No. 877,451. PATENTED JAN. 21, 1908.

G. W. PICKARD.

MEANS FOR RECEIVING INTELLIGENCE COMMUNICATED BY ELECTRIC WAVES.

APPLICATION FILED NOV. 12, 1907.

Fig. 1.

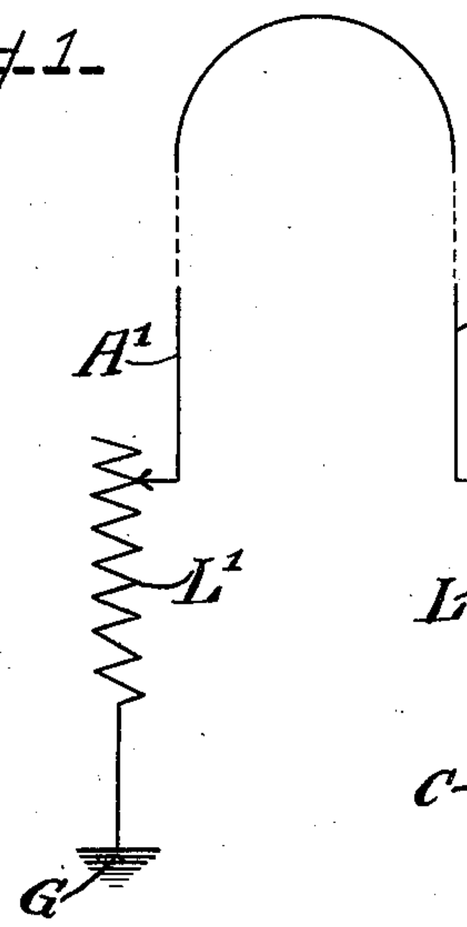
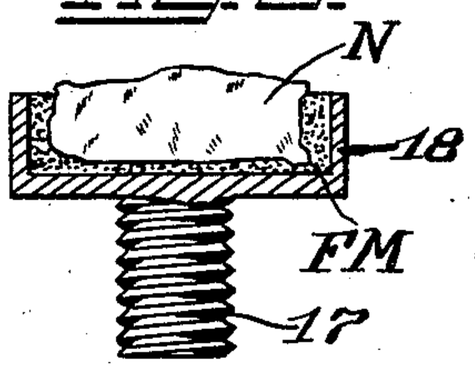


Fig. 2.

Fig. 3.



Attest:
C. D. Perkins
C. S. Ashley

Inventor:
Greenleaf Whittier Pickard

by
Philip Farnsworth Atty

UNITED STATES PATENT OFFICE.

GREENLEAF WHITTIER PICKARD, OF AMESBURY, MASSACHUSETTS.

MEANS FOR RECEIVING INTELLIGENCE COMMUNICATED BY ELECTRIC WAVES.

No. 877,451. Specification of Letters Patent. Patented Jan. 21, 1908.

Original application filed August 30, 1906, Serial No. 332,697. Divided and application filed November 8, 1906, Serial No. 342,465. Again divided and this application filed November 12, 1907. Serial No. 401,856.

REISSUED

To all whom it may concern:

Be it known that I, GREENLEAF WHITTIER PICKARD, a citizen of the United States of America, and a resident of the town of Amesbury, State of Massachusetts, have invented certain new and useful Improvements in Means for Receiving Intelligence Communicated by Electric Waves, the principles of which are set forth in the following specification and accompanying drawing, which discloses the form of the invention which I now consider to be the best of the various forms in which the principles of the invention may be embodied.

This application is a division of my application Serial Number 342,465, filed Nov. 8, 1906, which was a division of my application Serial Number 332,697, filed Aug. 30, 1906, and granted Nov. 20, 1906 as Patent No. 836,531.

This invention relates to means for receiving intelligence communicated by electric waves.

The object of the invention is to provide a commercially useful means for operating a device for translating the communications into intelligible form, exclusively by the energy of the oscillatory currents generated by the receipt of the waves. To this end the object is to practically convert the received oscillations into a form suitable for operating an indicating device, such for example as a telephone receiver, without the use of any auxiliary energy, and without resistance due to conductor-attenuation or imperfect contact.

Of the drawings, Figure 1 is a diagrammatic illustration of a well-known form of wireless telegraph receiving station apparatus, this being the apparatus with which the invention has been actually used. Figs. 2 and 3 are a side elevation and section respectively of the present preferred embodiment of the detector employed in the invention in its present most efficient form, Fig. 3 being a slightly modified form.

In Fig. 1 the general arrangement is the well-known loop form of wave-intercepter A, A′ operatively provided with the usual adjustable capacity C, inductance L, adjustable in both the wave-intercepter and oscillation-receiving circuits, the inductance L′, adjustable in the wave-intercepter circuit, and the connection of the latter circuit to ground at G.

In Fig. 1, the circuit L, T, J, C′—T, L receives the oscillations generated in the wave-intercepting loop A, A′, the inductance L being adjustable in the oscillation circuit which is well adapted for use with the oscillation receiver or detector of this invention, as it includes the adjustable condenser C′, and the indicating device T in shunt to this condenser. The device is preferably a telephone receiver and may be any other form of device such as a sensitive galvanometer which will indicate an abrupt flow of direct current. The receiver or detector should in use be maintained in good electrical connection in the oscillation circuit, and the contact-junction T J should be a substantially perfect electrical contact. The lead to the shunt-connected condenser C′ and the telephone T is taken from the lower end of the inductance L, so that the telephone and its parallel connected condenser are in series between the detector and a part of the inductance L which is of lower potential with respect to the ground.

The receiver or detector of this invention, roughly indicated at T J in Fig. 1 is shown in detail in Fig. 2. To a wooden base I are secured an angular metal support 2 and a metal plate 3, provided with binding posts 4, 5 for the leads of the oscillating circuit of Fig. 1. One element of the detector is the chuck which is removably screwed into the plate 3 by the part 6. This chuck consists of a piece of metal M to which is soldered a metallic plating M P, such as copper or silver, which plating is deposited on the material N in order to provide a large area of surface contact between them, as compared with the area of the contact junction T J. The deposition may be by electro-plating or by fusing a layer of the material N upon a metallic surface, or otherwise; and as shown in Fig. 3, it is sufficient to place the material N in a liquefied mass of fusible metal F M in a chuck-cup 18, provided with a screw 17, so that when the metal F M cools and solidifies, the material N will be firmly embedded in, and in good electrical and large-areaed contact with the metal F M.

The operative contact-junction (T J of Fig. 1) is located at the lower end of the hollow metallic sleeve 7 of Fig. 2, which junction is of substantially less surface area than that of the contact between N and M

P. The sleeve 7 can slide along the metallic projection 8, which depends from the metallic ball 9, the ball forming a ball-and-socket universal joint with the part 10 of thin metal, which is stamped to shape and secured to the metallic support 2 so as to complete the circuit. The member 7 of the receiver may be of any conductor which coöperates properly with the member N. The member N may be the element silicon, which appears to be most useful either in the massive amorphous or graphitic solid form; or it may be a suitable equivalent which accomplishes the objects of the invention, *i. e.*, a conductor within the scope of the invention which possesses high resistivity and which when operatively in substantially perfect electrical contact with the other conductor, as 7, operates in coöperation therewith to produce a direct current suitable for operating the indicating device. When the member 7 is metallic, as of copper in accordance with this disclosure, and therefore has low resistivity, there is a very substantial difference in the degree of resistivity possessed by the two conductors. When the member N has high thermoelectromotive power in coöperation with the member 7, in addition to high resistivity, or when there is a substantial difference in the resistivity of the two conductors, a considerable part of the energy of the received oscillations is concentrated in the form of Joulean heat, at the contact junction, where it may be converted into a direct current owing to the coöperative thermo-electromotive power of the two conductors. The junction between the massive conductors 7 and N should be a substantially perfect electrical contact, and this is secured by the spring 11, which presses the two conductors together with sufficient force to exclude substantially all contact resistance and action of a loose-contact or coherer nature arising from the resistance of an imperfect contact, such as to cause the contact to be a substantially perfect one. Such a perfect contact not only accomplishes the objects of the invention, but avoids the uncommercial instability of imperfect contacts. The spring 11 also serves to make good contact between the part 7 and the good conducting part 8, and also presses the good-conducting part 8 into good contact with the conducting part 10 which is secured to part 2, thus establishing a good electrical connection between part 7 and its circuit-terminal 4. No means for delicate adjustment of the spring-pressure, such as a fine screw, is necessary, since operatively the spring is such as to always exert sufficient pressure to insure a substantially perfect contact. The spring 11 however, coöperatively with the movable part 8, permits the selection by manual adjustment of different locations of the contact T J, owing, in this disclosure, to inequalities of different parts of the operating surface of part N, whereby the pressure of the spring is slightly varied within the limits of perfect contact pressure, so as to slightly vary the area of electrical contact and the sensitiveness of operation under different external conditions of use. In no case, however, is it necessary to continuously move either 7 or N with respect to each other during operation. The device is most efficient in the form shown, as to the lower end of part 7 having a substantial rounded surface in physical contact of considerable area with part N, but having an extremely small electrical contact therewith. In no case need either member 7 or N possess such attenuation as might thereby generate heat.

I am aware of devices in the prior art which employ conductor-attenuation as an essential means of generating heat, and of those which employ the resistance of an imperfect contact as an essential means of generating heat. In this invention however, it is unnecessary to employ either of such means, the action being efficient in all cases of pairs of conductors included within the invention which coöperatively have high resistivity and are in small-aread substantially perfect contact with each other.

In order to obtain the best results, the above specification should be carefully followed. So far I have been able to convert upward of ten percent. of the energy of the oscillations into direct current energy. The device is therefore an electrical converter or rectifier. In the preferred form of this invention the action due to the inherent properties of the silicon member or its equivalent is of extraordinary vigor, as is indicated by the fact that the only energy employed to commercially operate the telephone T is that of the received oscillations. All resistance-varying action should be reduced to a minimum, as by employing the conductors in substantially massive form and in substantially perfect contact with each other, because the energy of the oscillations should not be wasted without contributing substantially to effective action.

The remarkable fact that the telephone can be operated in a commercial manner solely by the converted energy of the received oscillations, is explained by the statement that that feeble energy which is received at the ordinary commercial wireless telegraph station is amply sufficient to operate a sensitive receiving instrument, provided that the translation of this energy into the form of a direct current is efficiently accomplished. It is, of course, necessary in commercial work to effect this conversion, because there is no known indicating means which can be sensibly affected by the received energy of commercial long-distance

wireless telegraphy when in the form of high frequency oscillations, notwithstanding the fact that a sensitive telephone may, as an experimental feat, be slightly affected by the oscillations emitted from a nearby or very powerful sending station.

The energy required commercially operate a telephone, that is, to produce in it a clearly defined dot, in, for example, the Morse code, is approximately one millionth (1×10^{-6}) erg. The energy received in long-distance wireless communication is, at the minimum, of the order of magnitude of one-thousandth of an erg per dot. The efficiency of the apparatus of this invention, as demonstrated by trial under commercial conditions, is upwards of ten per cent. There is thus ample margin for commercial operativeness for the least sensitive form of this invention in the case of the present longest distance wireless telegraphy.

The speed of reception with this invention is unlimited, since it is not only self-restoring to its sensitive state, but this restoration is practically instantaneous because, so far as the thermoelectromotive action is concerned, the small quantity of heat which is generated by the received oscillations comprising a signal is rapidly conducted away, partly by thermal conduction to the metal portion 7, and the remainder by the conversion into an electric current which finally expends its energy in the indicating device.

The advantages of the new detector are as follows. It fulfils all requirements of commercial wireless telegraphy as to sensitiveness, speed, stability and freedom from delicate adjustments. I have found that the continued sensitiveness of the detector is in nowise impaired by severe static discharges. It is also simple and cheap in construction. It is not affected by changes in atmospheric temperature or humidity. Its sensitiveness so far has not been impaired by continuous and continued use. Any portion of any one of the classes of material having the inherent properties of the conductors included within this invention, makes an operative contact with another suitable conductor if that contact be substantially perfect. This invention requires no auxiliary source of heat as has been necessary with previous converters designed for high frequency oscillations. It is an important practical as well as commercial advantage of this invention that it essentially dispenses with auxiliary sources of energy, in that such sources, such as batteries and the requisite accompanying potentiometers, are expensive and require frequent replacement. There is apparently no limit to the operative life of the detectors included in this invention.

In the claims, the conducting material is specified as "substantially massive," this term here meaning a non-attenuated, non-comminuted solid having a substantially uniform chemical composition throughout the mass. This word "massive" as used in the claims, does not possess its special mineralogical meaning which may exclude either crystalline form or crystalline structure, because it here includes non-attenuated, non-comminuted solids which may have either such form or such structure; nor does the word "massive", in the claims, possess its special geological meaning of homogeneity as to being destitute of structural divisions such as planes of stratification, because it here includes non-attenuated, non-comminuted solids which may have cleavage formations. The only limitations here placed on the word "massive" are that the material is not a chemical formation on a mere surface, or a conductor attenuated for the necessary purpose of thereby obtaining necessary heat-producing resistance, and that it is not comminuted to such degree as to lose its massive character as and for the purposes set forth.

The expression "substantially perfect electrical contact" in the claims, means the good electrical contact for the purpose of this invention, that is to say, a contact which has substantially no contact resistance, *i. e.*, is not imperfect or microphonic such as might be necessarily employed to result in the generation of heat by means of the resistance of an imperfect contact, or to operate by varying contact-resistance. The substantially perfect contact of this invention is characterized by considerable pressure sufficient to exclude material imperfection or looseness and substantially all contact resistance due to such looseness, as distinguished from the empirical or definite looseness, or contact resistance, necessarily employed outside of this invention. On the other hand, the two conductors of this invention are individually separate, and the expression "substantially perfect electrical contact" of the claims is to be distinguished from such a perfection of contact as may be obtained by soldering or welding two conductors together, or by otherwise causing the two conductors to become integral or unitary.

The word "resistivity" in the claims is used to mean specific or inherent electrical resistance.

The meaning of the adjective "non-metallic" as used herein, is the commonly accepted one which excludes all metals, alloys or chemical mixtures of one metal with another, and which includes all non-metal elements, and chemical compounds of non-metals with metallic substances.

I claim:

1. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive individual electrical conductors operatively in

substantially perfect contact with each other, said conductors having different degrees of resistivity, and coöperatively having high resistivity, at least one of said conductors having high resistivity; in combination with a mass of fusible metal supporting said high resistance conductor, and a supporting receptacle for said fusible metal.

2. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive individual electrical conductors of different degrees of resistivity, and coöperatively having high resistivity, at least one of which conductors possesses high resistivity; in combination with a spring which operatively holds the said conductors in substantially perfect small-areaed electrical contact with each other; and a freely movable, non-threaded support for said spring to permit a variation of contact pressure within wide limits of substantially perfect contact pressure, and thereby slightly vary the area of the minute electrical contact.

3. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive individual conductors operatively in small-areaed substantially perfect contact with each other, and having different degrees of resistivity and coöperatively having high resistivity, at least one of said conductors having high resistivity; in combination with a mass of good conducting material having a broad surface of intimate contact, relative to said small-areaed contact, with said high resistance conductor.

4. Means for receiving intelligence communicated by electromagnetic waves, which comprises a substantially massive conducting solid having low resistivity, and a substantially massive non-metallic solid having high resistivity and also thermoelectromotive power; said conductors being individually separate, but operatively connected together in substantially perfect electrical contact.

5. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive individual conducting solids, one of which has low resistivity, and the other of which has high resistivity and also thermoelectromotive power; said conductors being operatively connected together in substantially perfect electrical contact.

6. Means for receiving intelligence communicated by electromagnetic waves, which comprises a substantially massive low resistance metallic member, and a separate substantially massive conducting solid having high resistivity; said members being connected together in substantially perfect electrical contact; said member which has high resistivity having also thermoelectromotive power, whereby the device acts as a vigorous generator into direct currents of the oscillation energy.

7. An electro-regenerative thermo-junction device for converting oscillatory electrical currents into direct currents, which comprises a substantially massive low resistance conducting solid in substantially perfect electrical contact but not integral with a substantially massive conducting solid having high resistivity and also thermoelectromotive power.

8. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive individual electrically conducting solids coöperatively having high resistivity and also thermo-electromotive power; in combination with means for holding said conductors together in substantially perfect contact.

9. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive electrically conducting solids which are individually separate, but coöperatively connected together in substantially perfect electrical contact, said conductors coöperatively having high resistivity and also coöperatively possessing thermoelectromotive power.

10. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive electrically conducting solids, which are individually separate, but operatively connected together in small-areaed substantially perfect electrical contact, said conductors coöperatively having high resistivity and also cooperatively possessing thermoelectromotive power.

11. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive electrically conducting solids which are individually separate, but coöperatively connected together in small-areaed substantially perfect electrical contact, said conductors coöperatively possessing thermoelectromotive power, and having substantially different degrees of resistivity, at least one of the conductors having high resistivity.

12. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive electrically conducting solids which are individually separate, but operatively connected together in substantially perfect electrical contact, said conductors coöperatively having high resistivity and also thermoelectromotive power, and the individual conductors having substantially different degrees of resistivity.

13. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive electrically conducting solids which are individu-

ally separate, but operatively connected together in small-areaed substantially perfect electrical contact, said conductors having substantially different degrees of resistivity, and coöperatively having high resistivity.

14. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive electrically conducting solids which are individually separate, but operatively connected together in substantially perfect electrical contact, said conductors coöperatively having high resistivity, at least one of them having high resistivity; a mass of fusible good conducting material in which the high resistance conductor is embedded; and a receptacle for the fusible conductor.

15. Means for receiving intelligence communicated by electromagnetic waves, which comprises two substantially massive individual electrical conductors of different degrees of resistivity and coöperatively having high resistivity, at least one of said conductors possessing high resistivity; in combination with a supporting member mounted to be movable and having a telescopic joint with one of said conductors; and a spring operatively located within the telescopic joint to hold the two conductors in substantially perfect contact with each other.

16. Means for receiving intelligence communicated by electromagnetic waves, which comprises two individual massive electrical conductors of different degrees of resistivity and coöperatively having high resistivity, at least one of which conductors has high resistivity; in combination with a supporting member having a telescopic joint with one of said conductors; a spring operatively located within the telescopic joint to hold the two conductors in substantially perfect contact with each other; and means to permit the manual alteration of the location of the contact junction of the two conductors.

GREENLEAF WHITTIER PICKARD.

Witnesses:
EDWARD H. ROWELL,
MYRA S. ROWELL.