No. 711,132. Patented Oct. 14, 1902.

H. SHOEMAKER.

WIRELESS SIGNALING SYSTEM.

(Application filed Sept. 19, 1902.)

(No Model.)

Fig 1.

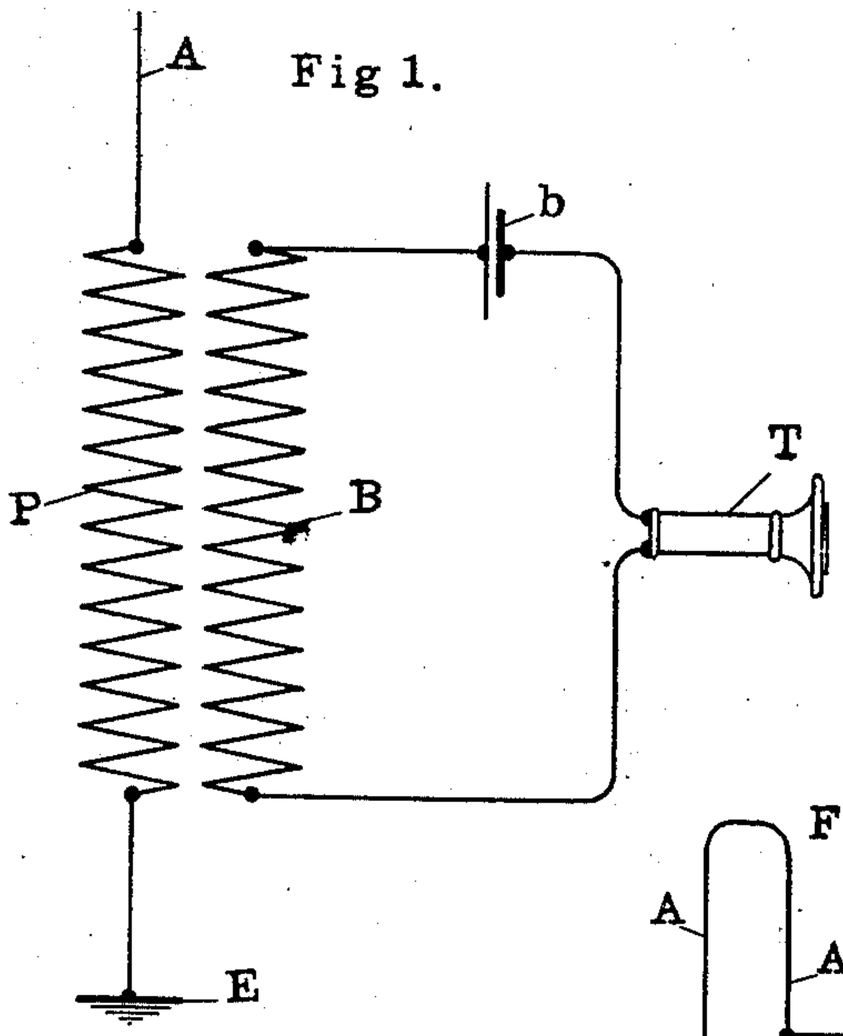


Fig 2.

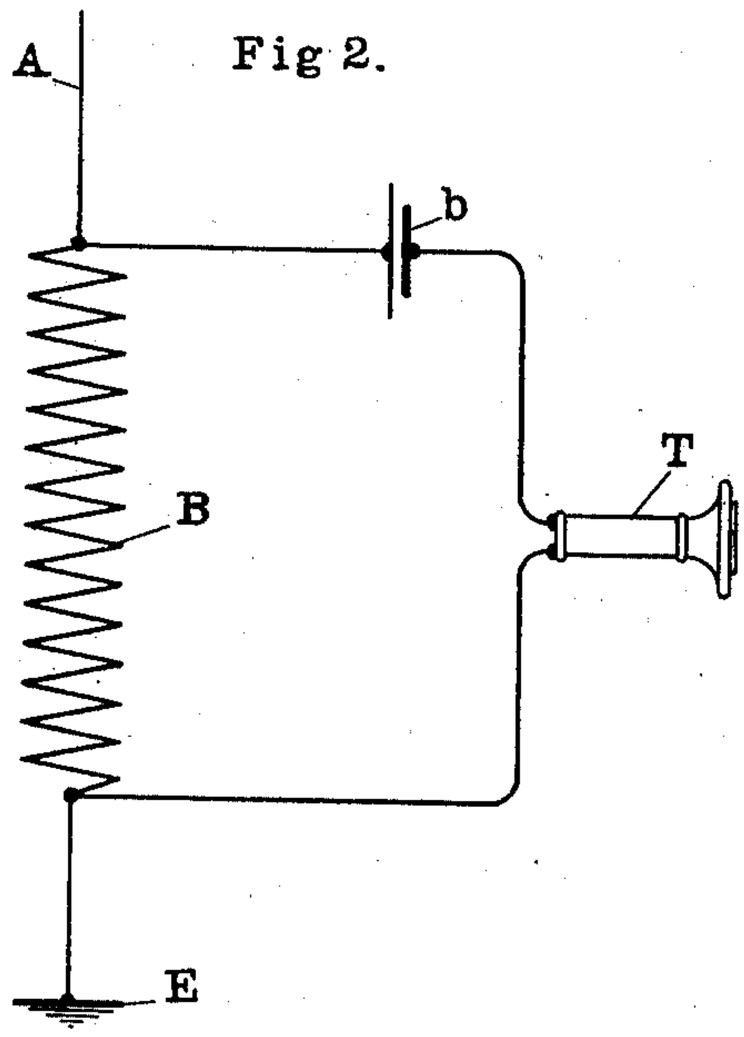


Fig 3.

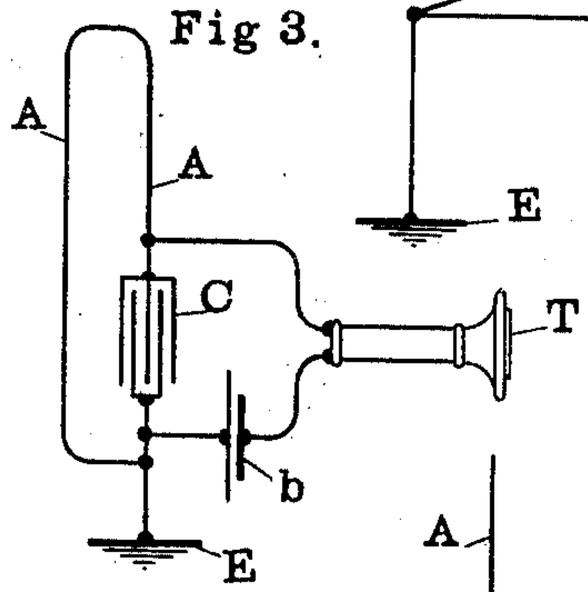


Fig 4.

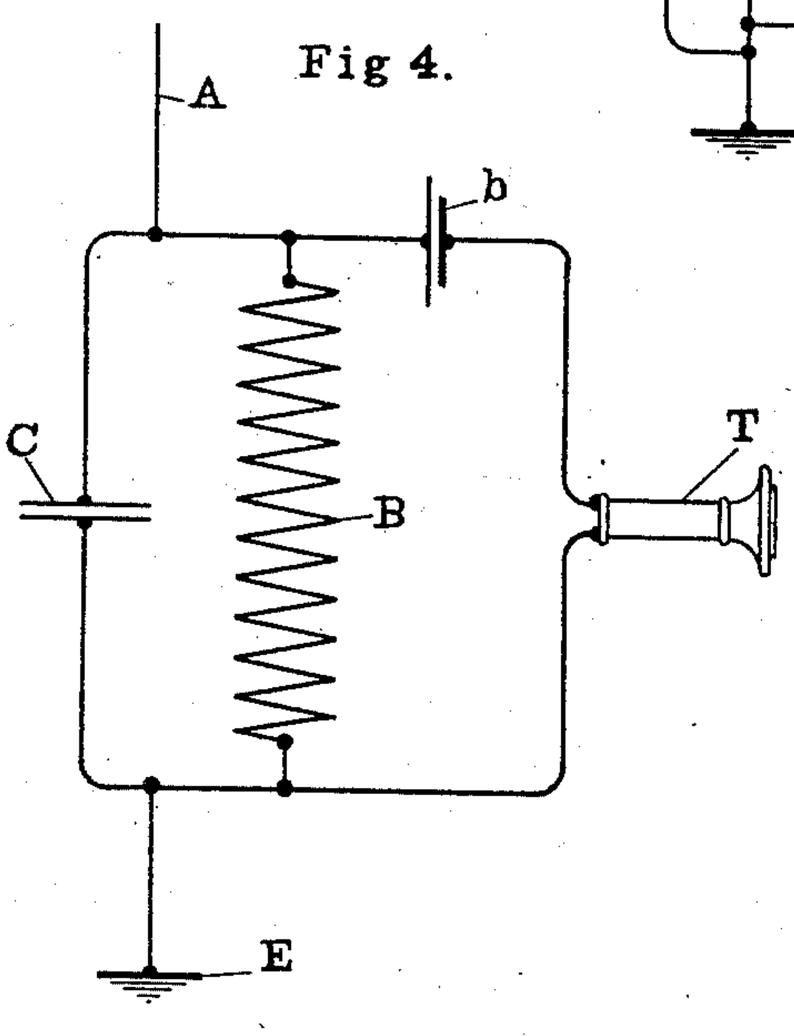
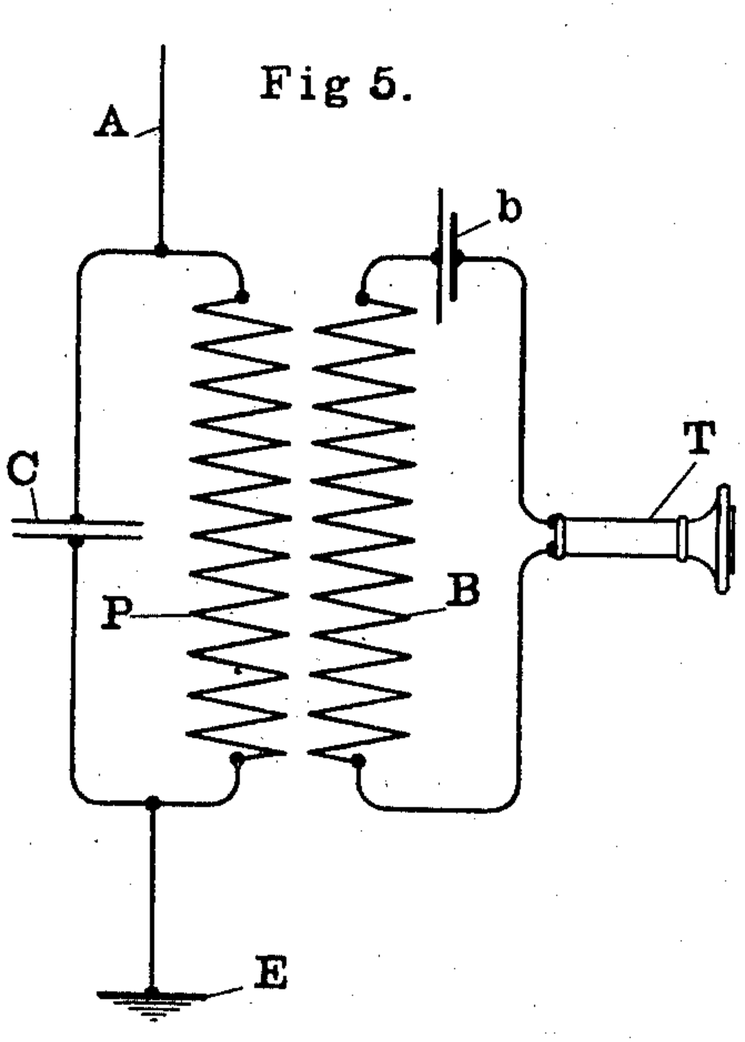


Fig 5.



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UNITED STATES PATENT OFFICE.

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WIRELESS SIGNALING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 711,132, dated October 14, 1902.

Original application filed August 9, 1902, Serial No. 119,030. Divided and this application filed September 19, 1902. Serial No. 123,976. (No model.)

To all whom it may concern:

Be it known that I, HARRY SHOEMAKER, a citizen of the United States, residing at Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented a new and useful Wireless Signaling System, of which the following is a specification.

My invention relates to electrical signaling systems, more particularly those in which electroradiant energy is impressed upon the natural media and causes manifestations at the receiving-stations.

My invention comprises arrangements of the receiving-circuits of a wireless signaling system which are comprised in part of a conductor which has the property of changing its resistance due to a magnetic field. Of such materials many are well known in the art, though bismuth is a good example of such material.

My invention comprises circuit arrangements in which the electroradiant energy received from the natural media is caused to vary the resistance of a material which is responsive to magnetic fields, and thereby produce a signal or record a message.

My invention comprises a system of arrangements of circuits whereby electroradiant energy either directly or indirectly varies the resistance of a material which is not in the nature of an imperfect electrical contact, but in the nature of a continuous conductor of relatively low resistance or great conductivity as compared with the imperfect electrical contacts known in the art.

By the use of bismuth or other materials which change their resistance when in a magnetic field I am enabled to construct a receiving device for wireless signaling systems in which the received electroradiant energy causes directly or indirectly a change in the resistance of such material and the change of such resistance is caused to control a local circuit to produce a signal or record a message. The use of such material is distinctly different from the use of imperfect contacts now well known in the art as coherers and the like, which in general manifest great and sudden changes in resistance and are more or less uncertain in their action. By employing bismuth or other similar material and subjecting it to the varying magnetic field due to received electroradiant energy there is attained a smooth variation in the resistance of a circuit which renders the receiver certain in its operation in marked contrast with the operation of the imperfect electrical contacts heretofore employed in wireless signaling systems.

Besides bismuth it is to be understood other materials may be used which have the same property—namely, that of changing resistances when in a magnetic field. I have found that iron and even copper behave similarly to the bismuth when placed in a magnetic field.

Reference is to be had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view of the receiving-circuits of a wireless signaling system in which a bismuth conductor is placed in the field generated by received energy within a winding in series with the aerial conductor. Fig. 2 is a diagrammatic view in which the bismuth or like material is connected in series with the aerial conductor. Fig. 3 is a diagrammatic view in which a loop of bismuth or like material is used for the aerial conductor and comprises in these two aerial conductors bismuth or other material which are connected at their tops. Fig. 4 is a modified arrangement of the circuits of a receiving device in which by proper proportions of the electrical constants of the circuit the magnetic field produced by the arriving energy is very great compared with the amount of such energy. Fig. 5 is similar to Fig. 4, except that the bismuth or other material is placed in the field generated by a winding through which an abnormal amount of current flows under the influence of a certain amount of received energy.

In Fig. 1, A represents the usual aerial conductor, in series with which is connected the winding P, which connects at its lower terminal with earth-plate E. The received radiant energy causes oscillations in the aerial conductor and through the winding P to manifest a magnetic field. Within this field is

placed a length of bismuth, preferably in the form of wire B, forming a part of the circuit including the telephone-receiver T and the source of energy *b*. The bismuth B normally has a certain resistance, and there is accordingly a certain current flowing through the telephone-receiver T producing no sound. Upon the reception of electrical energy, however, the resistance B varies, due to the magnetic field generated by the winding P, and there results a fluctuating current through the receiver T, causing a sound to be produced in accordance with the received energy. In this manner the code characters or other signal characters may be read by the ear.

In Fig. 2, A is the usual aerial conductor, in series with which there is connected a bismuth winding B, which connects at its lower terminal with the earth-plate E. The received radiant energy causes oscillations through said conductor B, producing a magnetic field. This magnetic field, generated by the winding B, causes in the conductor B a change of resistance, which is noted by means of the telephone-receiver T and the source of energy *b*, as in the case of Fig. 1.

In Fig. 3, A A represent two aerial conductors of bismuth or similar material, which conductors are joined at their upper ends. The left-hand conductor A connects directly to earth-plate E, while the right-hand conductor connects to earth-plate E through condenser C. The condenser C is so large as to be perfectly transparent to the oscillations received in the right-hand conductor A, and in effect, therefore, the right-hand conductor A is connected directly to earth. In shunt to the condenser C or what is the same thing in series with the two conductors A A is connected the telephone-receiver T and the source of energy *b*. In this case the conductors upon the reception of radiant energy are surrounded by a magnetic field, and such field in turn causes a variation of resistance of such conductors A A. There results, therefore, a variation in the resistance of the circuit embracing source of energy *b*, telephone-receiver T, right-hand conductor A, and left-hand conductor A. From such change of resistance there results a variation in the flow of current through the telephone-receiver T, producing a signal, as previously described.

In Fig. 4, A is the usual aerial conductor, between which and the earth-plate E are connected the condenser C and inductance-winding B in parallel relation with each other. The condenser C and this inductance-winding B are so related to each other as to their magnitudes that they form what is known as an "antiresonant" or "closed resonant" circuit for the frequency of oscillations which are received upon the aerial conductor A. When the radiant energy received upon the said conductor A is of a particular frequency, there is set up in the local circuit, embracing the condenser C and the inductance B in series with each other, a current many times greater than that appearing in the aerial conductor itself. This inductance B is composed of bismuth wire. The excessive current flowing through it, due to the relations above stated, causes an abnormally-powerful magnetic field to be produced in the vicinity of said winding, resulting in a correspondingly great variation in resistance of the bismuth wire forming the winding of such inductance. The variation in resistance of such bismuth inductance B is recorded then by the telephone-receiver T with the aid of the source of energy *b*, as described in the previous cases.

In Fig. 5, A is the aerial conductor, between which and the earth-plate E are connected in parallel with each other the condenser C and the primary winding P. The relations of this condenser C and the winding P are the same as described in connection with Fig. 4 for the condenser C and the inductance B. As described in connection with Fig. 4, the winding P will produce an abnormally strong magnetic field due to the antiresonant effect, and within this field is located a bismuth conductor B, as in the case shown in Fig. 1, and the variation of resistance of such conductor B is recorded by the telephone-receiver T with the aid of the source of energy *b*.

I do not wish to be limited to the precise arrangement of circuits as herein described by me, for it is apparent that this system may be applied in many other relations by those skilled in the art. It is broadly new to me to generate a magnetic field by the received electroradiant energy and to cause such field to vary the resistance of certain materials and cause such variation of resistance to control a local circuit to produce a signal or record a message.

It is of course to be understood that in place of telephone-receivers sensitive relays may be employed to control local circuits. Furthermore, the telephone-receivers may be omitted and the primary of a transformer substituted therefor, and in the secondary circuit of such transformer may be placed telephone-receivers or other devices, such as relays and the like. By this arrangement upon a change of resistance in the bismuth or like material there is a large change in the strength of the current in the primary of the transformer, because a large source of energy is used, resulting in a great change in the ampere-turns of the primary of the transformer, and consequently a great change in the potential of the secondary circuit. In the arrangement shown in the drawings the telephone-receivers are to be of low resistance, so that normally there may be a relatively large current flowing through the telephone-receiver. In virtue of this slight change in resistance of the material there will be considerable change in the current strength, and therefore considerable change in the ampere-turns in the telephone-receiver.

The bismuth or other material as used in

my system may be in the form of wire. The cross-section of the conductor or wire is such as to permit the use of a considerable current in the circuit of the wave-responsive device, which is, in fact, the wire. Heretofore in wireless signaling systems but very slight amounts of current has been used in the wave-responsive device, in the case of coherers and the like the current has been extremely small, and in the case of other systems employing a metallic conductor as a wave-responsive device the current employed has been extremely small. In my system, however, I am enabled for the first time in the art to employ currents of relatively great magnitude through the wave-responsive device. This is an advantage which is appreciated in view of the considerations named above. In other words, if the telephone-receiver T were of high resistance as compared with the bismuth or like material the slight fluctuation in the resistance of such material would cause but slight effect in the receiver. The bismuth or other material being of relatively low resistance the telephone-receiver should also be of relatively low resistance.

This application is a division of my application filed August 9, 1902, bearing Serial No. 119,030.

What I claim is—

1. In a signaling system, the combination of means for producing a magnetic field, a material located within said field and having the property of changing its resistance in virtue of change of the magnetic field, a circuit controlled by said material and means in said circuit to produce a signal.

2. In a signaling system, the combination of means for generating a field of force, a material located within said field of force and having the property of changing its resistance in virtue of the change of said field of force, a circuit including said material and means in said circuit to produce a signal due to the change of resistance of said circuit.

3. In a signaling system, a receiving-conductor, means associated with said conductor for producing a magnetic field, a material located in said field and having the property of changing its resistance according to change of magnetism, and a signal-producing means controlled by said material.

4. In a wireless signaling system, a receiving-circuit, means associated therewith for producing a magnetic field in virtue of the received energy, a material located in said field and having the property of changing its resistance in virtue of change of magnetism, and a circuit controlled by said material.

5. In a wireless signaling system, a receiving-conductor, means associated therewith for producing a magnetic field, a material located in said field and having the property of changing its resistance in virtue of a change of magnetism, a source of energy, a translating device, and a circuit embracing said material, source of energy and translating device.

6. In a signaling system, a receiving-conductor, means associated therewith for producing a magnetic field in virtue of the received energy, a material influenced by said magnetic field and having the property of changing its resistance with changes of magnetism, and a signal-producing circuit controlled by said material.

7. In a wireless signaling system, a receiving-circuit, means associated therewith for producing a magnetic field in virtue of the received energy, a continuous conductor influenced by said magnetic field and having the property of changing its resistance in virtue of changes of magnetism, and a recording-circuit controlled by said continuous conductor.

8. In a wireless signaling system, a receiving-circuit, means associated therewith for producing a magnetic field in virtue of the received energy, a continuous conductor influenced by said field and having the property of changing its resistance in virtue of changes of magnetism, and a signal-recording circuit, including said continuous conductor.

9. In a wireless signaling system, a receiving-circuit, a continuous conductor associated therewith and having the property of changing its resistance in virtue of changes of magnetism, and a signal-producing circuit controlled by said continuous conductor.

10. In a wireless signaling system, a receiving-circuit, a closed circuit associated therewith and attuned to the frequency of the transmitted electroradiant energy, means in said closed circuit for producing a magnetic field, a continuous conductor influenced by said magnetic field and having the property of changing its resistance in virtue of changes of magnetism, and a signal-producing circuit controlled by said continuous conductor.

11. In a wireless signaling system, a receiving-circuit, a closed resonant circuit associated therewith, means in said closed circuit for producing a magnetic field, a material influenced by said field and having the property of changing its resistance in virtue of changes of magnetism, and a signal-producing circuit controlled by said material.

12. In a wireless signaling system, a receiving-circuit, a closed resonant circuit associated therewith, means included in said circuit for producing a magnetic field, a continuous conductor influenced by said field and having the property of changing its resistance in virtue of changes of magnetism, and a circuit including said continuous conductor, a source of energy, and a translating device.

13. In a wireless signaling system, a receiving-conductor, means for producing a magnetic field associated therewith, a material of low resistance under the influence of said field and having the property of changing its re-

sistance in virtue of changes of magnetism, and a signal-recording circuit including said material, a source of energy of low potential and large current capacity, and a translating device of low resistance.

14. In a wireless signaling system, a receiving-circuit, means associated therewith for producing a magnetic field in virtue of the transmitted energy, a low-resistance continuous conductor under the influence of said field and having the property of changing its resistance in virtue of changes of magnetism, and a circuit controlled by said continuous conductor and including a source of low-potential energy and a signal-producing means of low resistance.

15. In a wireless signaling system, a receiving-circuit, a wave-responsive device influenced thereby and having the property of changing its resistance with changes of magnetism, and a signal-producing circuit controlled by said wave-responsive device.

16. In a wireless signaling system, a receiving-circuit, a wave-responsive device influenced thereby and having the property of changing its resistance in virtue of changes of magnetism, and a local recording-circuit including said wave-responsive device.

17. In a wireless signaling system, a receiving-circuit and means associated therewith for changing the resistance of a material having the property of changing its resistance in virtue of changes of magnetism, and a signal-producing circuit controlled by said material.

18. In a wireless signaling system, a receiving-circuit, means associated therewith for increasing the current component of the received electric energy, means for producing a magnetic field, in virtue of said increased current component, a material under the influence of said magnetic field and having the property of changing its resistance in virtue of changes of magnetism, and a signal-producing circuit controlled by said material.

19. In a wireless signaling system, a receiving-circuit, means associated therewith for increasing the current component of the received electric energy, means for producing a magnetic field by said increased current component, a continuous conductor under the influence of said field and having the property of changing its resistance in virtue of changes of magnetism, and a signal-producing circuit controlled by said continuous conductor.

20. In a wireless signaling system, a wave-responsive device consisting of a material having the property of changing its resistance in virtue of changes of magnetism.

21. A wave-responsive device consisting of a continuous conductor having the property of changing its resistance in virtue of changes of magnetism.

22. A wave-responsive device comprising a continuous conductor of relatively low resistance and having the property of changing its resistance in virtue of changes of magnetism.

23. A wave-responsive device comprising a material which changes its resistance under the influence of a magnetic field.

24. A wave-responsive device comprising a continuous conductor having the property of changing its resistance under the influence of a magnetic force.

25. A wave-responsive device comprising a material having the property of changing its resistance in virtue of changes of magnetism, and having relatively high current-carrying capacity.

26. In a wireless signaling system, a wave-responsive device comprising a conductor having large current-carrying capacity.

27. In a wireless signaling system, a wave-responsive device comprising a metallic conductor of large current-carrying capacity.

28. In a wireless signaling system, a wave-responsive device comprising a metallic conductor of relatively large cross-section.

29. In a wireless signaling system, a wave-responsive device comprising a continuous metallic conductor having large current-carrying capacity.

30. In a signaling system, the combination of means for producing a magnetic field, a mass of bismuth located in said field, a circuit controlled by said bismuth, and means in said circuit to produce a signal.

31. In a signaling system, the combination of means for generating a field of force, a mass of bismuth located within said field of force, a circuit including said bismuth, and means in said circuit to produce a signal due to the change of resistance of said circuit.

32. In a signaling system, a receiving-conductor, means associated with said conductor for producing a magnetic field, a mass of bismuth located in said field, and a signal-producing means controlled by the bismuth.

33. In a wireless signaling system, a receiving-circuit, means associated therewith for produing a magnetic field in virtue of the received energy, a mass of bismuth located in said field, and a circuit controlled by the mass of bismuth.

34. In a wireless signaling system, a receiving-conductor, means associated therewith for producing a magnetic field, a mass of bismuth located in said field, a source of energy, a translating device, and a circuit embracing the bismuth, source of energy and translating device.

35. In a wireless signaling system, a receiving-circuit, means associated therewith for producing a magnetic field varying with the received energy, a continuous conductor of bismuth located in said field, and a recording-circuit controlled by the bismuth conductor.

36. In a wireless signaling system, a receiving-circuit, means associated therewith for producing a magnetic field in virtue of the received energy, a continuous conductor of

bismuth influenced by said field, and a signal-producing circuit including said bismuth conductor.

37. In a wireless signaling system, a receiving-circuit, a continuous conductor of bismuth associated therewith, and a signal-producing circuit controlled by said bismuth conductor.

38. In a wireless signaling system, a receiving-circuit, a closed resonant circuit associated therewith, means in said closed, resonant circuit for producing a magnetic field, a mass of bismuth in said field, and a signal-producing circuit controlled by the bismuth.

39. In a wireless signaling system, a receiving-conductor, means for producing a magnetic field associated therewith, a low-resistance conductor of bismuth subjected to the influence of said field, and a signal-producing circuit including said bismuth conductor, a source of energy, of large current capacity, and a translating device of low resistance.

40. In a signaling system, a receiving-circuit, a wave-responsive device influenced thereby and consisting of a mass of bismuth, and a signal-producing circuit controlled by said wave-responsive device.

41. In a signaling system, a receiving-circuit, means associated therewith for increasing the current component of the received electric energy, means for producing a magnetic field in virtue of said increased current component, a mass of bismuth influenced by said magnetic field, and a signal-producing circuit controlled by the mass of bismuth.

42. In a signaling system, a wave-responsive device comprising a mass of bismuth.

43. A wave-responsive device consisting of a continuous conductor of bismuth.

44. A wave-responsive device comprising a continuous conductor of bismuth, having relatively low resistance.

45. A wave-responsive device consisting of bismuth in a mass having relatively high current-carrying capacity.

46. In a wireless signaling system, a wave-responsive device comprising a conductor of bismuth having large current-carrying capacity.

47. In a wireless signaling system, a wave-responsive device consisting of bismuth having relatively large cross-section.

48. In a wireless signaling system, a wave-responsive device consisting of bismuth wire.

49. In a wireless signaling system, a wave-responsive device consisting of a bismuth wire of a cross-section permitting the employment of relatively large currents.

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