WIRELESS AS CONNECTED WITH AERONAUTICS

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[Abstract from Mr. Dubilier's paper read before the Aeronautical Society of America, June 11th, where he prefaced his remarks with a note on the history of wireless and its adaptation to aeronautics. At the conclusion of his considera- tion of various systems he showed lantern slides of various experimen- tal sets which have been employed here and abroad in military and civilian trials, and then showed in operation two complete sets as have been adapted and ordered by the English and the American Govern- ments for aeroplane and balloon work.]

For wireless installations on board aeroplanes and balloons the most important consideration has been to install apparatus which will conform to the limitations of the weight and space, and still provide a suitable and efficient means for transmitting messages to the de- sired points with the small aerial wire system and power limited to the size of air craft. The demand for light and easy removable sta- tions for Army and Navy work is constantly increasing. During the time of war, wireless communica- tion, due to the way in which the stations can be quickly removed, is of great service in connection with aeronautics, for it enables the lead- ers of the battle to send commands rapidly and to receive the position of the enemy. The operator is usually carried as a passenger and transmits signals at the same time as he makes observations. The ap- paratus used in all respects is inter- changeable with the portable field sets, as this enables any operator of the field signal corps to work the aeroplane outfit when necessary. It is so arranged that the machines are of double key type so that messages can be sent by either the aviator or the passenger.

The current is obtained from a generator friction driven from the fly wheel of the engine or from stor- age cells. Experiments have also been made with wind motors, where the generator was driven by an aero fan.

The equipment at present used by the U. S. Government has an output of about 125 watts, weighs about 75 pounds, and it has been claimed that a radius of 30 miles has been obtained. The new equip- ment designed by the author has a total weight of less than 20 pounds with double the capacity and less than ½ the space, so that immedi- ately one will be able to see the advantages from every standpoint.

Recently several European gov- ernments have been making experi- ments with apparatus for army work and have arranged conditions contrary to those which have been planned and adopted by all wire- less workers up to date; in fact, have gone back to old days when the ordinary Hertz oscillator, un- tuned and of open circuit, was used. Now several officials have suggested the use of apparatus wherein the transmitter is not tuned, and they advance several points in its favor.

First, in transmitting a sharply tuned signal it takes a longer time for the receptor to get into proper adjustment for receiving these sig- nals.

Secondly, the transmitter can be more quickly adjusted, as it is not necessary to carefully adjust the oscillating circuits in order to bring them in resonance.

Thirdly, messages can be sent in secret code, hence it does not matter whether the enemy receives them or not. Then if the signals sent out are not tuned sharply, the greatest hindrance can be done to the enemy by interfering with their stations, for it will be difficult for them to tune out these highly damped waves. It has therefore been desirable to send out waves with a flat resonance curve.

In order to get the largest amount of power out of the transmitting station and to arrange the circuits in resonance, the following figures will be of great interest to give one an idea of the size of the aerial and capacities that is necessary in installations The speed of electric waves is about one billion feet per second. If oscillations or waves of a frequency of one million is de- sired, it will be necessary to have a wave length of about 1,000 feet, for to send messages with wave lengths of very much less, is not practical, due to many difficulties, such as absorption, heat losses, in- duction losses, etc., therefore, if signals are to be sent longer wave lengths should be obtained by using larger inductances. The size of these are also limited, for the ma- chine again becomes inefficient when too much inductance and too little aerial capacity is used, hence, a compromise must be made, where- by sufficient aerial length and sur- face is used, coupled with a fairly large inductance. To get an idea of the length of the aerial, roughly, the wave length transmitted is 5 times the length of the aerial, plus 10 times the length of wire in the coil or helix. To make up the length, usually a trailing wire is used, which is let down from the aeroplane or balloon or an auxiliary balloon used for elevating wires. This plays a very important part in determining the range of a wire- less station, for, roughly, it varies directly with the height of an aerial and cube root of the power.

Many different kinds of apparatus have been designed for aeroplane work. Portable stations supplied by the Marconi Company, type L, especially adopted for aeroplanes, weigh 50 pounds, have a capacity of 50 watts and a radius of about 10 miles. Type L1 weighs 200 pounds, has a capacity of about 500 watts and a sending radius of 50 miles, while type M. for dirigible balloon work, has a capacity of 1,500 watts, a sending radius of 200 miles and weighs 500 pounds. One of these installations was tried on board the Flanders, a British machine, and was made up in 2 separate con- tained units with the idea of dis- tributing the weight. It fitted un- derneath the pilot and passenger seats, and the only part exposed was the manipulating key with sev- eral controller switches, which were placed in the most convenient posi- tion for the operator to carry out the simultaneous work of observing and reporting.

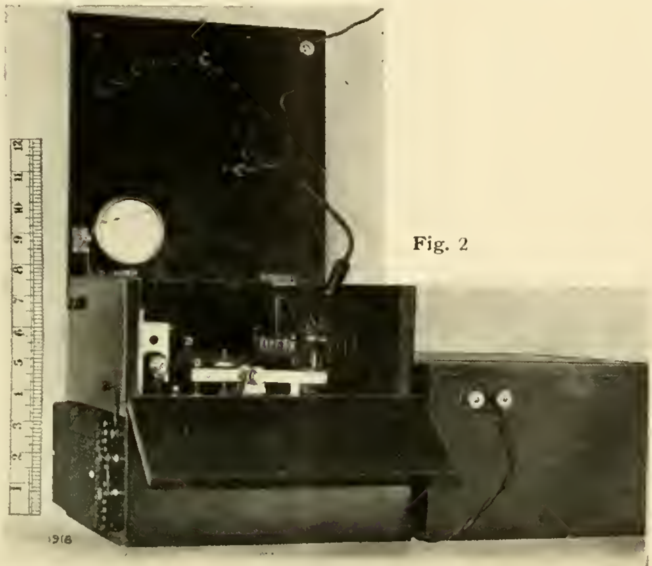

Fig. 2

Another aeroplane installation used is one constructed by the Lor- enz Company, using a quenched dis- charge gap for the production of nearly continuous oscillations. The outside dimensions of the box are 15 x 15 x 21 inches. The weight of the transmitter without the gen- erator is 100 pounds, the dynamo used is 500 volts with a capacity of 500 watts. This apparatus consists of a discharge gap made of 2 large electrodes, each electrode shaped like a half ball and cooled by a hydro-carbon vapor. Although this apparatus is not efficient, it has already been installed by several foreign governments.

The Telefunken Company have also made an apparatus for aeroplane work which has a capacity of about 300 watts and occupies 3 cubic feet. A small dynamo is used, belt or friction driven from the main engine, and this apparatus has a sending radius of from 15 to 20 miles.

For balloon installations, where large aerials can be constructed, much greater distances could be obtained. It has been reported that the Zeppelin airships are transmitting signals 200 miles with a 5 kw. installation, and all the Zeppelin airships that are making public trips have on board regular telegraph forms, the same as used on ship stations, and passengers can send tbeir messages at published rates to any part of the world.

Tbe greatest danger attached to balloons from wireless installations is the fact that the gas may become ignited hy sparks produced by induced currents that occur in metal parts. This danger cannot be eliminated with the larger installations where high voltage transformers are used, but there are certain systems, such as the Poulsen, Lorenz and that devised by the author, where the voltage of the transmitting oscillations are greatly reduced, thus eliminating to some extent the danger of induced currents. All metal parts, such as the valves, etc., must be thoroughly covered with a thick coating of some form of insulating varnish. For balloon work the wireless telephone is the most practical method for transmitting communications, for it eliminates the telegraph operator, the danger of explosions by brush discharges and makes possible quick transmission of signals. Fig. I shows Dubilier wireless telephone installations for balloons and aeroplanes.

The aerial on board the Zeppelin balloon is almost 600 feet long, and a 500 cycle generator is driven by an independent engine at a speed of 3,000 revolutions per minute. The wave length varies from 400 to 1,200 meters.

The illustration (Fig. II, Dubilier wireless telegraph apparatus for aeroplanes) herewith shows a portable Duhilier apparatus weighing 20 pounds with a maximum capacity of ½ kw. The system devised by Mr. Dubilier eliminates the use of the difficult high frequency alternator. A small direct current dynamo is used, and then hy a simple device alternating currents are produced having any desired frequency from 200 to 800 cycles, thus sending signals with musical notes. The apparatus is much easier and cheaper to construct than any yet provided for portable work, is much smaller and much more compact for a given power, therefore more portable and readily adapted for transport purposes. It is especially designed for aeroplane installations, where power, space and weight are important considerations.

From tests made both by the British and United States Government the apparatus has proven itself 100 per cent. more efficient than any of the machines yet tried. In a report issued by Captain LeFroy, at Aldershot, a 60 watt, 110 volt set was used, and signals were sent from a standard portable aerial and received on a service peck aerial 30 feet high consisting of 2 wires in parallel, 4 feet apart. A ground net with a peg driven 12 inches into the earth was used as a balanced capacity. The station was erected on grass, and 104 volts direct current were used for transmitting. The current in the aerial was 1½ amperes. The condenser capacity was .0015 mf., a loose coupler being used. The maximum voltage across the spark gap was 7,000, which was of the quenched type adjusted to give the best readings in the aerial. Tests were made with three ranges, in connection with a 300 watt Marconi installation s[illegible]) alongside for comparisons. From Aldershot a motor car with a portable installation went out to three distances, first to Hook Common, 9 miles; second to Overton, 2[illegible] miles; third, to Whitchurch, 25 miles. In the first two places signals were received clear and good, being 8 times audibility at the latter test. At the third test the receiving end was connected to the wrong side of the aerial, which was directive and which was in a valley so that no signals were obtained. Captain LeFroy reported that this apparatus, which weighed but 15 pounds less the generator had a safe range of 20 miles over land. The same apparatus operated on a 50 volt accumulator weighing 35 pounds had a radius of approximately the same distances.

Roughly, the principal used is the producing of pulsating currents of a musical frequency from direct currents by means of a tuned circuit. This circuit contains a condenser charging device, condenser and an inductance. The condenser charging device is set in operation mechanically or electro mechanically, and hy means of springs is given a certain definite working frequency, say 500 cycles. Then the inductance and capacity is so varied that its natural frequency is also 500 or a harmonic of the frequency of the oscillator. Under this condition the primary current is transformed into pulsating currents having a sine wave with over 90 per cent. efficiency. A suitable analogy can be shown by having constant water flowing out of a faucet, which will represent direct current, and then having another faucet with water running out into a cup or into a vessel which operates a lever by means of its weight when it becomes filled. This lever closes a valve, and at the same time drops and turns over the vessel, which releases the water. The release of the water operates the lever in the opposite direction, due to its lighter weight, and the vessel is then brought up again in position. The valve is simultaneously opened and the water again allowed to flow into the vessel until it is filled, and then the operation is repeated. Hence, we have quantities

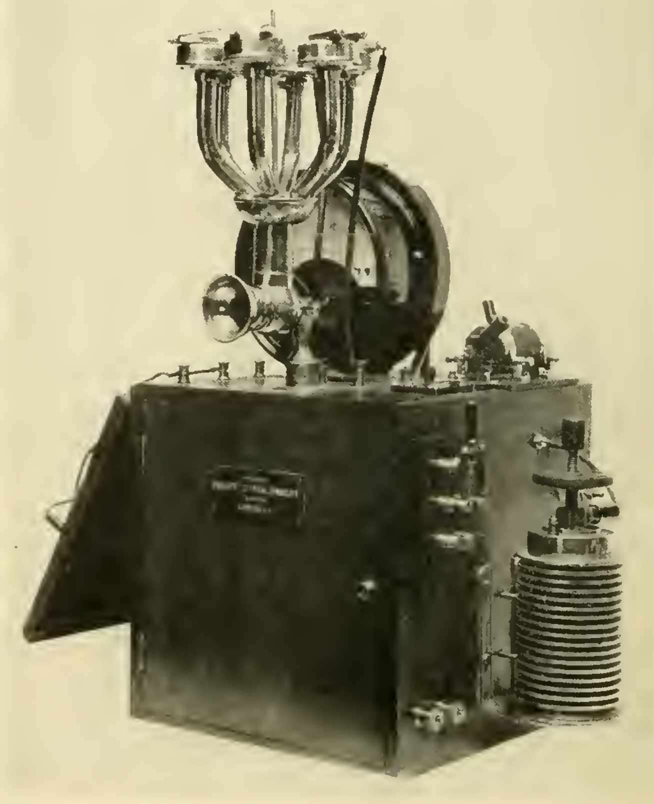

Fig. 1.

of water being thrown out instead of a continuous flow; so does this system operate on direct current.

The inductance of the primary oscillating circuit acts as the primary of a high tension transformer, the secondary discharge of which produces oscillations in the well-known manner. A quenched spark is used of a special design and is shown on the cover of the apparatus. This gap consists of long copper bars with smoothly planed ends placed about .003 of an inch apart, the discharge taking place between the planed ends. Any number can be connected by a small short circuiting rod. The inductance is mounted in back of the instrument and is connected to a hot wire ammeter, which indicates the amount of power that is being radiated.

In experiments carried out by Mr. E. J. Simon and L. J. Lesh, an aerofan was used to drive the generator. This was equipped on board a Curtiss military hydro-aeroplane and was of about ¼ kw. capacity, with a 500 cycle generator driven by a fan 20 inches in diameter, and aerial wire 600 feet long was wound on a reel and weighted by a 3-pound piece of lead; this was used as the trailer and taken in as it became necessary. The installation weighed 105 pounds, and it was found necessary to attain a fairly good speed to generate enough power to operate the apparatus efficiently.

In connection with aeroplane military work, a motor car installation is being used by the English Government. The capacity is 1½ kw., and the generator is run by the motor engine. The aerial can be erected in a short time and when folded up fits on the side of the car. It has been found that these motor car stations are only suitable for well-constructed roads. The range of the apparatus was from 50 to 70 miles.

The question of receiving signals on board aeroplanes and balloons has been a very difficult one, for the noises and vibrations of the engines and air currents make it unpractical to receive signals with a telephone receiver. A receiving apparatus was designed for the Austrian Government in which a visible signal was used. The operator is able to observe dots and dashes by means of a small light. It is advisable to use Prof. Flemming's oscillation valve or Dr. De Forest's audium, for they act as amplifiers to the received signals and are not affected by vibrations.