RADIO CONTROL

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THE ingeniousness of the American Inventor is perhaps nowhere so well exemplified as in harnessing the Hertzian electro-magnetic waves for the operation of practically any mechanical device. Wherever manual or metallic operation is impossible, impracticable or economically wasteful, whether to moving or stationary objects nearby or at a distance, complete mastery is now possible through the use of especially designed electrical apparatus, which functions by the radio signals which it receives.

The possibilities, both commercially and for military purposes, are inexhaustible with saving benefits in both manual labor and time. This small field of Communication Engineering holds forth the prospect of centrally controlled train signalling and safety devices, remote operation of power sub-stations, maneuvering of manless navies, flight direction of aerial torpedoes, traffic control of aeroplanes and automobile bus-lines, automatic operation of lighthouses, fog signals and innumerable other uses.

Not very far from Columbus, at McCook's Field, in Dayton, Ohio, there has been designed and developed by the engineering division of the air service a radio controlled car for the purpose of testing a control system applicable to a flying aeroplane. This yellow and blue car can be seen running around the flying field, stopping, starting, backing, or sounding its horn, turning either to the right or left, with no human person present to manage its activities. The means of locomotion of this car is a 12-volt motor geared to the rear wheels and the control of its activity is by radio signals transmitted to it by an operator located in some building on the field. The antenna used for reception is a condenser type, of which the top and floor of the car form the two plates, and a Signal Corps receiving set is used to detect and amplify the control signals. The Hammond Progressive Selective System of Control is used, where the selector will operate on twelve signals, thereby directing into the proper electrical channels the signal to operate a certain control, such as the stopping apparatus, for instance. The car was designed with controls for stopping, starting, turning, backing, signalling, firing machine guns, dropping bombs, and lighting its headlights, etc.

During the recent well-advertised controversy on the Navy versus Aeroplane, which culminated in bombing tests at Hampton Roads, Norfolk, Va., it was found necessary to be able to maneuver the battleship "Iowa," which was to be the target of the aeroplane bombers, without crew, in order that in case of a hit no loss of life would result. This problem was solved by the installation of a radio control system which directed the movements of this ship throughout the entire tests.

The control of an aeroplane in motion, equipped with suitable radio apparatus and a means of stabilization, was satisfactorily demonstrated within the past year in France.

Although probably the first experimental work upon the subject of radio dynamics dates as far back as 1897 and such men as Dr. Branley, Tesla and Marconi have devoted time and energy to its development, yet it was not until January 24, 1921, that John Hayes Hammond, Jr., under patent No. 1390288, renewed from July 24, 1913, and issued September 13, 1921, presented a commercial product adaptable for universal service. The electrical and mechanical functioning of a control system is to the inexperienced layman extremely complicated and intricate, but the fundamental principals may be best presented and understood by the use of typical generalized diagrams.

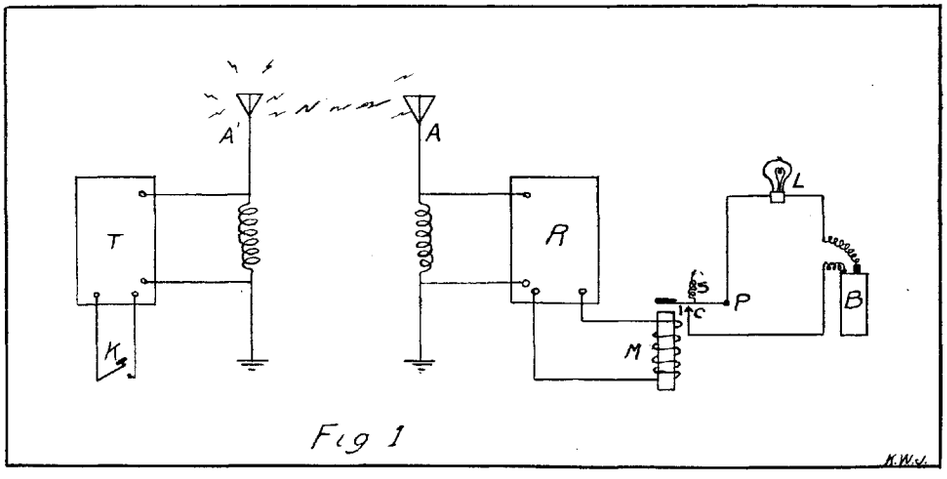

Figure I.
Single Control Circuit Simplest form of Radio Control Receiving Circuit.

SIMPLEST FORM OF RADIO CONTROLLED RECEIVING CIRCUIT

The simplest form of radio-controlled receiving circuit is one which has but one operation or control to accomplish the work desired. Such a cir-

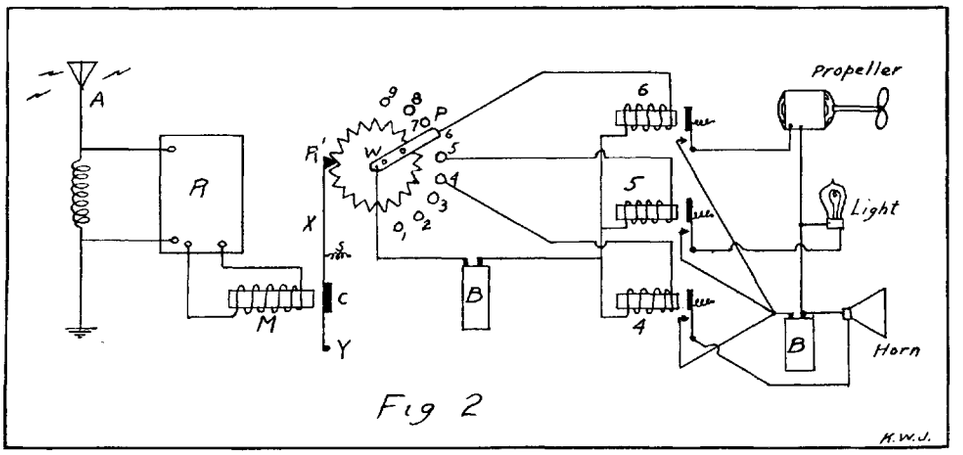

Figure II.
"Distributor Circuit" receiving circuit with distributor controlling individual control circuits.

cuit is illustrated in Fig. 1. It consists of an antenna A, receiving set R, electromagnet M and an auxiliary circuit or battery B, lamp L and armature C, which consists of a small piece of iron pivoted at P and normally held open by the spring S. When the key K at the transmitting station T is closed the antenna A radiates an electromagnetic wave which travels across the ether medium to the receiving antenna A and through the receiving set R. The reception of this wave sets up a current in the electromagnet M which energizes it sufficiently to overcome the tension of spring S in attracting the armature C. The armature touches the surface of contact I, thereby closing the electrical circuit which controls the lighting of the lamp L. It is to be understood, of course, that the receiving antenna is tuned to the same wave length as that of the transmitting antenna and that the light L will remain lighted only so long as the key K remains closed.

Since the primary object to be attained by the distributor is simply to cause the desired control to operate in response to the signal for that control, either a mechanical or an electrical device may be used. The illustration in Fig 2 shows a ratchet wheel W to which is permanently fixed a pointer P. C is an armature pivoted at Y and held open by spring S and has an extension arm X at the end of which is the pawl R. Outside and around the perimeter of the wheel W are contact points numbered 1, 2, 3, 4, etc., which are connected electrically to various electromagnets 1, 2, 3, 4, etc., and then to plus battery. The negative side of the battery is connected to the pointer P. When an impulse is received by the receiving antenna A the electromagnet M is energized and armature C is attracted, causing R to move the wheel W one notch for every impulse received. This movement of wheel W, therefore, will place the pointer P on the desired numbered contact by transmitting the proper number of impulses.

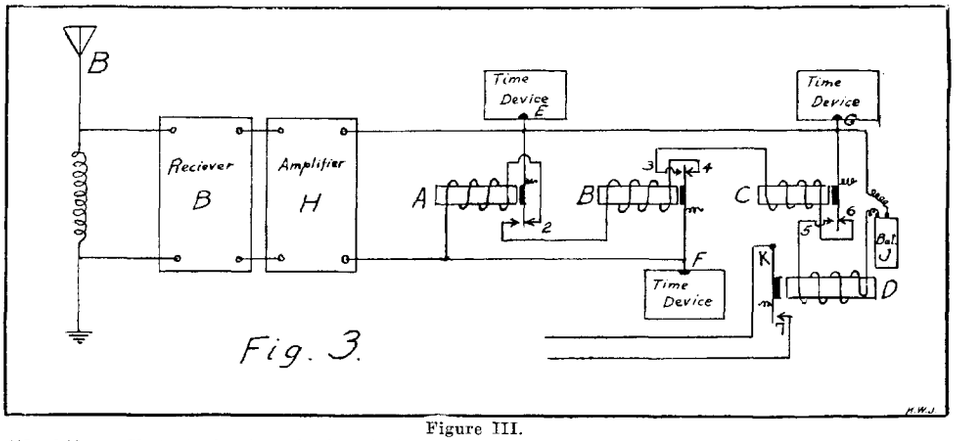

Figure III.
"Lock" or Shutout showing timeing devices synchronized with lock control transmitting apparatus which radiates prearranged code signals for closing lock relay D.

"DISTRIBUTER"

Disregarding all the obvious disadvantages of the signle control circuit which are at once apparent to the experienced, its main objection is that it is not adaptable to the operation of several mechanisms, as it admits of only one control. It is necessary, therefore, to introduce an additional piece of apparatus which we will term a distributor in order to be able to allow our apparatus to perform more than one function.

When P is on the desired contact the battery circuit from B will be completed through the desired electromagnet, which being energized will attract its armature in the control circuit to be operated. The closing of the armature in the control circuit completes the electrical circuit and consequently causes the desired operation to be performed by that circuit. The distributor, therefore, will close and cause to operate any one

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of the many controls at the will of the controlling operator in response to his operating signals. It is, of course, necessary to remove the undesired contacts from the electrical circuit as P is passing over these unwanted numbers and it is further desirable and necessary to allow certain controls to function continuously or during the period of operation of other controls, but for simplicity of diagram and explanation such essential features were overlooked until a general comprehensive perspective is presented covering the requirements demanded of such a system, and it is expected that a future article is so arranged that periodically armatures E, F, G are returned to their normal position, so that any operator, although on the same wave length for which antenna B is tuned, cannot, unless he happens to send the code signal with the same synchronization of time, get through the electrical network and operate electromagnet D. Presuming the illustrated lock will operate on three dashes with the proper time element present, our first received dash will attract the armature E to contact 1 which allows the next dash to attract armature F from 4 to 3 and out third dash will energize electromagnet C and attract armature C from contact 6 to 5. This will complete the battery circuit from battery T through

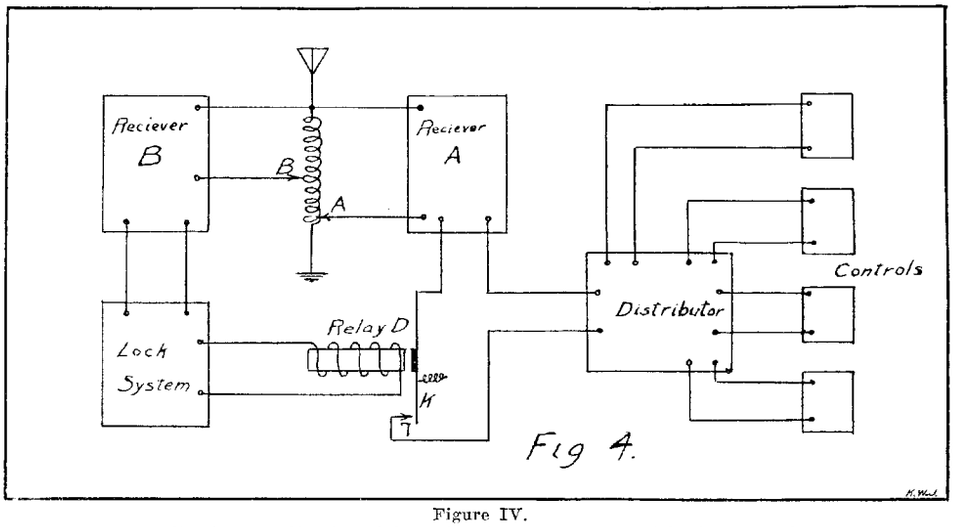

Figure IV.
Radio Control Circuit. Schematic of necessary essentials for operation.

will appear containing a replica of the exact circuits used and a more thorough explanation of their functioning.

THE "RADIO LOCK" OR SHUTOUT

In the control network so far covered, we have made no mention of a contingency which would continuously arise whereby our apparatus will operate for any operator or operators who happened to be sending on the same wave length as that for which our receiving antenna is tuned. This must be provided against and is accomplished by the use of what we will term a shutout or "radio lock." This shutout or radio lock is controlled by a distinctive code signal sent on a special wave length, and until it is operated on, no one can interfere with any one of the various control circuits. Normally the distributor circuit is always open and is closed only by the radio lock relay. Therefore, to operate a certain control the operator must first close the distrbiutor circuit, and to do so he must operate the shutout or lock. The shutout or lock system is illustrated in Fig. 3.

It consists of an antenna B tuned to a different wave length than the control antenna A, receiving set B. amplifier H for increasing our current and electromagnets A, B, C, D, with armatures E, F. G. The armatures E, F, G are controlled by a timing device which is in synchronism with a special transmitting apparatus at the sending station for transmitting the special code signal for operation of the shutout. The timing device the electromagnet D, which is the shutout magnet. When D is energized, armature K will be attracted to contact 7 and our distributor circuit will now be electrically completed and closed for the operation required by the controlling operator.

Figure 4 graphically illustrates the necessary essentials for operation by radio control. An antenna tuned to two waves, one of which operates the "lock" or shutout system, the other by means of the distributor directs and operates the various control units.