

(No Model.)

3 Sheets—Sheet 1.

S. W. HOLMAN.
MULTIPLE TELEPHONE.

No. 578,992.

Patented Mar. 16, 1897.

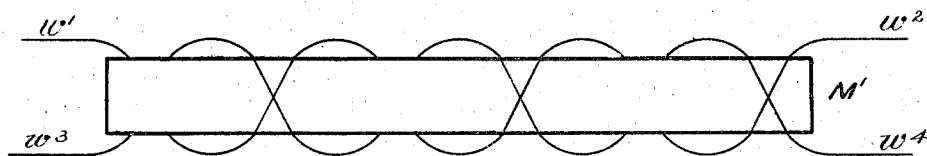


Fig. 1.

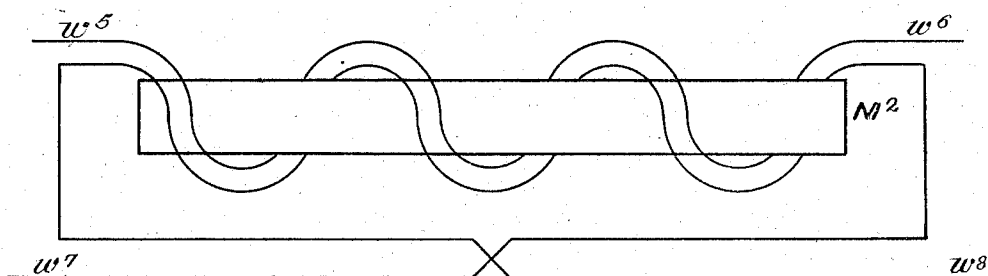


Fig. 2.

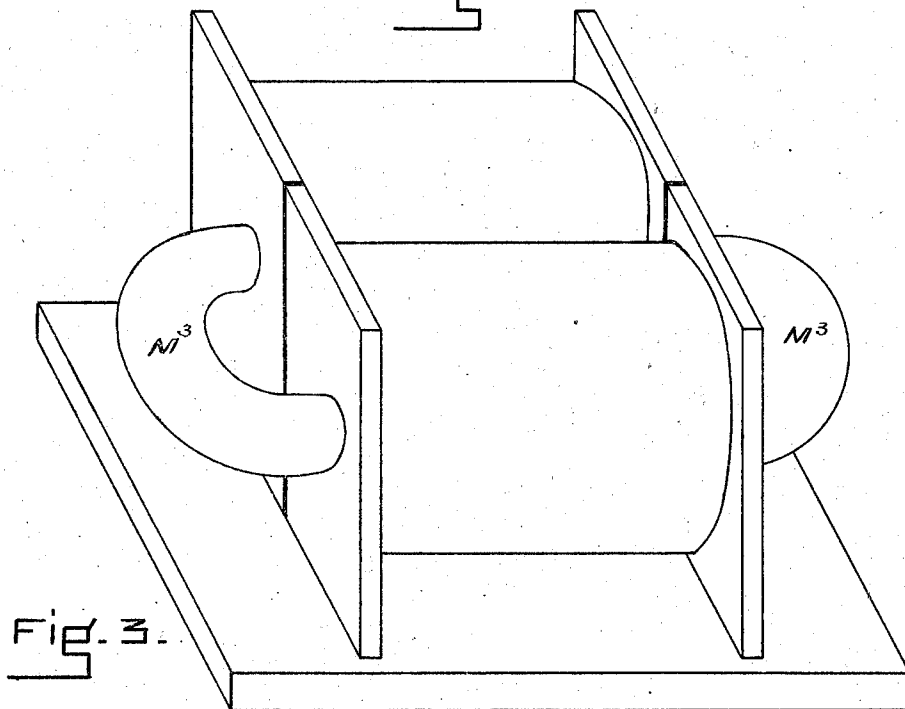


Fig. 3.

WITNESSES

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(No Model.)

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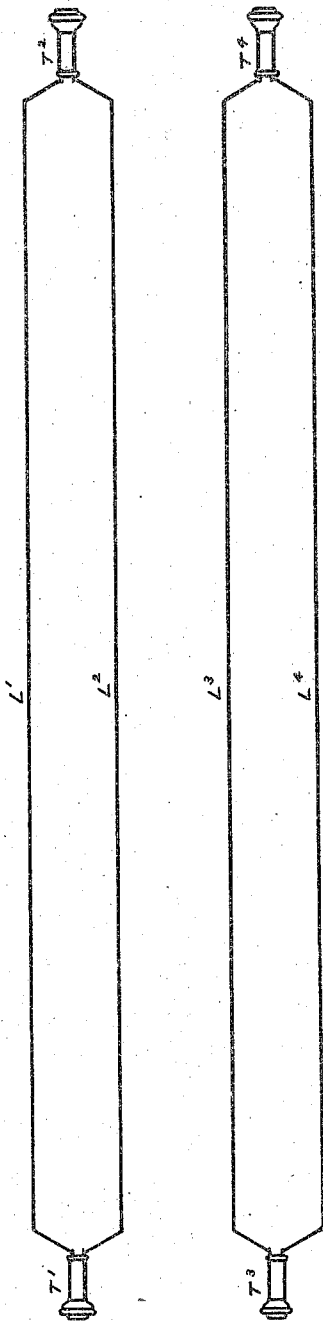


Fig. 4.

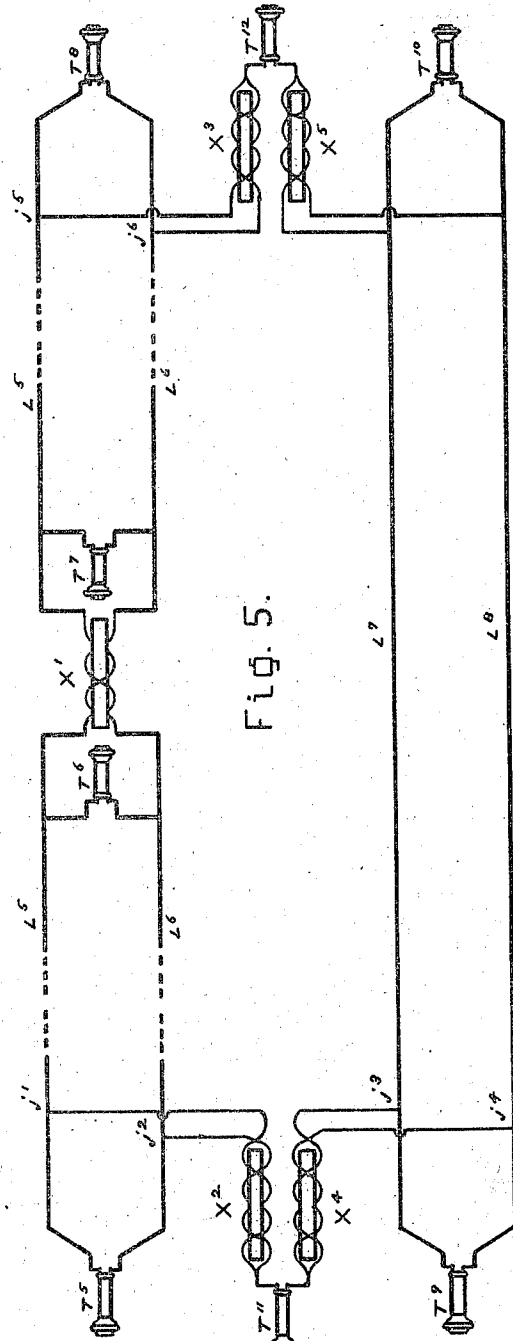


Fig. 5.

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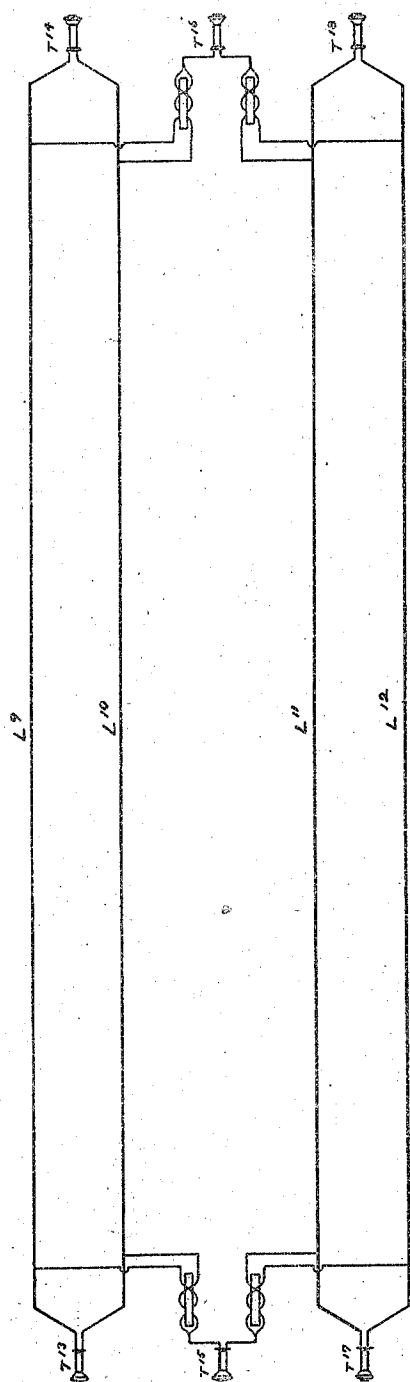


Fig. 6.

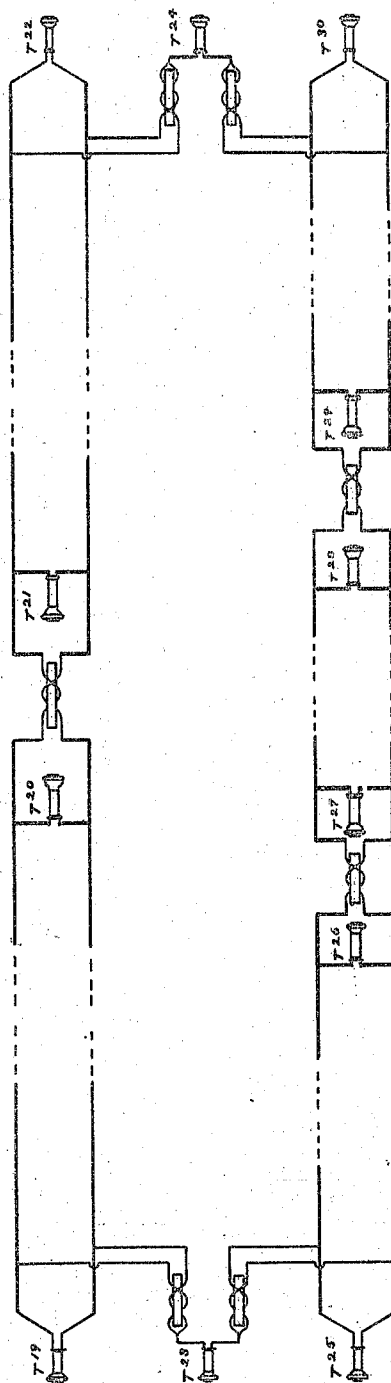


Fig. 7.

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UNITED STATES PATENT OFFICE.

SILAS W. HOLMAN, OF BOSTON, MASSACHUSETTS.

MULTIPLEX TELEPHONY.

SPECIFICATION forming part of Letters Patent No. 578,992, dated March 16, 1897.

Application filed May 31, 1893. Serial No. 476,090. (No model.)

To all whom it may concern:

Be it known that I, SILAS W. HOLMAN, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain
5 Improvements in Multiplex Telephony, of which the following is a specification.

The object of my invention is, with a given number of metallic circuits, to increase the number of such circuits without adding to
10 the number of wires.

By the use of my invention I may obtain from two long circuits an additional series of shorter intermediate circuits, or I may obtain from two long circuits an additional long
15 circuit, or from a series of shorter circuits I may obtain one or more additional longer circuits. While none of the circuits are decreased in efficiency, the longer added circuits are more efficient than are original circuits
20 of the same length. All of the circuits, whether original or added, may be operated in every respect as if they were all original circuits, each with a separate pair of wires.

A special feature of my invention is the
25 use of a double-wound electromagnetic impedance-coil which is separate from and additional to the transmitting and receiving instruments, but which is hereinafter more fully described, whose peculiar usefulness arises
30 in part from the fact that it is impermeable to telephone-currents tending to pass through the two windings in series and yet readily permeable to telephone-currents passing through the two windings in multiple and in
35 part from the fact that it acts as an equalizer of two otherwise unequal undulatory currents passing through the two windings in multiple.

In the drawings, Figure 1 is a diagrammatic view of the double-wound electromagnetic impedance-coil used in practicing my
40 invention. Fig. 2 shows an alternative method of winding the coil that is equally efficient and more convenient in construction. Fig.
45 3 is a perspective view of the coil as actually constructed for use in practicing my invention. Fig. 4 is a diagram showing how two telephone-circuits are arranged from four parallel wires in the manner heretofore generally in use. Fig. 5 shows two long and two
50 short telephone-circuits contrived from the same four parallel wires according to my in-

vention. Fig. 6 shows three long telephone-circuits contrived from the same four wires according to my invention. Fig. 7 shows one
55 added long telephone-circuit contrived from a series of short local circuits according to my invention.

The same letters designate like parts in the same or different figures, numerals being
60 added to the letters to indicate the different parts of the same kind.

Thus T represents a telephone; L, a line-wire; X, a double-wound electromagnetic impedance-coil; M, a magnetic core; *w*, a wire
65 wound upon a core, and *j* a junction between two wires.

In order that the invention may be fully understood, it is convenient to first describe the double-wound electromagnetic im-
70 pedance-coil, which plays so important a part in practicing the invention.

Referring to Fig. 1, *M'* is a magnetic core. *w' w²* is a wire wound around the core in one direction, (say left-handed,) and *w³ w⁴* a similar wire wound around the core in the opposite direction, (say right-handed.) In practice each winding should have a large number of turns, so that alone and without the other it would present a considerable im-
80 pedance to a telephone-current. If it is desired that the ohmic resistance of the coil shall not be large, wire of large sectional area should be used. In practice, also, the core should consist of an annular bundle of soft-iron
85 wires to increase the impedance, as shown in Fig. 3. The bobbin may be in two parts for convenience of construction. Each bobbin, however, has two separate windings, as shown in Fig. 1. The peculiar usefulness of this
90 coil arises from the fact that its self-induction is so large as to practically prevent the flow of telephone-currents through the two windings in series, while the mutual induction of the two windings is such that it practically annuls the effect of the self-induction
95 of the single coils when a current flows equally through the two windings in multiple. Thus the coil is practically impermeable to a telephone-current tending to pass
100 over the path *w' w² w⁴ w³* and yet is readily permeable to a telephone-current or to two equal telephone-currents passing in multiple over the two paths *w' w²* and *w³ w⁴*. Moreover,

the coil does not act as a transmitter or receiver, but as an equalizer of two otherwise unequal telephone-currents passing through the two windings in multiple, tending to increase the lesser current and to decrease the greater without material loss of energy. Thus if the telephone-current passing over the path $w' w^2$ were somewhat greater than the telephone-current passing over the path $w^3 w^4$ the effect of the coil as a whole would be to diminish the stronger current and increase the weaker current until they become equal. This equalizing effect of course extends within limits to whatever circuit the windings $w' w^2$ and $w^3 w^4$ may be connected with, so that we have here an instrument capable of equalizing two otherwise unequal telephone-currents flowing, for instance, upon two parallel telephone-line wires.

For convenience of construction I may wind the two wires side by side about each portion of the core, as shown in Fig. 2, in which case the coil is impermeable to a telephone-current tending to flow over the path $w^5 w^6 w^8$ and yet is readily permeable to a telephone-current or to two equal telephone-currents passing in multiple over the two paths $w^5 w^6$ and $w^7 w^8$.

Any form of double-winding may be adopted in which two equal wires are wound equally about each portion of the core in opposite directions regarding the currents flowing through the two windings in multiple—i. e., so that two equal currents, whether constant, intermittent, or variable, flowing through the two windings in multiple shall exert equal and opposing magnetizing forces not only on the core as a whole, but upon each portion of the core. In proportion as the above desiderata are attained will the benefits of this feature of my invention be realized.

For convenience in studying the remaining diagrams I have designated the above-described double-wound electromagnetic impedance-coil by the letter X.

Having thus described the method of construction and properties of the double-wound electromagnetic impedance-coil, it remains to show how I make use of it in practicing my invention.

Fig. 4 shows four parallel line-wires connected to form two metallic telephone-circuits in the manner heretofore generally in use. The two line-wires L^1 and L^2 form one metallic circuit for the two telephones T^1 and T^2 , and the two line-wires L^3 and L^4 form a second metallic circuit for the two telephones T^3 and T^4 .

Fig. 5 shows how, by the use of my invention, we may contrive two long and two short telephone-circuits from the same four line-wires, here designated L^5 , L^6 , L^7 , and L^8 . X^1 is a double-wound electromagnetic impedance-coil, such as is above described, inserted in lines L^5 and L^6 , as shown. As this coil is impermeable to a telephone-current tending to pass through the two windings in series,

the lines L^5 and L^6 are divided by it into two telephone-circuits $T^5 T^6$ on one side and $T^7 T^8$ on the other, and an inspection of the diagram shows that while conversation may be carried on between T^5 and T^6 or between T^7 and T^8 no communication is possible between T^5 or T^6 on the one hand and T^7 or T^8 on the other. Telephone T^9 is in communication with telephone T^{10} by the line-wires L^7 and L^8 . Let us next see how telephone T^{11} is put in communication with telephone T^{12} without affecting any of the other telephones of the system. A current from telephone T^{11} passes through the two windings of the coil X^2 in multiple (hence without impedance) and joins the two line-wires L^5 and L^6 at junctions j^1 and j^2 . It then passes along the two line-wires L^5 and L^6 in multiple, through coil X^1 in multiple, (hence without impedance,) leaves the line-wires at j^5 and j^6 , passes through X^3 in multiple, through telephone T^{12} , through coil X^5 in multiple, over lines L^7 and L^8 in multiple, through coil X^4 in multiple, back to its starting-point in telephone T^{11} . The current from T^{11} , arriving at j^1 and j^2 , has no effect on telephone T^5 , because it charges the two junctions j^1 and j^2 to the same potential. For the same reason it has no effect on telephones T^6 , T^7 , T^8 , T^9 , and T^{10} . Moreover, if the lines L^5 and L^6 , because of slight electrical inequality, should not otherwise carry equal telephone-currents away from or toward junctions j^1 and j^2 , the coil X^2 will react on these lines to make the currents equal, in the manner above described. In the same way coil X^1 has an equalizing effect on currents at the two terminals of T^6 and also on the two terminals of T^7 , as also coil X^3 equalizes the potential of the terminals of telephone T^8 , coil X^5 those of telephone T^{10} , and coil X^4 those of telephone T^9 . In fact these various coils act together to remove any inequalities of potential between lines L^5 and L^6 or between lines L^7 and L^8 which might come from slight differences of conductivity, capacity, insulation, or self-induction on these line-wires.

Fig. 6 is in all respects like Fig. 5, excepting that there is no intermediate station. T^{13} and T^{14} are in communication over lines L^9 and L^{10} , T^{17} and T^{18} over lines L^{11} and L^{12} , and T^{15} and T^{16} are in communication over lines L^9 and L^{10} as one side of the circuit and over lines L^{11} and L^{12} as the other. The added circuit $T^{15} T^{16}$ is found in practice to be telephonically superior to either of the original circuits $T^{13} T^{14}$ or $T^{17} T^{18}$. This I suppose to be due to the facts that the resistance and impedance of the two line-wires L^9 and L^{10} in multiple are each one-half of either wire alone, that the same is true of line-wires L^{11} and L^{12} , and that the capacity of L^9 and L^{10} in multiple toward L^{11} and L^{12} is very little greater than the capacity between either original pair of wires.

Fig. 7 shows a long telephone-circuit $T^{23} T^{24}$ contrived from a series of shorter circuits—

viz., $T^{19} T^{20}$ and $T^{21} T^{22}$ forming one branch and $T^{25} T^{26}$, $T^{27} T^{28}$, and $T^{29} T^{30}$ the other branch. As in Fig. 6, the long circuit $T^{23} T^{24}$ is electrically superior to an original circuit of the same length and of course superior per mile to the shorter circuits here shown.

In special cases it may be desirable to employ a single conductor or even the earth in place of a metallic circuit forming one branch of an added circuit. Thus in Fig. 5, for example, the telephone-circuit between T^{11} and T^{12} , which passes from T^{11} to T^{12} over the path $T^{11} X^2 L^5 L^6$ in multiple, X^3 , T^{12} might be returned from T^{12} to T^{11} by a single conductor or by ground instead of by the path $X^5 L^7 L^8$ in multiple, X^4 , in which case the telephone-circuit $T^9 T^{10}$ would of course be dispensed with.

I claim—

1. In combination with two original metallic telephone-circuits, each consisting of two conductors and a telephone at each end of each, an added metallic telephone-circuit consisting, at each end, of a telephone, each terminal of which is connected in multiple with the two conductors of one original circuit through two wires wound equally about each portion of a magnetic core, in opposite directions regarding currents which flow through the two windings in multiple.

2. In combination with an original metallic telephone-circuit, consisting of two conductors and a telephone at each end, an added telephone-circuit consisting, at each end, of a telephone one terminal of which is connected in multiple with the two conductors of one original circuit through two wires wound equally about each portion of a magnetic core in opposite directions regarding currents which flow through the two windings in multiple, while the other terminal is connected to the corresponding telephone at the distant end by one or more conductors or by the earth.

3. In combination with two original metallic telephone-circuits, each consisting of two conductors and a telephone at each end of each, two wires connecting the two conductors of one original circuit to the two conductors of the other original circuit, said wires being wound equally about each portion of a magnetic core in opposite directions regarding currents which flow through the two windings in multiple.

4. In combination with two original metallic telephone-circuits, each consisting of two conductors and a telephone at each end of each, an added metallic telephone-circuit consisting, at each end, of a telephone, each terminal of which is connected in multiple with the two conductors of one original circuit through the two windings of a differentially-wound electromagnetic coil.

5. In combination with an original metallic telephone-circuit, consisting of two conductors and a telephone at each end, an added telephone-circuit consisting, at each end, of a telephone, one terminal of which is con-

nected in multiple with the two conductors of one original circuit through the two windings of a differentially-wound electromagnetic coil, while the other terminal is connected to the corresponding telephone at the distant end by one or more conductors or by the earth.

6. In combination with two original metallic telephone-circuits, each consisting of two conductors and a telephone at each end of each, two wires connecting the two conductors of one original circuit to the two conductors of the other original circuit, said wires being differentially wound about a magnetic core.

7. As an equalizer for two undulatory currents flowing in multiple through two conductors, a double-wound impedance-coil, consisting of a magnetic core with two wires wound about each portion of it in opposite directions regarding currents which flow through the two windings in multiple, one of said windings being connected to each of said conductors.

8. In a line for electrical communication, the combination of two conductors; receiving and transmitting instruments connected therewith, and a differentially-wound electromagnetic coil which has its two windings respectively connected to the two conductors and which acts as an equalizer of the currents flowing in multiple therein and not as a transmitter or receiver.

9. In combination with two original metallic telephone-circuits, each consisting of two conductors and a telephone at each end of each, an added metallic telephone-circuit consisting, at each end, of a telephone, each terminal of which is connected in multiple with the two conductors of one original circuit through two wires wound equally about each portion of a magnetic core, in opposite directions regarding currents which flow through the two windings in multiple.

10. In combination with an original metallic telephone-circuit, consisting of two conductors and a telephone at each end, an added telephone-circuit consisting, at each end, of a telephone, one terminal of which is connected in multiple with the two conductors of one original circuit through two wires wound equally about each portion of a magnetic core in opposite directions regarding currents which flow through the two windings in multiple, while the other terminal is connected to the corresponding telephone at the distant end by one or more conductors or by the earth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 25th day of May, 1893.

SILAS W. HOLMAN.

Witnesses:

WILLIAM W. JACQUES,
REUBEN L. ROBERTS.