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E. B. Tomlinson.
Geol. Woodworth.

INVENTOR=

John Stone Stone
Valer P Brorson
attorney

J. S. STONE.
SPACE TELEGRAPHY.
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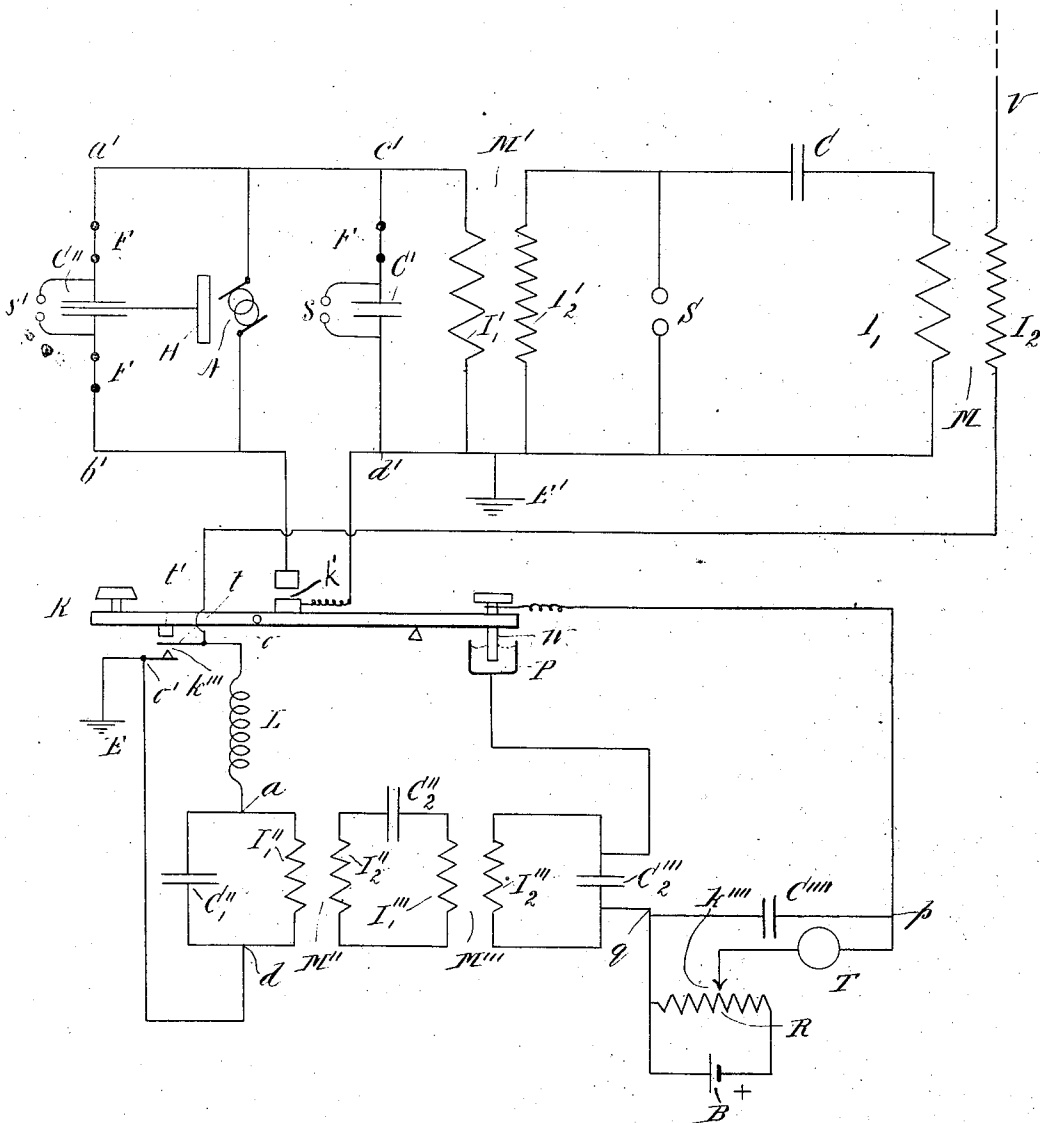


Fig. 2.

WITNESSES=

E. B. Tomlinson.
Geo. Woodworth.

INVENTOR

John Stone Stone
by Alex. P. Brown
attorney

UNITED STATES PATENT OFFICE.

JOHN STONE STONE, OF CAMBRIDGE, MASSACHUSETTS.

SPACE TELEGRAPHY.

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To all whom it may concern:

Be it known that I, JOHN STONE STONE, a citizen of the United States, and a resident of Cambridge, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Space Telegraphy, of which the following is a specification.

My invention relates to the art of transmitting intelligence from one station to another by means of electromagnetic waves without the use of wires to guide the waves to their destination; and it relates more particularly to the system of such transmission in which the electromagnetic waves are developed by producing electric vibrations or oscillations in an elevated conductor, preferably vertically elevated.

The objects of the present invention are to provide certain novel circuit arrangements for space telegraph transmitting and receiving systems; to provide means in the primary power circuit for protecting the electrical apparatus in said primary power circuit from the effects of excessive currents and potentials; and to provide certain improved details of construction which may be employed in connection with the circuit arrangements set forth in my prior patents, Nos. 714,756, Dec. 2, 1902, 767,984, Aug. 16, 1904, and 767,994, Aug. 16, 1904.

Other objects of my invention will hereinafter appear and will be particularly pointed out in the appended claims.

My invention may best be understood by having reference to the drawings which accompany and form a part of this specification and which illustrate certain apparatus and circuit arrangements embodying my invention; but it is to be understood that my invention is not limited to the particular embodiments thereof which are illustrated in said drawings inasmuch as my invention may be subjected to a wide range of variation without departing from the principle thereof.

In the drawings, Figure I diagrammatically represents a space telegraph transmitting system; Fig. 2 diagrammatically represents a combined transmitting and receiving space telegraph system.

In the figures, D A is a motor-generator comprising a direct-current motor D and an alternating current generator A; V is an

elevated conductor; E E' E'' are earth connections; M M' M'' M''' are transformers; I₁ I₁' I₁'' I₁''' are transformer primaries; I₂ I₂' I₂'' I₂''' are transformer secondaries; C C' C'' C''' C₁ C₂ C₃ C₄ C₅ are condensers; P is an oscillation responsive device herein shown as a Wollaston anode W in an electrolyte contained in a cup P; T is a telephone or other suitable signal-indicating device; B is a battery; R is a resistance; and S is a spark gap.

In Fig. 1 the circuit S C I₁ is a sonorous or persistently oscillating circuit inductively associated with the elevated conductor system V I₂ E by means of the transformer M whose windings I₁ I₂ preferably are so spatially related as to render the period of said sonorous circuit practically independent of the electromagnetic constants of said elevated conductor system, as more fully explained in the aforesaid patents. The circuit containing the alternator A and the primary I₁' of the transformer M' is the primary power circuit the energy of which is delivered at the desired tension to said sonorous circuit by means of said transformer. The motor-generator is energized by any suitable source of direct current, to the mains of which the motor D is connected.

For the purpose of protecting the armature windings of the alternator A, I connect the branch circuit a' b' across the terminals of said alternator and connect one armature of the condenser C'' included in said circuit to the frame H of the alternator, so that any electrical oscillations which may be created in the primary power circuit by the reaction of the sonorous circuit thereon, will be prevented from creating a difference of potential between said armature windings and the metallic parts of the alternator which lie adjacent to said windings. In order to protect the condenser C'' from the effects of excessive oscillating potentials which may be developed between the points a' and b', I connect a spark-gap s' across the terminals of said condenser. In order to protect the alternator from excessive currents which may be developed in the primary power circuit in case of condenser breakdown or arc at the spark-gap s' caused by the reaction of the sonorous circuit thereon or from any other cause I may connect a fuse F on either side of the condenser C'' in the branch a' b'.

A branch $c' d'$ is connected across the terminals of the primary I'_1 of the transformer M' and is connected to earth at E' . A spark-gap s is connected across the armatures of the condenser C' which is included in said branch $c' d'$. By means of said branch $c' d'$ and its connection to earth $d' E'$, the primary I'_1 of the transformer M' and the armature of the alternator A are protected from excessive potentials or currents developed in the primary power circuit by the reaction thereon of the sonorous circuit $S C I_1$. For the purpose of further protecting said primary power circuit as above set forth from excessive currents a fuse F may be connected on one side of the condenser C' , but obviously is not needed on the earthed side thereof. Both condensers C' and C'' should be so proportioned that each of the branches $a' b'$ and $c' d'$ should have for the frequency of the power current an impedance high as compared to its impedance for the frequencies of the oscillations developed in the sonorous or oscillating circuit.

When a direct-current source is employed as indicated in Fig. 1, the sparking at the commutator of the direct-current generator creates oscillatory surgings in the mains and these surgings being of relatively high frequency and having considerable amplitude will create currents in the receiving system which generally is located in close proximity to the transmitting system and which sometimes is intimately associated therewith as shown in Fig. 2.

For the purpose of eliminating the effect on the receiving system and its oscillation responsive device of such relatively high frequency oscillatory surgings I may connect the branch $e' f'$ across the motor side of the motor-generator $D A$ for conducting to earth the currents developed in the motor circuit by the sparking at the commutator of the generator which supplies the mains to which the motor is connected or the currents induced in said motor circuit by the surgings created in a neighboring direct-current transmission system. For this purpose the condenser C''' may be serially included in the branch $e' f'$ and one of its armatures may be earthed as shown at E'' . A fuse F may be included in said branch $e' f'$ on either side of the condenser C''' and a lightning arrester Q may be shunted across the terminals of said condenser.

The condenser C_5 , shown in the present instance as connected across the terminals of the primary of the transformer M' , has its capacity so related to the inductance of the primary power circuit as to reduce the impedance of the primary power circuit for currents of the frequency developed therein by the alternator A and thereby increase the power factor of said circuit. Obviously the

condenser C_5 may be arranged in other ways for effecting this result. It will of course be understood that, in general, the capacity of the condenser C_5 is larger than the capacity of either of the condensers $C' C''$.

In order to increase the power factor of the primary power circuit and render said power factor constant over a wide range of the secondary circuit current values I may include the inductance L_2 between one terminal of the primary I'_1 and one terminal of the condenser C_5 and arrange said inductance so that it will be out of inductive relation with the secondary I'_2 as shown in Fig. 1. In such case an inductance coil L_1 may be introduced in the primary power circuit as a means of assisting the condenser C_5 and inductance coil L_2 in maintaining the power factor of the primary circuit high and approximately constant for varying loads in the secondary or sonorous circuit. For this purpose the inductance of the coil L_1 plus the inductance of the armature of the generator A should equal approximately the sum of the inductance of the coil L_2 and the apparent inductance of the primary I'_1 of the transformer M' . The coil L_2 in this case serves to compensate for variations in the apparent or effective inductance of the primary I'_1 due to varying loads in the secondary circuit, and therefore maintains the inductance of the branch consisting of the primary I'_1 and the coil L_2 more nearly constant for varying loads on the transformer. A rheostat comprising the contact arm r and resistance R' may, as shown, be included in the circuit of the generator A and primary I'_1 to control the supply of energy to the transformer M' .

In Fig. 2 the protective devices are the same as those already described in connection with Fig. 1. The elevated conductor is connected to the spring contact t at the point o and the contact member which co-operates with said contact t is connected to earth at E . Between the points o and o' the receiving system is connected and it will be apparent that upon the depression of the key K the projection t' presses the spring t into contact with its cooperating member and closes the contact k''' thereby short-circuiting the receiving system between the points $o o'$ and thereby connecting the receiving system to the elevated transmitting conductor system $V I_2 o t o' E$ at a point having practically zero potential to earth. It will be apparent also that the potential difference developed between the points $o o'$ during transmission, even when currents of very large amplitude are developed in said elevated conductor system, will be negligibly small and will not develop in the receiving system currents of sufficient amplitude to injure the delicate parts thereof such as the coil L or the coils of the transformers

M'' M'''. Simultaneously with, or before or after, the closure of the contact k''' the receiver is rendered inoperative by raising the Wollaston anode W out of the electrolyte contained in the cell P. It is immaterial whether the anode be raised out of contact with said electrolyte before or after the closure of the contact k''' , all that is necessary being that both these operations occur prior to the closure of the contact k' .

I do not wish to limit myself to the particular means shown in Fig. 2 and described above for rendering the receiver inoperative, inasmuch as various other means may be employed for this purpose.

The elevated receiving conductor system consists of the elevated conductor *per se* V, the secondary I_2 , the conductor connecting the latter to the point o , the inductance L, the parallel branch circuit $C''_1 I''_1$ and the conductor connecting the latter to earth at E. The electromagnetic constants of said parallel branch circuit are so proportioned that for a persistent train of waves of the frequency to which the resonant receiving circuit $I_2''' C_2'''$ is attuned said parallel branch circuit will balance by its reactance the reactance of the rest of the elevated receiving conductor system, in which system it will be noted, the secondary I_2 operates merely as an inductance. The resonant weeding-out circuit $C''_2 I''_2 I''_1$ may, if desired, be interposed between the parallel branch circuit and the resonant receiving circuit $I_2''' C_2'''$ as more fully explained in my prior patents.

When electrical oscillations having the frequency to which the resonant receiving circuit is attuned are developed in said resonant receiving circuit, a maximum difference of potential exists across the terminals of the condenser C''_2 which is one of the tuning elements of said resonant circuit and therefore across the terminals of this condenser I connect the electrolytic receiver P in lieu of connecting said receiver in series with said resonant circuit. The apparent resistance of the electrolytic receiver P is large and if such receiver is connected in series with the resonant receiving circuit the selectivity of said circuit is considerably reduced. Furthermore the electrolytic capacity of said receiver is not quite constant so that by connecting an electrolytic receiver across a point of maximum potential development of said circuit and in shunt to a condenser of relatively large capacity, the receiver exerts a much less pronounced effect upon the selectivity of said circuit than when it is serially connected therewith. The signal-indicating device T and the variable resistance R, which resistance with the battery B and contact k'''' constitutes a potentiometer, may as shown be connected in series with the receiver P because the large distributed ca-

capacity inherent in these devices offers but little opposition to the flow of high frequency electrical currents therethrough. If desired, a condenser C'''' may be connected as shown across the terminals of the device T and resistance R for the purpose of increasing the capacity of the receiver circuit and reducing the opposition of said circuit to the passage of high frequency currents therethrough.

It is often desirable, and for commercial operation it is necessary, that a receiving operator should be able to "break" the transmission from a distant station when he fails to understand a message or a portion thereof, and such operation of "breaking" is accomplished by the apparatus shown in Fig. 2 by the simple expedient of depressing the key K. By the depression of the key K the receiver is rendered inoperative, the receiving system is short-circuited by the closure of the contact k''' and the elevated transmitting conductor is connected to earth, and then by a farther movement of the key K the primary power circuit is closed at k' thereby effecting the radiation of electromagnetic waves from the elevated conductor system. These waves are absorbed by the elevated receiving conductor system at the station from which signals are being transmitted to the receiving operator who is "breaking"; and when the key at said transmitting station is in normal position the "break" signal may be read by the transmitting operator at said station between his own signal elements. For this purpose the operators retain the telephone T, which preferably is a head telephone, in position while sending and it will be obvious that the connection of the receiving system to the elevated conductor transmitting system at a point of zero potential during transmission will permit an operator so to retain the telephone T in position with safety. It is also to be noted that the telephone T being in a tertiary circuit is not conductively connected to the transmitting system at any time. It will be noted that the means operated by the sending device K for short-circuiting the receiving system between the points $o o'$ are not connected either electrically or mechanically with said sending device.

As shown in Fig. 1, u represents the laminated iron core of the transformer M'. One terminal of both the primary and secondary is connected with said core which is earthed at E'. The object in connecting these two windings to said core is to minimize differences of potential which might otherwise arise between said core and portions of said windings most nearly adjacent thereto. The entire transformer M' is inclosed in a tin jacket X and sealed in with a molded sealing compound of high dielectric strength. Said jacket is likewise connected with one

terminal of the primary and secondary windings and the laminated iron core *u* and is earthed at *E'*.

I claim,

1. In a space telegraph system, a power circuit including a generator, a sonorous circuit operatively associated with said generator, a radiating system related to said sonorous circuit, a circuit connected across the terminals of said generator and including a condenser, and a metallic connection from one armature of said condenser to the frame of said generator.

2. In a space telegraph system, a power circuit including a generator, a sonorous circuit operatively associated with said generator, a radiating system related to said sonorous circuit, a circuit connected across the terminals of said generator and including a condenser, a metallic connection from one armature of said condenser to the frame of said generator, and means for protecting said condenser from excessive potentials.

3. In a space telegraph system, a power circuit including a generator, a sonorous circuit operatively associated with said generator, a radiating system related to said sonorous circuit, a circuit connected across the terminals of said generator and including a condenser, a metallic connection from one armature of said condenser to the frame of said generator, and a spark-gap connected across the terminals of said condenser.

4. In a space telegraph system, a power circuit including a generator, a sonorous circuit operatively associated with said generator, a radiating system related to said sonorous circuit, and a circuit connected across the terminals of said generator and including a condenser, a metallic connection from one armature of said condenser to the frame of said generator, and means in the condenser circuit for protecting said generator from excessive currents.

5. In a space telegraph system, a power circuit including a generator, a sonorous circuit operatively associated with said generator, a radiating system related to said sonorous circuit, a circuit connected across the terminals of said generator and including a condenser, a metallic connection from one armature of said condenser to the frame of said generator and a fuse in said condenser circuit.

6. In a space telegraph system, a power circuit including a generator, a sonorous circuit operatively associated with said generator, a radiating system related to said sonorous circuit, a circuit connected across the terminals of said generator and including a condenser, a fuse in said circuit, a metallic connection from one armature of said condenser to the frame of said generator, and a

spark gap connected across the terminals of said condenser.

7. In a space telegraph system, a power circuit including the primary of a transformer, a circuit connected across the terminals of said primary including a condenser, and a spark-gap connected across the terminals of said condenser.

8. In a space telegraph system, a power circuit including the primary of a transformer, a circuit connected across the terminals of said primary including a condenser, a fuse in said circuit, and a spark gap connected across the terminals of said condenser.

9. In a space telegraph system, a power circuit including the primary of a transformer, a circuit connected across the terminals of said primary including a condenser, a spark-gap connected across the terminals of said condenser, and a connection from one armature of said condenser to earth.

10. In a space telegraph system, a power circuit including the primary of a transformer, a circuit connected across the terminals of said primary including a condenser, a fuse in said circuit, a spark-gap connected across the terminals of said condenser, and a connection from one armature of said condenser to earth.

11. In a space telegraph system, a power circuit including the primary of a transformer, a secondary inductively associated with said primary, a metallic connection from one terminal of said primary to one terminal of said secondary and an earth connection for said metallic connection.

12. In a space telegraph system, a motor-generator, means associated with the motor side thereof for protecting the same from induced currents, a transformer connected with the generator side of said motor-generator, an oscillating circuit associated with said transformer and means for protecting the transformer and generator windings from the reaction of said oscillating circuit.

13. In a space telegraph system, a motor-generator, a space telegraph transmitting system associated with the generator side of said motor-generator and means associated with the motor side of said motor-generator for conducting to earth the currents induced in the motor circuit by extraneous electrical forces.

14. In a space telegraph system, a motor-generator, a sonorous circuit operatively associated with the generator side of said motor-generator, a radiating system related to said sonorous circuit, a circuit connected across the motor side of said motor-generator and including a condenser, means in said circuit for protecting said condenser from excessive currents and means connecting one armature of said condenser to earth.

15. In a space telegraph system, a motor-generator, a sonorous circuit operatively as-

sociated with the generator side of said motor-generator, a radiating system related to said sonorous circuit, a circuit connected across the motor side of said motor-generator and including a condenser, a fuse in said circuit and means connecting one armature of said condenser to earth.

16. In a space telegraph system, a motor-generator, a sonorous circuit operatively associated with the generator side of said motor-generator, a radiating system related to said sonorous circuit, a circuit connected across the motor side of said motor-generator, and including a condenser, and means connecting one armature of said condenser to earth.

17. In a space telegraph system, a motor-generator, a sonorous circuit operatively associated with the generator side of said motor-generator, a radiating system related to said sonorous circuit, a circuit connected across the motor side of said motor-generator and including a condenser, means for protecting said condenser from excessive potentials and means connecting one arm of said condenser to earth.

18. In a space telegraph system, a motor-

generator, a sonorous circuit operatively associated with the generator side of said motor-generator, a radiating system related to said sonorous circuit, a circuit connected across the motor side of said motor-generator, and including a condenser, a spark gap connected across the terminals of said condenser and means connecting one armature of said condenser to earth.

19. In a space telegraph system, a motor-generator, a sonorous circuit operatively associated with the generator side of said motor-generator, a radiating circuit related to said sonorous circuit, a circuit connected across the motor side of said motor generator and including a condenser, a fuse in said circuit, a spark gap connected across the terminals of said condenser and means connecting one armature of said condenser to earth.

In testimony whereof, I have hereunto subscribed my name this 24th day of Feb. 1906.

JOHN STONE STONE.

Witnesses:

E. B. TOMLINSON,
GEO. K. WOODWORTH.