Leaflet No. 4046.

"Taylor" — "Cambridge"

THE CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY, LTD., CAMBRIDGE, ENGLAND.

S. G. BROWN'S HERTZIAN WAVE DETECTOR.

PATENT.

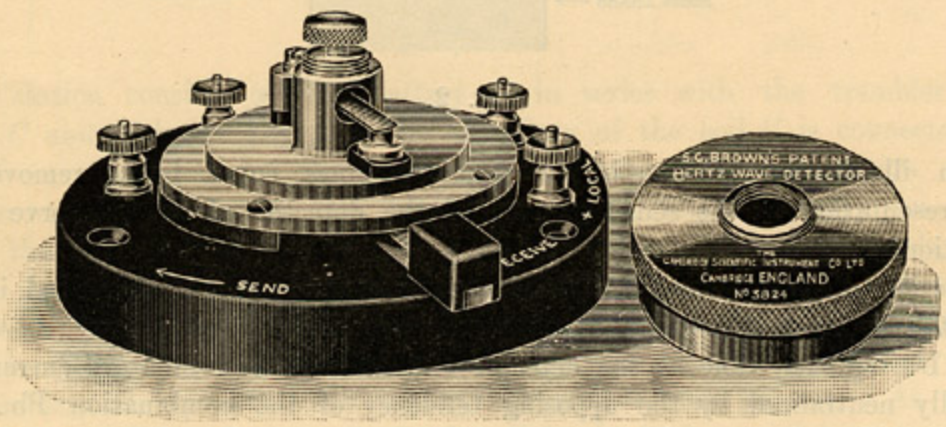

Fig. 1.

Practically all systems of wireless telegraphy are worked upon the following broad principles. At the sending station the apparatus is arranged so that oscillatory currents of high frequency are induced in a conductor, or series of conductors, these currents generally starting with a spark across a gap in the conductor. The extent of the sending conductors and the length of the spark gap generally increase with the distance over which it is desired to send signals.

The oscillatory currents in the sending conductor cause a series of electro-magnetic waves to spread out through the surrounding space and when these waves strike upon any conductor in their path they induce in that conductor currents similar to but feebler than those at the sending station.

If the distance between the sending and receiving stations is short, the currents induced in the receiving conductor may actually be of sufficiently high potential to cross a spark gap and signals may thus be directly observed. But in practice the distances are always too great for this method, so it becomes necessary to use some indirect method for manifesting the existence of the induced currents, and this is best carried out by observing, in a secondary or relay circuit, some change induced by the received oscillations.

A very convenient detector for this purpose has been designed by Mr S. G. Brown.

This instrument is a simple form of detector which, owing to its lightness and simplicity, is peculiarly suitable for use in portable and field work. It is also very convenient for teaching the principles of wireless telegraphy.

There are no mechanically moving parts and there are no liquids.

The essential part of the detector is a small pellet of lead-peroxide held between a plate of lead and another plate of platinum. This combination acts as an electrolytic cell or valve in which the lead-peroxide is the electrolyte and the lead and platinum plates are the electrodes.

If an external E. M. F., as for instance that of an accumulator cell, is impressed upon the detector so that a current flows from platinum to lead, the passage of that current will be partially opposed by the E. M. F. of the combination. A steady condition will be arrived at when the current flowing is due to the excess of E. M. F. of the accumulator over that of the detector. This steady current may be made to give a deflection to a galvanometer needle.

If now oscillatory currents are made to pass through the detector, it will act as an electrolytic valve, the apparent back E. M. F. will increase, and this will be shown by a decrease in the deflection of the galvanometer needle.

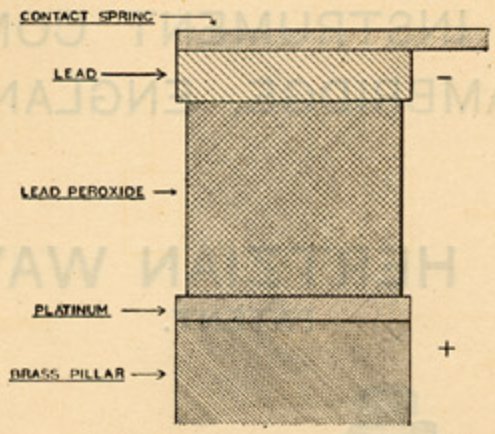

Fig. 2.

Fig. 1 is an illustration of the instrument, the brass cover being removed; Fig. 2 is a diagrammatic representation of the sensitive part of the detector which will serve to illustrate the following explanation.

Under the action of the current from the accumulator, positively electrified ions of lead tend to pass upward to the lead cathode and negatively electrified ions of oxygen downward to the platinum anode. During such time as the detector is unaffected by oscillatory currents, this tendency is however partially neutralized by the opposing tendency of the combination $Pb . PbO_2 . Pt$ to act as an independent cell and to send a current in the reverse direction to that of the external electromotive force. By this current negatively electrified oxygen ions would be sent upward to the lead and positively electrified ions of lead down to the platinum.

Under the influence of the oscillatory currents resulting from the Hertzian Waves, this tendency of the detector to act as a cell is brought actively into operation with the result that the current due to the accumulator is diminished. When the oscillatory currents cease the accumulator current removes the films of lead from the platinum and of oxygen from the lead and the current returns to its former value.

That this explanation suffices, at least to a great extent, to explain the action of the detector is shown by the fact that if a metal (such as iron) more electro-positive than lead relatively to platinum, be used for the upper electrode, the deflection of the needle due to the first oscillatory currents is greater than in the case of lead. This combination, however, becomes less and less sensitive to further currents while the recovery is very much slower owing to the fact that electro-positiveness and ease of oxidation go together and, in the case of iron, the current from the accumulator can only remove very slowly the film of oxide formed upon the iron electrode.

The properties of this detector are used as follows. An accumulator cell is arranged to pass a current through a galvanometer and the detector in series. The receiving conductors are then connected so that any currents induced in them pass through the detector, the existence of such currents being shown by a diminution in the galvanometer deflection.

A two-way switch is arranged with the detector by means of which the receiving and sending circuits are made or broken as desired, and the detector is completely shielded by metal when the station is being used to send messages.

DEMONSTRATION.

Fig. 3 shows the connections of the apparatus as arranged for demonstration.

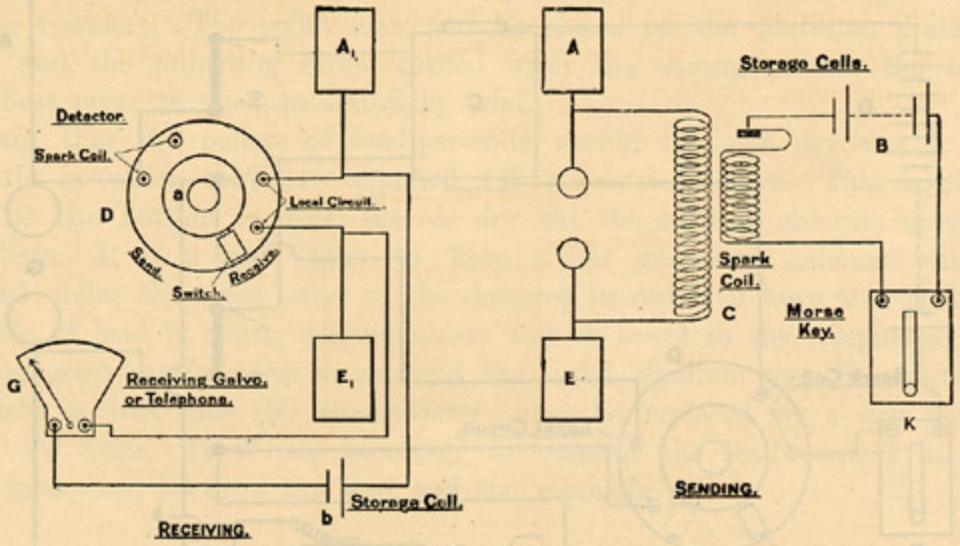

Fig. 3.

The sending station consists of the battery B in series with the trembler and primary of an induction coil C and with the key K. The secondary of the coil C is connected to the sending aerials A and E on either side of the spark gap. At the receiving station a similar pair of aerials A_1 E_1 are connected to the two terminals marked "local circuit" on the detector D, that is, through the lead-peroxide pellet. As a shunt across the pellet a relay circuit is also arranged between the same two terminals. This relay circuit contains a 2 volt accumulator cell b and a galvanometer G and the current due to b will cause a deflection of the needle of the galvanometer. When the key K is depressed, current flows through the primary of the coil C, actuating the trembler, which makes and breaks the circuit very rapidly. As a result, currents are induced in the secondary of the coil C of sufficiently high-potential to cross the spark gap in a series of sparks, causing oscillatory currents of very high frequency to traverse the aerials A and E. Similar currents will be induced in the receiving aerials A_1 E_1 and will pass through the pellet in the detector D, increasing its apparent back E. M. F., and so causing a diminution in the deflection of the galvanometer G. Only a very small fraction of the induced currents between A_1 and E_1 will pass through the relay circuit instead of through the detector owing to the self-induction of the galvanometer. The same remark applies where a telephone is used instead of a galvanometer. By depressing the key for shorter or longer periods, "dot" and "dash" signals may be transmitted. The effects of resonance may be studied by shunting the spark gap with a condenser and putting a choking coil in series with the aerials A or E.

The price of the various items needed for demonstrating the principles of wireless telegraphy will be found at the end of this pamphlet.

TELEGRAPHY.

When using the detector for practical telegraphy an arrangement is needed differing in detail from that in the foregoing description, as each station must be capable of use either as a sending or receiving station. Fig. 4 shows a typical arrangement which could of course be modified in detail to suit special requirements. B is the battery giving current for the primary of the spark coil C, in series with the morse key K and the detector D by the terminals marked "spark coil." This circuit can only be completed by the key K when the switch in the detector is at "send." The secondary of the spark coil C is connected through a double-pole change-over switch S, S to the spark gap G and the aerial and earth wires A and E. The diagram shows

the circuits arranged for sending messages. When it is desired to receive, the switch on the detector is set to "receive" and the double-pole switch *S*, *S* is changed over so that spark gap *G* is shunted by the pellet in the detector *D*. The relay circuit here consists of an accumulator

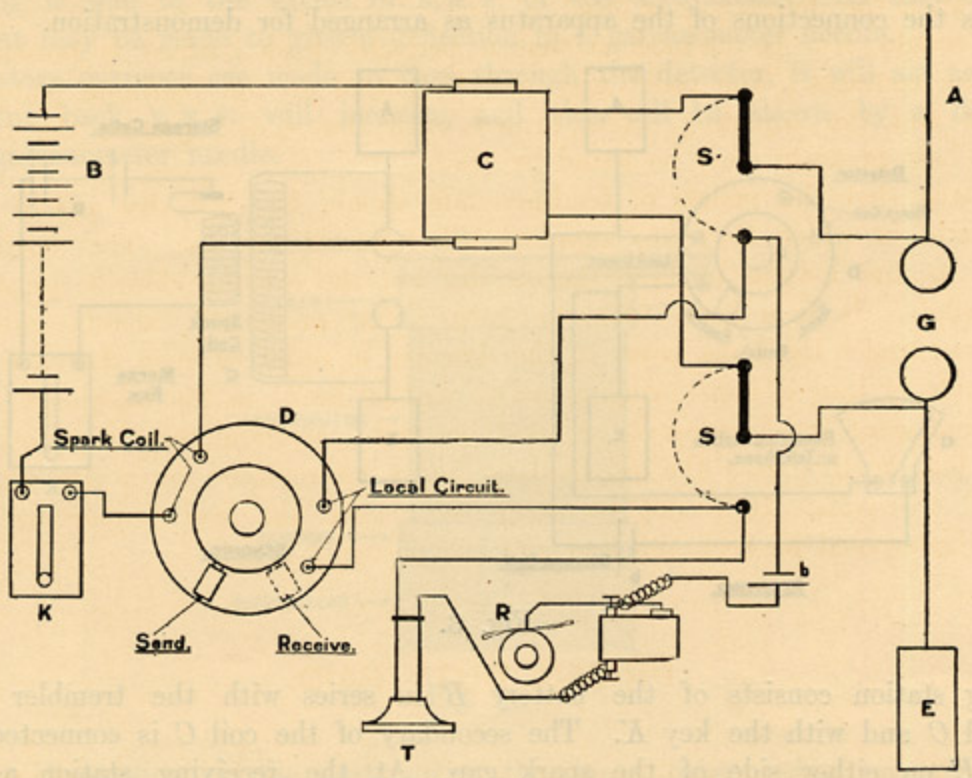

Fig. 4.

cell *b* but instead of the galvanometer a recorder *R* and a telephone *T* are connected in series. The usual arrangements can of course be made to introduce self-induction and capacity into the aerial circuit.

HINTS ON THE USE OF THE DETECTOR.

The connections indicated in Figs. 3 and 4 may be followed in the general arrangement. It is generally preferable to join the air wire to the + and the earth wire to the – of the two terminals marked "local circuit," but it is well, when making preliminary experiments, to try whether any improvement results from a reversal of these connections.

The + pole of the 2 volt accumulator in the local circuit must be joined to the + terminal on the detector. On no account should these connections be reversed.

If the telephone in the local circuit is of low self-induction it may be found advisable to add one or two small choking coils to the circuit. These may consist of say 100 turns of No. 22 silk-covered wire wound on a small insulating bobbin. These should be placed in the local circuit close to the terminals on the detector, care being taken that they are not connected in the air or earth wires by mistake.

The resistance of the telephone may be varied for different circumstances. If the induced currents are strong the telephone may be of low resistance, say 100 ohms, and the signals will be strong and easily read. On the other hand if the induced currents are weak then the resistance of the telephone should be high, say 1500 ohms, thus reducing the battery current, and so rendering the variations, though small, of greater relative importance.

The primary circuit to the spark coil for sending messages should be brought to the two terminals on the detector marked "spark coil" so that this primary circuit can only be completed when the switch on the detector is in the position marked "send."

Having made the above external connections the pellet of the lead-peroxide may be placed in position in the detector. To do this unscrew the brass cover by means of its milled edge. A flat steel spring will be seen fixed at one end and carrying underneath the other end a small plate of lead. Below this spring is a small platinum plate mounted on the head of a brass pillar.

Both the lead and platinum plates should be carefully cleaned before use, the former by rubbing firmly upon a piece of paper and the latter with a clean cloth. Do not use the same piece of paper to clean both contacts, otherwise lead may be transferred to the platinum plate with consequent trouble when the detector is in use.

The pellet should also be cleaned so that a perfectly fresh surface is presented both to the lead and platinum contacts. The pellet may now be placed on the platinum plate and underneath the lead contact and the adjusting screw turned until the spring presses the lead lightly upon the pellet. The best pressure must be found by trial.

It is important that the pellets of lead-peroxide should be kept dry and it is best to keep them in the bottle in which they are supplied till required for use. This bottle contains some calcium chloride at the bottom to keep the air dry but the calcium chloride must not be allowed to touch the pellets. It is a good plan to keep a few grains of calcium chloride in a small lead or glass vessel under the brass cover of the detector in order to keep the enclosed air dry.

If the peroxide of lead is moist, singing noises will be heard in the telephone.

In cases where great sensitiveness is required the metal thallium may be substituted for lead as the top contact but in this case the accumulator must be replaced by a dry cell as the voltage must not exceed 1·5 volts. It is not necessary to remove the lead contact as a thin piece of thallium may be interposed between the lead and the peroxide pellet.

PRICES, DUTY PAID.

	$	Code Word.
Brown's Hertzian Wave Detector, as illustrated	96.00	*Lowbell*
Detector Galvanometer	46.00	*Loyally*
Accumulator cells, 2 volt, 35 ampere-hours' capacity, charging current, 3 amperes, (No. 671*t*, List 39) ... ... each	7.20	*Efface*
Spring key on wood base with Platinum contacts	4.80	*Lossless*
Laboratory Pattern Induction Coil, 4″ Spark, with Condenser, Double Discharge Pillars and Contact Breaker	92.00	*Lubbard*
Small Pattern Induction Coil, about 1″ Spark, with Discharge Points and Contact Breaker, but without Condenser	24.00	*Luckless*

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