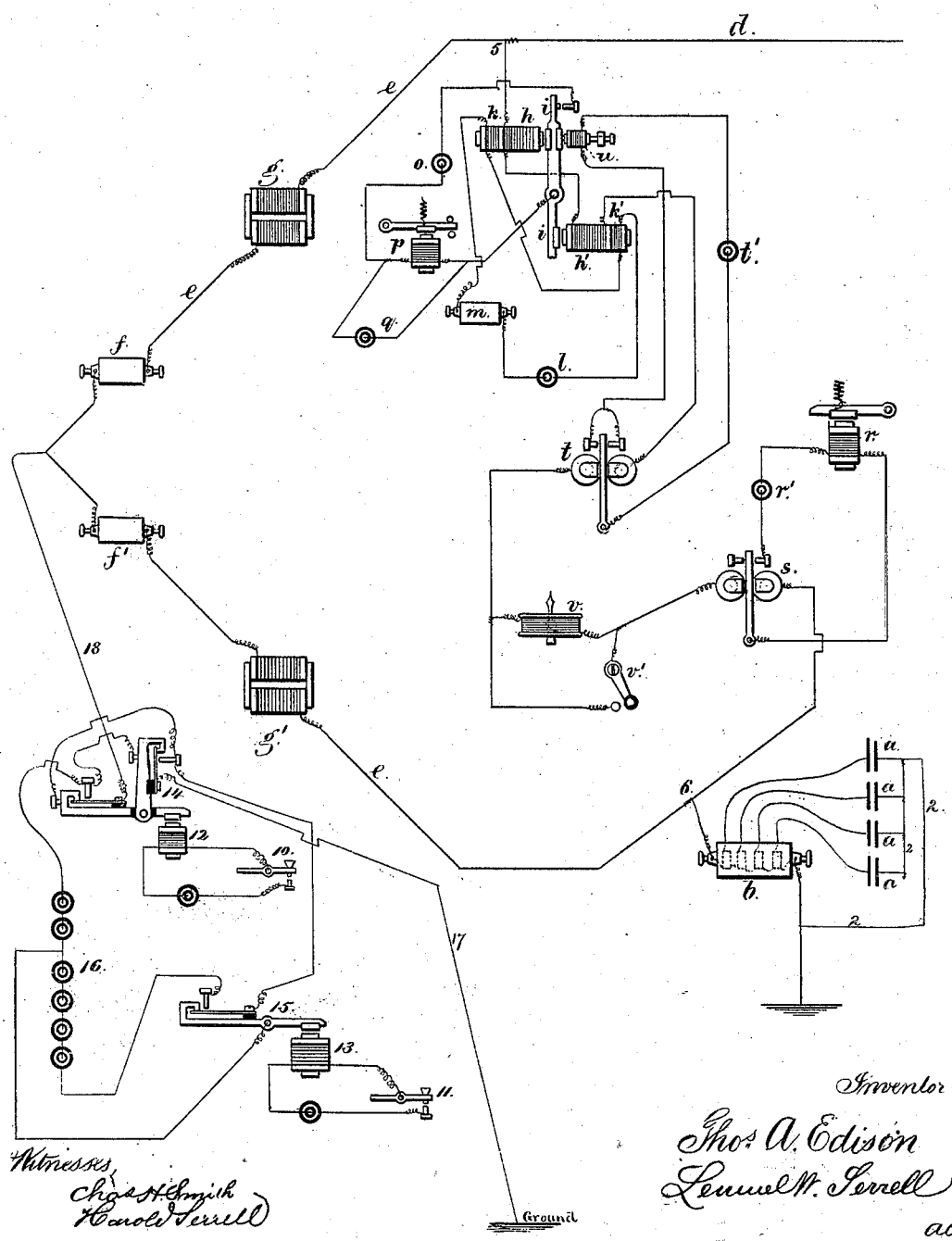
T. A. EDISON.
Duplex Telegraph.

No. 207,724. Patented Sept. 3. 1878.



Witnesses,
Chas. H. Smith
Harold Serrell

Inventor
Thos. A. Edison
Lemuel W. Serrell
att'y.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF NEWARK, NEW JERSEY.

IMPROVEMENT IN DUPLEX TELEGRAPHS.

Specification forming part of Letters Patent No. 207,724, dated September 3, 1878; application filed December 28, 1874.

To all whom it may concern.

Be it known that I, THOMAS A. EDISON, of Newark, in the county of Essex and State of New Jersey, have invented an Improvement in Duplex Telegraphs, of which the following is a specification:

Duplex telegraphs have been made with an artificial line connected to a bridge, and a resistance and condensers have been used in such artificial line; but the artificial line does not properly represent the telegraph-line, and there are inaccuracies in the action of the artificial line arising from the fact that the energy of the current sent is greatest near the sending-station and diminishes toward the receiving-station, and the reaction or static discharge is in the same proportion, the last portion thereof being the weakest; but in the artificial line the condensers discharge so nearly simultaneously that the static discharge from them does not properly balance the static discharge from the line.

The first portion of my present invention relates to the arrangement of the condensers and rheostats composing the artificial line.

The second portion of my invention relates to the combination of a retractile magnet with the armature of the receiving-magnet, the retractile magnet being so arranged as to release its action upon the said armature at the moment of the reversal of polarity of the main battery.

In carrying out the first part of my invention, instead of making use of a single condenser having a static capacity equivalent to that of the line, as has heretofore been the practice, I employ two or more separate condensers, the number depending upon the length of the line, and having an aggregate capacity equal to that of the single condenser heretofore employed.

It is well known that the static capacity, and consequently the charge of a long line, is greatest at the end adjacent to the battery, and decreases progressively from thence to the distant end, where it becomes *nil*. When, therefore, the line is discharged by disconnecting the battery, and connecting the same end to the earth, as in duplex transmission, the initial portion of the discharge is the most powerful, after which it decreases rapidly until it becomes imperceptible, for the reason that the portion of the charge contained in the distant portion of the line is not only proportionately smaller in amount, but also has a greater length of line or resistance to pass through to reach the point of discharge.

In order to produce a corresponding action in the artificial line, I employ a suitable number of separate condensers, *a a*, of progressively-increasing capacity, and of which the aggregate capacity is equal to that of the line. For example, suppose the capacity of the line is represented by 1,600, and four condensers were employed, as shown in the drawing, then the capacities of the respective condensers should be approximately 700, 500, 300, and 100. Between the several condensers and the line I also place rheostats *b b*, so adjusted and arranged that the condensers will be charged and discharged through resistances having to each other the relation of the numbers 1, 2, 3, and 4. When arranged on this principle the charging and discharging of the group of condensers *a a* will correspond with that of the line with sufficient accuracy for all practical purposes. This arrangement is applicable to all descriptions of duplex and multiple telegraphs.

The line *d*, wires *e e*, and connections from 5 to 6 form the bridge, and in the bridge-wires *e* are the rheostats *f f'* and electro-magnets *g g'*, and these electro-magnets neutralize the effects of the secondary currents from the receiving-magnets placed between 5 and 6 in the bridge, which, were it not for these electro-magnets and their neutralizing discharge, would circulate in the circuit formed by *e e* 5 6, and cause the relay-magnets in such circuits to stick, or respond too slowly. The rheostats *f f'* should be adjusted to properly regulate the resistance in *e e*.

The double-coiled receiving-magnet *h h'* is worked by increased or decreased current from the distant station. I find that it is better to divide this magnet into two parts, so as to use short spools and obtain as great or greater power, with less resistance, than would arise if the whole of the wire were coiled on one core, and these magnets *h h'* are at opposite sides of the armature-lever *i* and its fulcrum, so as to act in unison.

There is a second coil or spool, *k k'*, to each core of the electro-magnets *h h'* in a local circuit, with a battery, *l*, and adjustable rheostat, *m*. The action of these coils is so adjusted by the rheostat that any currents that may leak into the line from the ground by imperfect insulation or otherwise are neutralized, and for this purpose the poles of the battery are to be properly connected, according to the character of the current leaking to the line. Thereby the line is better adapted to quadruplex transmission, because if the action of the current from the distant station is varied by its strength being increased by an addition of the same polarity, or lessened by a leakage of opposite polarity, the effect is neutralized by the local circuit from *l*, and the coils *k k'* acting upon the cores of the magnets *h h'* in a way to balance the effect on such cores by the leakages of the line.

The armature-lever *i* operates the local circuit of the battery *o*, and in this is the sounder *p*, for receiving from the distant station, and to this sounder is also connected the local circuit *q*, as explained in one of my previous applications for patents. In this case the sounder *p* responds according to the pulsations from the distant station, whether the same is a rise or decrease of tension; so, also, the sounder *r* in the local circuit from *r'* is operated by the polarized magnet *s*, according to the reversal of the currents from the sending-station, as before explained in my previous application.

In the circuit between 5 and 6 is placed a second polarized magnet, *t*, and its armature is operated only by the reversal of the current, and it opens and closes the circuit from *t'* through the retractile magnet *u*. This magnet *u* takes the place of a spring to draw back the armature *i*. It is known that when a reversal of the current takes place in an electro-magnet there is a moment of neutralization or no magnetism; hence at that moment a spring, if used, pulls the armature back, and produces a false operation in the quadruplex telegraph especially. The tongue of the polarized magnet *t* in the circuit of the permanent retractile magnet *u*, being moved by reversal of current on the main line, opens the circuit of *u* momentarily, and then closes the same, so as to neutralize as far as possible the risk of a false movement of *i* by breaking the circuit of *u* at the instant of reversing the polarity.

The galvanometer at *v* and a switch, *v'*, to place it in circuit are useful in the adjustment of the rheostats and the balancing of the electric energies. When the resistance of the artificial line is equal to that of the main line there will not be any current through the bridge; hence the galvanometer will remain uninfluenced.

The finger-keys 10 and 11 are employed to open and close local circuits to the electro-magnets 12 and 13, and these in turn operate the circuit-preserving keys 14 and 15, that are connected with the two-part battery 16, earth-wire 17, and line-wire 18, in a manner similar to that heretofore employed by me, so that one operator's message is indicated by the reversal of the polarity of the current, and the others by producing a rise and fall in the tension of the current sent.

The particular transmitting devices shown are not herein claimed, being included in my application designated as Case 99, filed September 1, 1874.

I claim as my invention—

1. In a duplex telegraph, an artificial line provided with two or more condensers of varying capacity, and a like number of rheostats of varying resistance, for regulating the charge and discharge of the same to correspond with that of the main line, substantially as and for the purpose specified.

2. The retractile magnet *u*, combined with the magnet *h* and polarized magnet *t*, that acts to momentarily break the circuit of *u* when the reversal of polarity takes place, substantially as set forth.

Signed by me this 14th day of December, A. D. 1874.

THOS. A. EDISON.

Witnesses:
GEO. T. PINCKNEY,
CHAS. H. SMITH.