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R. A. FESSENDEN.

SIGNALING BY ELECTROMAGNETIC WAVES.

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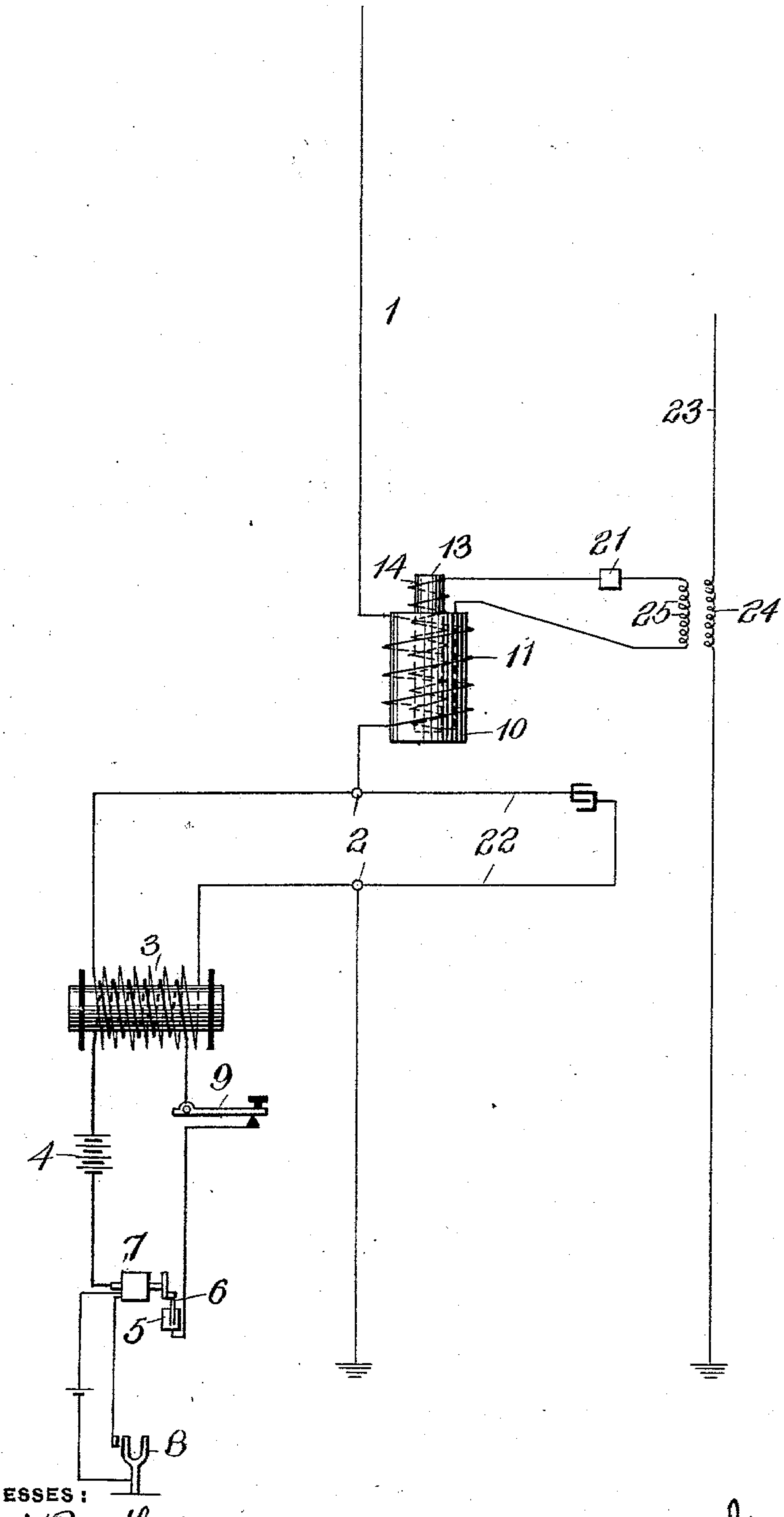
NO MODEL.



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UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO THE NATIONAL ELECTRIC SIGNALING COMPANY, OF PITTSBURG, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

SIGNALING BY ELECTROMAGNETIC WAVES.

SPECIFICATION forming part of Letters Patent No. 752,895, dated February 23, 1904.

Application filed March 14, 1903. Serial No. 147,726. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSENDEN, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered certain new and useful Improvements in Signaling by Electromagnetic Waves, of which improvements the following is a specification.

The invention described herein relates to certain improvements in signaling by electromagnetic waves, having for their object the prevention of external disturbances, so that stations may be worked simultaneously while situated close to each other. This is accomplished by arranging in suitable relation to the conductor of the station second or auxiliary conductors so proportioned that the effect of waves emitted from the disturbing-station on the station-conductor proper will be opposed and neutralized by the effect of the disturbing-waves upon the auxiliary conductor.

The invention is hereinafter more fully described and claimed.

In the accompanying drawing, forming a part of this specification, is shown a diagrammatic view illustrative of my invention.

In the practice of my invention the radiating-conductor 1 is connected to one of the sparking terminals 2, the other terminal being connected to ground. While any suitable form or construction of generator, such as an induction-coil or a dynamo or a dynamo and transformer, as described in my previous patents, may be employed, the invention is illustrated for convenience in connection with an induction-coil and battery. As shown, the terminals of the secondary of the induction-coil 3 are connected, respectively, to the sparking terminals 2. The primary of the induction-coil forms part of a circuit containing a battery 4 and a make-and-break mechanism independently operated at a predetermined rate. A convenient form of make-and-break mechanism consists of a cup 5, containing mercury, and a pin 6, movable into and out of the mercury. A suitable means for reciprocating the pin consists of a small electric motor 7, having the pin so connected to its armature-shaft as to be moved into and out of the mercury during the rotation of the shaft. The rotation of the motor may be controlled in any convenient manner, as by a tuning-fork 8, which is electrically driven and controls by a coil on the armature-shaft of the motor the rotation of said shaft, said coil being included in the circuit with the tuning-fork. This method of control is well known in the art. A sending-key 9 or any suitable form of make-and-break mechanism is included in the circuit of the primary coil. The conductor 1 is proportioned and arranged so as to radiate waves of any desired frequency—*e. g.*, two millions (2,000,000) per second. The primary 11 of a transformer is connected, as shown in Fig. 1, in series with the conductor 1, the coils of the primary being arranged for convenience upon a glass jar 10, filled with kerosene. It is preferred that this transformer should be arranged above the upper sparking terminal 2. The secondary 14 of the transformer is wound on a small glass jar 13, placed inside of the jar 10, and in series with this secondary is arranged a suitable receiving apparatus 21, such as a barretter or other suitable receiving device, as described in Letters Patent previously granted to me. In order to prolong the oscillations, a parallel-tuned circuit 22, containing a condenser, is connected in shunt to the sparking terminals, as described in Patent No. 706,735, granted to me August 12, 1902. It has been found by experiment that the local circuit 22 for prolonging the oscillations operates best when placed as near the nodal point of oscillation—*i. e.*, the ground—as possible. With high verticals—for example, one hundred and fifty feet long—whether the transformer is placed over or below the spark-gap makes little difference, as the length of wire on the transformer is generally a moderately small fraction of the total wave length. With lower verticals, having a height of, say, fifty feet, the length of wire between the spark-gap and the ground when the transformer is placed between spark-gap and ground becomes a larger fraction of the total wave length, and consequently the circuit 22 is relatively farther away from the nodal point. With the type of vertical consisting of single wire or a few wires, which was used at an early date by Marconi, the writer, and others and is still used in certain combinations and for certain purposes and in which the oscillations are practically dead-beat, this displacement of the circuit 22 from nodal point is not of so much importance as when verticals having a very large capacity, such as described in Patent No. 706,737, August 12, 1902, (large-capacity verticals,) giving prolonged oscillations, are used, for in this latter case if the circuit 22 is not near the nodal point interference is apt to be produced between the natural oscillations of the vertical and the oscillations of the secondary circuit 22. In such cases it is therefore preferred to place the transformer over the spark-gap instead of below, so as to bring the circuit 22 as near the nodal point as possible, in spite of the fact that there are certain advantages in the opposite arrangement—for example, the less liability to shock and less liability to puncturing insulation.

A neutralizing-conductor 23, connected to ground, is arranged in suitable relation to the conductor 1. This conductor is preferably shorter than the conductor 1 and has in series therewith the primary 24 of a transformer, the secondary 25 of said transformer being in series with the secondary 14 of the transformer having its primary in series with the conductor 1. The neutralizing-conductor 23 is tuned to the period of the waves emitted by the dirturbing-station, the station-conductor 1 being tuned to some other frequency. The height of the neutralizing-conductor 23 is so proportioned to the height of the station-conductor 1 that with the particular frequency emitted by the disturbing-station the currents generated in the secondaries 14 and 25 will be equal. This can be done as though the conductor 1 is higher than conductor 23. The latter is in tune with the disturbing-station and the station-conductor 1 is not. The secondaries 25 and 14 are so wound with reference to each other that their currents would be in opposite directions, and hence neutralize each other so far as their effect on the receiver 21 is concerned.

The proportioning of the main and neutralizing conductors can be effected by shortening the length of the neutralizing-conductor until the effect of the disturbing-waves thereon practically neutralizes the effect of such waves on the main conductor 1. The same result may be obtained by making the conductor 23 of a fixed height—*e. g.*, one-fifth ($\frac{1}{5}$) of the height of the conductor 1—and then changing the relative positions of the primary 24 and secondary 25 until, as before, the effects produced by the disturbing frequencies neutralize each other. The ability of the conductor 1 to respond to waves of a frequency to which it is not tuned does not show that it has no marked period of its own, as no matter how sharply a conductor is tuned it will always respond to some extent to waves of a different frequency. With reference to the values and proportions of the parts, if the conductor 1 has a height of one hundred and fifty (150) feet it is found in practice with the arrangement shown that one-fifth ($\frac{1}{5}$) to one-tenth ($\frac{1}{10}$) of the effect will be produced on it by the disturbing frequency to which it is not tuned compared with the effect of the frequency to which it is tuned. This ratio will of course depend greatly upon how near the disturbing frequency is to the resonant frequency; but the foregoing corresponds approximately to conditions found in working. Under these conditions it is found that with a main conductor 1 one hundred and fifty (150) feet high the neutralizing-conductor 23 should have a height of about thirty (30) feet, although as small a height as fifteen feet may be used. Precise formula for the neutralizing-conductor cannot be given, for the reason that its dimensions will vary with the amount the oscillations are prolonged, the character of the receiver, the arrangement of the apparatus in the stations, and other details, such as the sharpness of the tuning. When very sharp tuning has been used, it has been found possible to shorten the length of the neutralizing-conductor to about two feet long, the main conductor having a length of about one hundred and fifty feet; but under these conditions it is more difficult to keep it in adjustment. It is, however, always possible to operate the apparatus as shown by altering the length of the neutralizing-vertical 23 until the desired effect is produced. It is not essential that the neutralization should be absolutely complete, as with certain forms of receiver—as, for example, with the barretter described and shown in Letters Patent No. 706,744, dated August 12, 1902—the neutralization is less complete than with the mechanical receivers of the type described in Letters Patent No. 706,736, dated August 12, 1902, and in application, Serial No. 125,030, filed September 27, 1902; but even when using the barretter the effect is markedly beneficial, more especially when the indicating mechanism is mechanically tuned as described in application, Serial No. 121,173, filed August 27, 1902. It is possible that the inductive effect of the neutralizing-conductor may cut down the strength of the signals; but such effect is very small, as the neutralizing-conductor is not only shorter than the main vertical, but it is also out of tune with the oscillations which it is desired to receive. Consequently since the netralizing-conductor is one-fifth or less of the height of the main conductor and on account of the reciprocal relation in tuning it is only affected one-fifth as much by the untuned as by the tuned the total effect of the neutralizing-conductor on the receiver as regards messages of the proper periodicity will be only one twenty-fifth ($\frac{1}{25}$) as much as that of the main conductor.

While the arrangement herein shown and described is desirable, I do not limit myself to the particular form or construction of any of the parts or elements, as other forms of apparatus would readily suggest themselves to those skilled in the art.

I claim herein as my invention—

1. In a system of signaling by electromagnetic waves, the combination at a station of two conductors and a receiver for electromagnetic waves in operative relation to said conductors, said conductors being adapted to oppose the effects on the receiver produced by disturbing electrical impulses while permitting waves of the desired periodicity to affect the receiver, substantially as set forth.

2. In a system of signaling by electromagnetic waves, the combination at a station of two conductors one being tuned more closely to the period of the disturbing impulses than the other, said conductors being so arranged and proportioned as to exert equal and opposite effects on the receiver as regards impulses of the disturbing periodicities, substantially as set forth.

3. In a system of signaling by electromagnetic waves, the combination at a station of two aerial conductors and a receiver for electromagnetic waves in operative relation to said conductors, said conductors being adapted to oppose the effects on the receiver produced by disturbing electrical impulses while permitting waves of the desired periodicity to affect the receiver, substantially as set forth.

4. In a system of signaling by electromagnetic waves, the combination at a station of two conductors and a receiver for electromagnetic waves in operative relation to said conductors, said conductors being adapted to oppose the effects on the receiver produced by disturbing electrical impulses while permitting waves of the desired periodicity to affect the receiver, and a mechanically-tuned receiver, substantially as set forth.

5. In a system of signaling by electromagnetic waves, the combination at a station of two conductors one being tuned more closely to the period of the disturbing impulses than the other, said conductors being so arranged and proportioned as to exert equal and opposite effects on the receiver as regards impulses of the disturbing periodicities, and a mechanically-tuned receiver, substantially as set forth.

6. In a system of signaling by electromagnetic waves, the combination at a station of two aerial conductors one being more closely tuned to the period of the disturbing impulses than the other, said conductors being so arranged and proportioned as to exert equal and opposite effects on the receiver as regards impulses of the disturbing periodicities.

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:
JESSIE BENT,
CHAS. C. KEYSER.