(No Model.) 3 Sheets—Sheet 1.

S. W. HOLMAN.

MULTIPLE TELEPHONE.

No. 578,992. Patented Mar. 16, 1897.

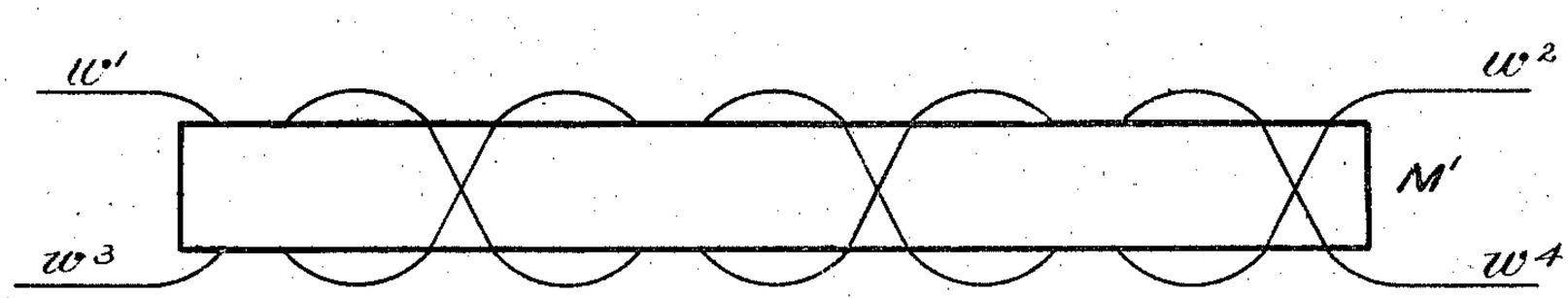

Fig. 1.

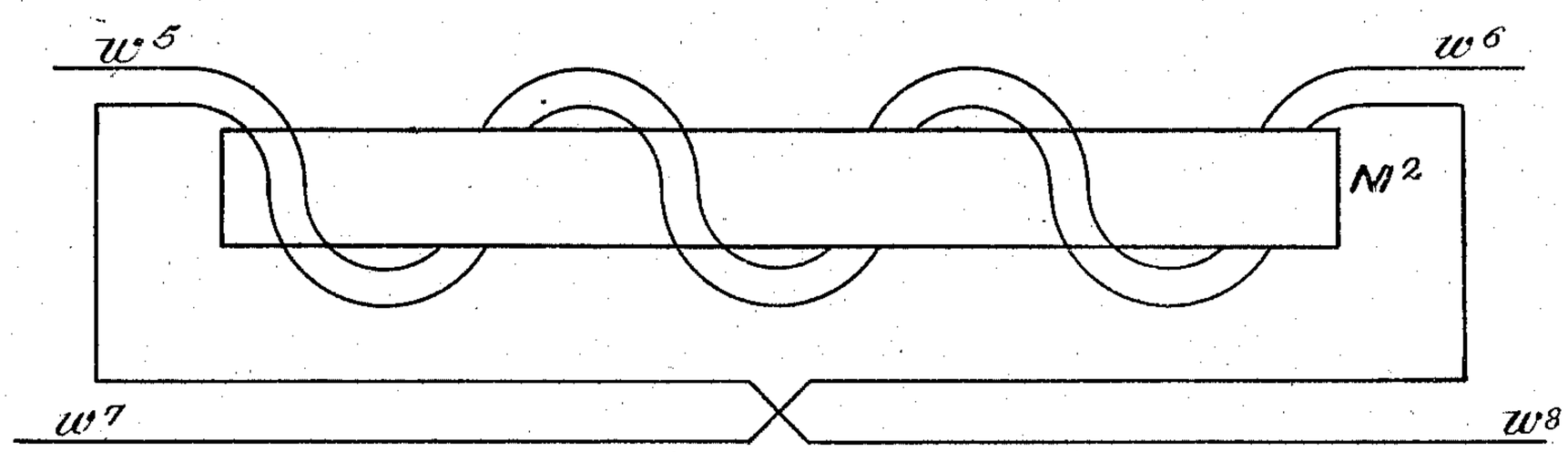

Fig. 2.

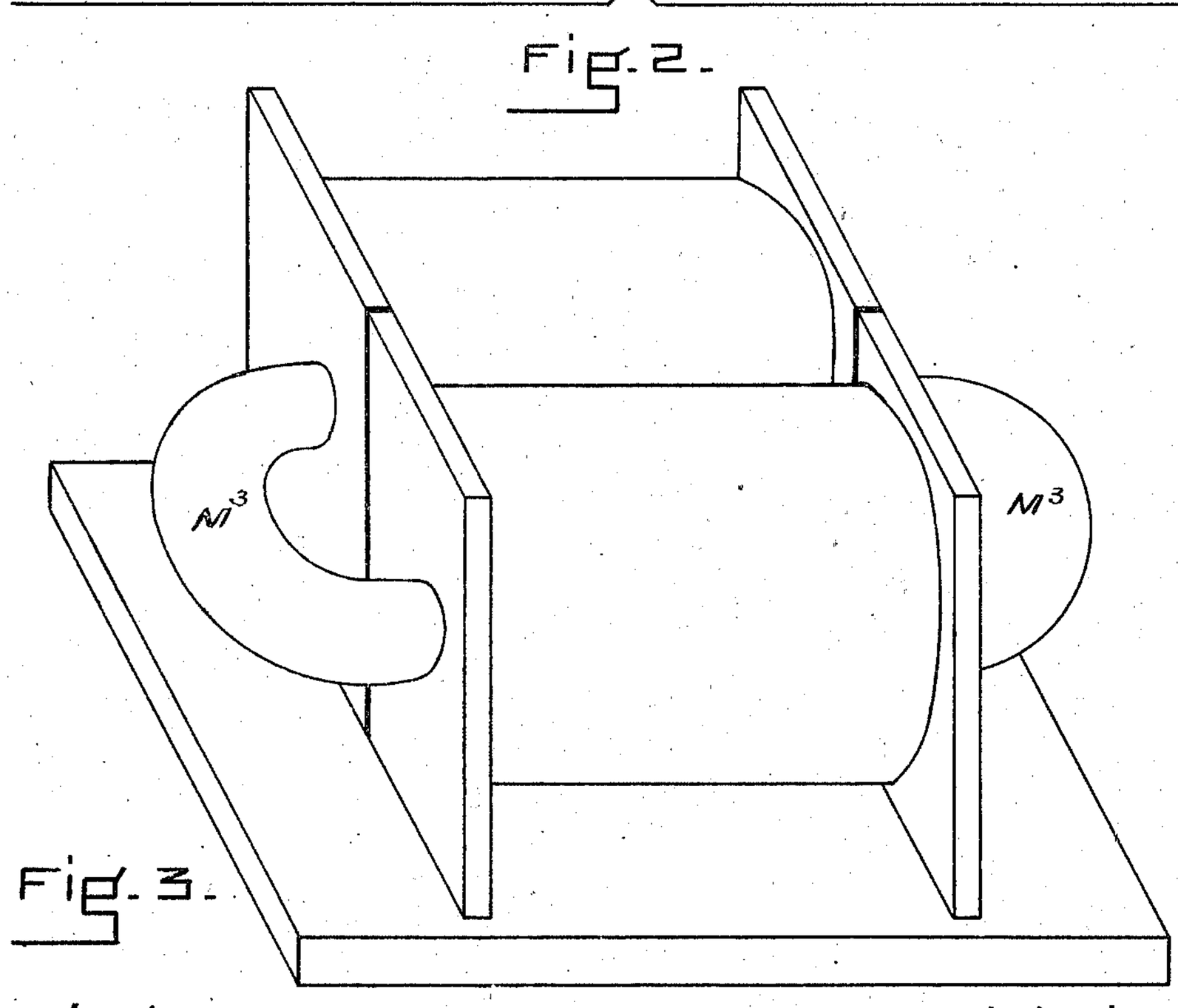

Fig. 3.

WITNESSES

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(No Model.) 3 Sheets—Sheet 2.

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MULTIPLE TELEPHONE.

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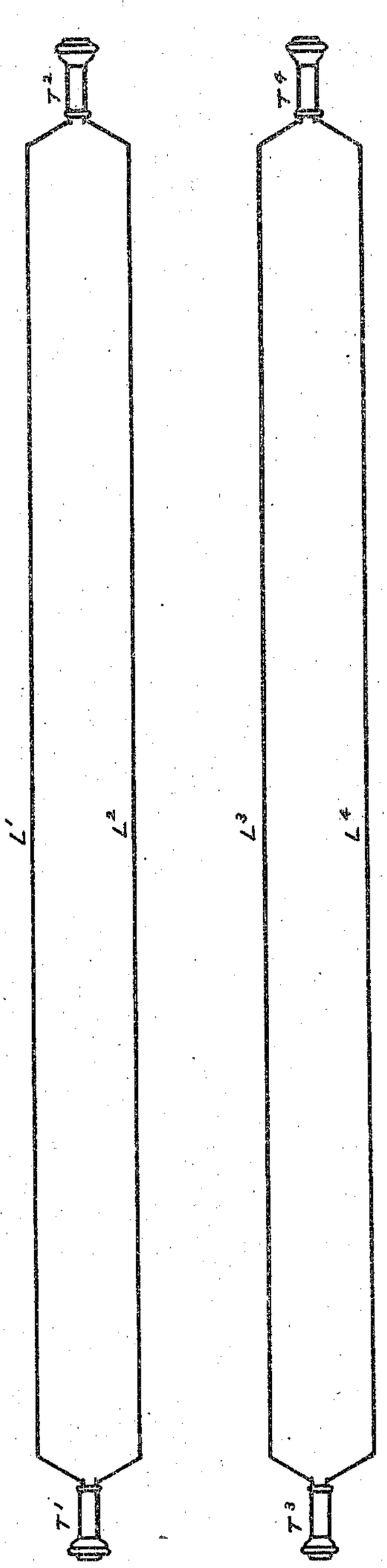

Fig. 4.

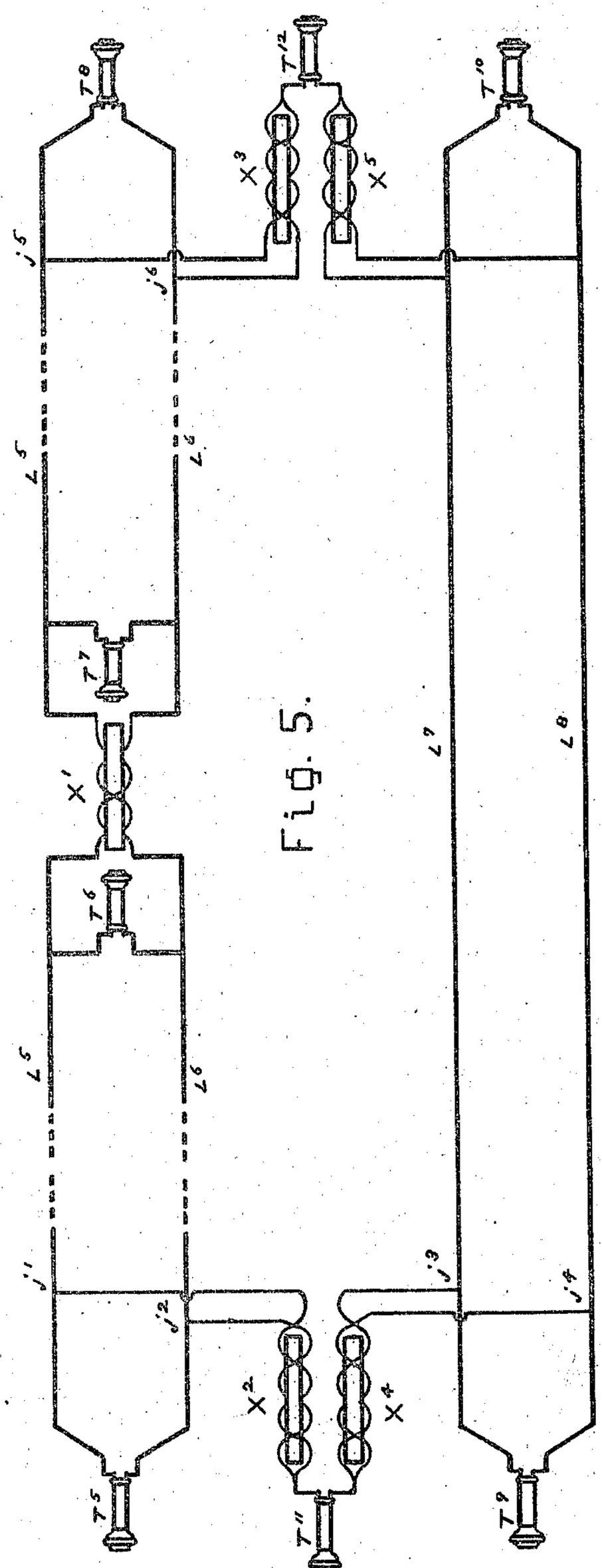

Fig. 5.

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(No Model.) 3 Sheets—Sheet 3.

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MULTIPLE TELEPHONE.

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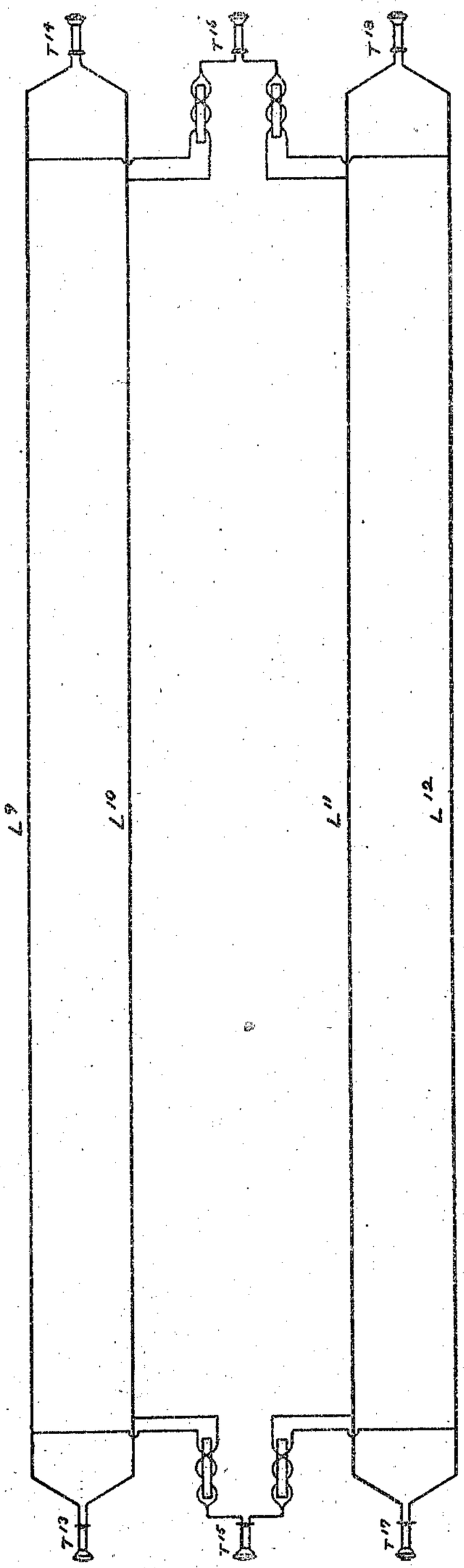

Fig. 6.

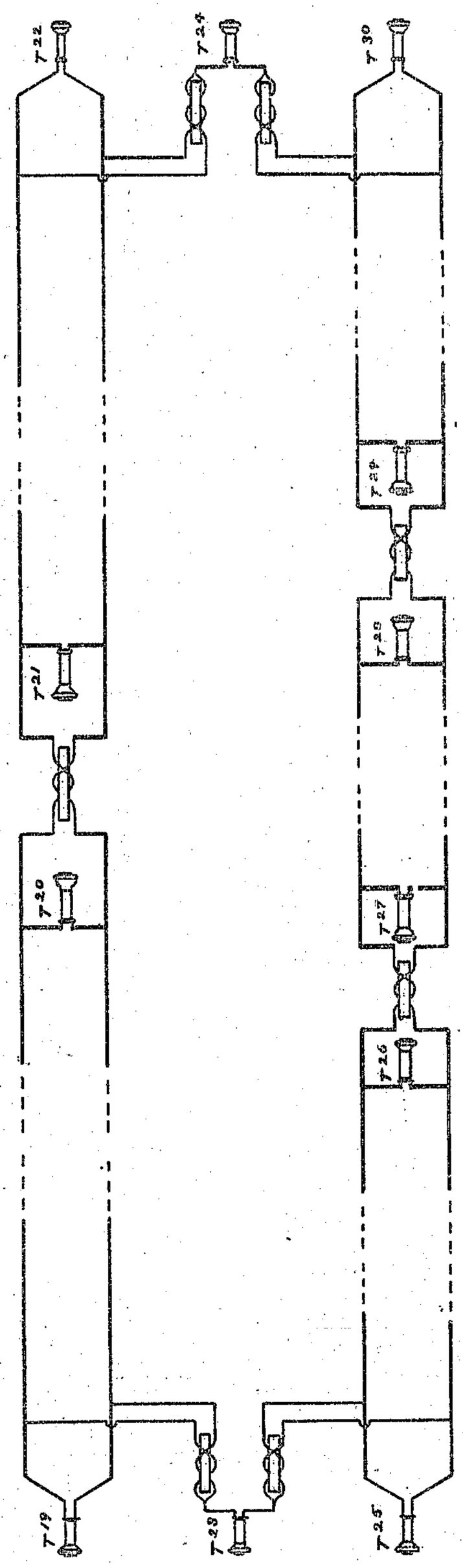

Fig. 7.

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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 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 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 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 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 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 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 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 invention. Fig. 2 shows an alternative method of winding the coil that is equally efficient and more convenient in construction. Fig. 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 short telephone-circuits contrived from the same four parallel wires according to my invention. Fig. 6 shows three long telephone-circuits contrived from the same four wires according to my invention. Fig. 7 shows one 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 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 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 impedance-coil, which plays so important a part in practicing the invention.

Referring to Fig. 1, M′ is a magnetic core. w' w^2 is a wire wound around the core in one direction, (say left-handed,) and w^3 w^4 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 impedance 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 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 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 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 over the path w' w^2 w^4 w^3 and yet is readily permeable to a telephone-current or to two equal telephone-currents passing in multiple over the two paths w' w^2 and w^3 w^4. 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 w^7 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′ and L² form one metallic circuit for the two telephones T′ and T², and the two line-wires L³ and L⁴ form a second metallic circuit for the two telephones T³ and T⁴.

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 L⁵, L⁶, L⁷, and L⁸. X′ is a double-wound electromagnetic impedance-coil, such as is above described, inserted in lines L⁵ and L⁶, as shown. As this coil is impermeable to a telephone-current tending to pass through the two windings in series, the lines L⁵ and L⁶ are divided by it into two telephone-circuits T⁵ T⁶ on one side and T⁷ T⁸ on the other, and an inspection of the diagram shows that while conversation may be carried on between T⁵ and T⁶ or between T⁷ and T⁸ no communication is possible between T⁵ or T⁶ on the one hand and T⁷ or T⁸ on the other. Telephone T⁹ is in communication with telephone T¹⁰ by the line-wires L⁷ and L⁸. Let us next see how telephone T¹¹ is put in communication with telephone T¹² without affecting any of the other telephones of the system. A current from telephone T¹¹ passes through the two windings of the coil X² in multiple (hence without impedance) and joins the two line-wires L⁵ and L⁶ at junctions j' and j^2. It then passes along the two line-wires L⁵ and L⁶ in multiple, through coil X′ in multiple, (hence without impedance,) leaves the line-wires at j^5 and j^6, passes through X³ in multiple, through telephone T¹², through coil X⁵ in multiple, over lines L⁷ and L⁸ in multiple, through coil X⁴ in multiple, back to its starting-point in telephone T¹¹. The current from T¹¹, arriving at j' and j^2, has no effect on telephone T⁵, because it charges the two junctions j' and j^2 to the same potential. For the same reason it has no effect on telephones T⁶, T⁷, T⁸, T⁹, and T¹⁰. Moreover, if the lines L⁵ and L⁶, because of slight electrical inequality, should not otherwise carry equal telephone-currents away from or toward junctions j' and j^2, the coil X³ will react on these lines to make the currents equal, in the manner above described. In the same way coil X′ has an equalizing effect on currents at the two terminals of T⁶ and also on the two terminals of T⁷, as also coil X³ equalizes the potential of the terminals of telephone T⁸, coil X⁵ those of telephone T¹⁰, and coil X⁴ those of telephone T⁹. In fact these various coils act together to remove any inequalities of potential between lines L⁵ and L⁶ or between lines L⁷ and L⁸ 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. T¹³ and T¹⁴ are in communication over lines L⁹ and L¹⁰, T¹⁷ and T¹⁸ over lines L¹¹ and L¹², and T¹⁵ and T¹⁶ are in communication over lines L⁹ and L¹⁰ as one side of the circuit and over lines L¹¹ and L¹² as the other. The added circuit T¹⁵ T¹⁶ is found in practice to be telephonically superior to either of the original circuits T¹³ T¹⁴ or T¹⁷ T¹⁸. This I suppose to be due to the facts that the resistance and impedance of the two line-wires L⁹ and L¹⁰ in multiple are each one-half of either wire alone, that the same is true of line-wires L¹¹ and L¹², and that the capacity of L⁹ and L¹⁰ in multiple toward L¹¹ and L¹² is very little greater than the capacity between either original pair of wires.

Fig. 7 shows a long telephone-circuit T²³ T²⁴ 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 connected 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 an 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.