

The Electric Dog following its luminous master, and a general view of its internal arrangement

The Electric Dog

Use of the Selenium Cell to Make an Orientation Mechanism

By Benjamin Franklin Miessner

THE principle of orientation is well exemplified in nature. A large variety of plants, flowers, and other living examples of the realm of botany, are endowed with the power of turning themselves for the purpose of gaining the beneficial effect of the sun's rays. A very common and good example of these is the sunflower, so named because of this well-defined ability to follow the path of the sun from east to west across the heavens.

The mechanism herein described is merely an example of one of the many ways in which an inanimate object may be made to act like one possessed of life and as such capable of reacting like living objects from the effects of external stimuli.

Nikola Tesla, in a classic discussion, "The Problem of Increasing Human Energy,"¹ expressed the firm belief that every man, every living organism, is "merely an automaton endowed with power of movement, which responds to external stimuli beating upon its sense organs, and thinks and acts accordingly." He goes on to say: "With these experiments it was only natural that, long ago, I conceived the idea of constructing an automaton which would mechanically represent me and which would respond, as I do myself, but of course, in a much more primitive manner, to external influences. Such an automaton, evidently, had to have motive power, organs for locomotion, directive organs, and one or more sensitive organs so adapted as to be excited by external stimuli. This machine would, I reasoned, perform its movements in the manner of a living being, for it would have all the chief mechanical characteristics or elements of the same. . . . Whether the automaton be of flesh and bone, or of wood and steel, it mattered little provided it could perform all the duties required of it like an intelligent being. To do so, it had to have an element corresponding to the mind, which would effect the control of all of its movements and operations, and cause it to act, in any unforeseen case that might present itself, with knowledge, reason, judgment, and experience. But this element I could easily embody in it by conveying to it my own intelligence, my own understanding."

In 1898 Tesla evolved the first practical telautomaton, which was in the form of a crewless boat that could be controlled from the shore or another boat by radiated energy. By means of this invention, which is the model from which all the wireless-directed torpedoes of today have been copied, Tesla was able to make an inanimate machine perform movements with the intelligence, reason, experience, and judgment of a living being.

This first automaton, it will be seen, was one which acted with the intelligence transmitted to it from the mind of its master, rather than with any intelligence which was an inherent part of its own makeup. Although, without a single doubt the intelligence of such an automaton as Mr. Tesla constructed, and which I in recent years have perfected for military purposes, would in any case be far superior to that of a machine

possessed of its own mechanical brain, my work on the electric dog represents an attempt to evolve an automaton which would conduct itself in much the same manner as do some of the lower forms of animal life, that is by purely reflex action.

In its first form the orientation mechanism was, like the sunflower, capable only of so turning itself as to face the source of energy producing the stimulation of its sensitive organs. This apparatus I devised for use with a searchlight-selenium system of torpedo control for Mr. John Hays Hammond, Jr., with whom I was associated at that time. The purpose of this mechanism was to keep continuously facing the controlling searchlights on shore or ship, a selenium cell connected to the control switches on the torpedo. Should the rays

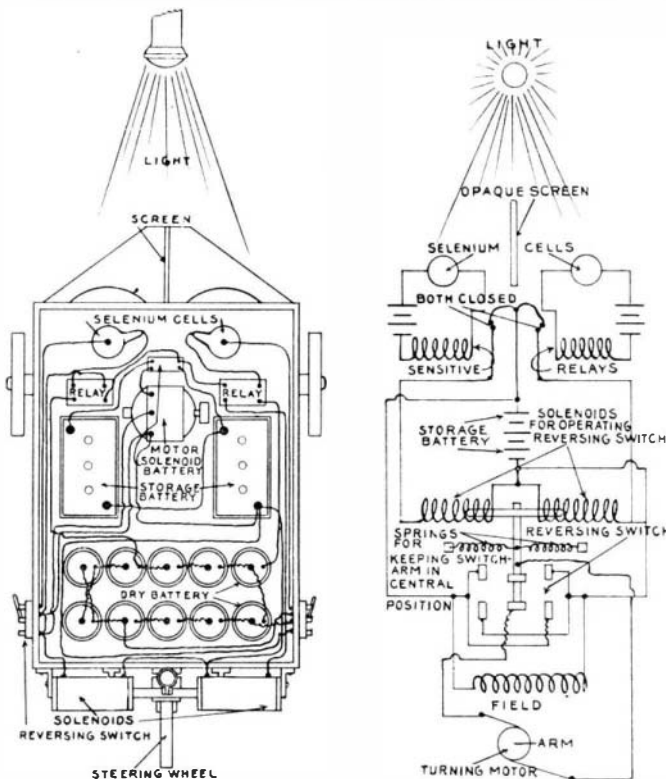
fully in rendering an automaton susceptible only to the call of its master is to prevent the calls of others from reaching it. This the orientation mechanism has done for the searchlight-selenium or infra-red ray systems of torpedo control.

It was about the time of our first experiments with the orientation mechanism that Professor Jaques Loeb first announced the results of his experiments and investigations with moths and the reasons for the familiar attractive effect on them by sources of light. He found that the moth flies into a flame because its flight is automatically directed by some kind of reflex action due to the stimulation of light-sensitive organs on either side of its body. Professor Loeb found further that when one alone of these organs is exposed to illumination the moth experiences an unpleasant sensation that induces a reflex action which causes the moth to turn the exposed side of its body away from the light in its effort to dispel the unpleasant sensation. As soon, however, as the other side becomes exposed to the radiation, the pain and reflex action is again set up, the same cycle of events being repeated. The forward flight of the moth therefore carries it directly toward the source of light.

Here in the moth we have the case of a living automaton capable of orientating itself with respect to a source of radiated energy, and possessed at the same time with organs of locomotion, an automaton which performs its motions mechanically in response to external stimuli.

The next form of my orientation mechanism was a reproduction of the moth mechanism, that is, one which, like the moth, was provided with means of propulsion. In its present form the electric dog consists of a rectangular box about three feet long, one and one-half feet wide and one foot high. This box contains all the instruments and mechanism, and is mounted upon three wheels, two of which are geared to a driving motor; the third, on the rear end, is so mounted that its bearings can be turned in a horizontal plane for steering, much like the front wheel of a child's velocipede. Two large, glass lenses on the forward end, separated by a protruding, nose-like partition, appear very much like huge eyes.

If a pocket flash light be turned on the machine it will immediately spring into action, but will stop as suddenly if the light be snapped off or turned away. If the light be held stationary and directed upon the dog, it will amble up until its own motion causes it to come directly under the light, and therefore into such a position that the light will not shine in its glass eyes; there it stops and the whining of its driving motor also ceases. If now one turns the flashlight into its eyes and walks about the room the dog will immediately respond and follow the moving light wherever it goes, with a loud metallic clank at each wag of its steering-wheel tail. This wagging of the tail occurs at every turn or every time at which, for any reason, the light fails to reach one of the great eyes. It always turns on these occasions so that the eye cut off from the light by the nose-like screen, will again see the light. So long as the light reaches both



The arrangement of the electric dog (left), and a conventional representation (right) of the electric elements involved

of the enemy's searchlights reach the receiving selenium cell in sufficient intensity, interference destructive to the original control would result.

It is this problem of interference which has ever baffled the most advanced in this new art in their efforts to produce an automaton able to recognize the voice of its master absolutely and without fail despite the efforts of others to imitate or reproduce that voice in the minutest detail. It is this problem which has made necessary the national and international laws relative to the use of radiotelegraphic apparatus. It is, I think, a problem of constructing an automaton which is possessed of more than human intelligence, for that automaton must be able to recognize the call of its master, and not the imitations of others, however perfect they may be. We ourselves cannot perform such a feat. The only method which can be applied success-

¹Century Magazine, June, 1900.

eyes in equal intensity, as when the source is directly ahead, the rear wheel is in the central position, and the dog moves ahead without turning. By turning over a switch, the dog can be made to back away from the light in a most surprising manner.

The electric dog is purely an automaton capable of self-propulsion and of self-direction, and the principle involved is applicable to any form of energy capable of transmission to a distance through the natural media. A suitable energy detector, which acts as the sensitive receptive organ, must be used; it must be capable, with the aid of auxiliary devices, of producing definite mechanical movements when influenced by the energy of the external stimulus. Thus, for visible waves in the ether, we use the selenium cell or its equivalent; with the infra-red or heat waves in the ether we use a sensitive thermopile, bolometer, radiometer or other heat detecting instrument; for the ultra-violet, the trigger vacuum tube; for sound waves in air or water, the microphone; for Hertzian waves in the ether, the radio detectors; in the case of Hertzian waves where the energy cannot well be directed as in the case of the other wave motions, the directive element must be incorporated in the receiver itself, that is, it must in all cases be so arranged that the direction from which the stimulating energy comes to it can be easily determined.

I have applied the Bellini-Tosi radio-goniometer and other radio direction finders as a means of determining the direction of the source of energy when electromagnetic waves are used. Two strongly directive antennae are supported with a certain small angle between their best directions for reception; each has connected to it a radio receiver terminating in a sensitive relay, and these control the dog mechanism exactly as do the selenium-controlled relays in the light-controlled dog. When the dog faces the source of the waves neither receiving set receives the full amount of energy; if for any reason the source moves or the dog changes its direction of motion, one of the receivers will receive a larger amount of energy while the other receives less; the result is that the balance is disturbed, a switch is moved to one side, and the steering apparatus is so operated as to bring the dog back into its original motion toward the source of energy. When refinements in radio direction finders are accomplished this form of electric dog will be well worthy of consideration for a protection against intentional interference in torpedo control systems using Hertzian waves.

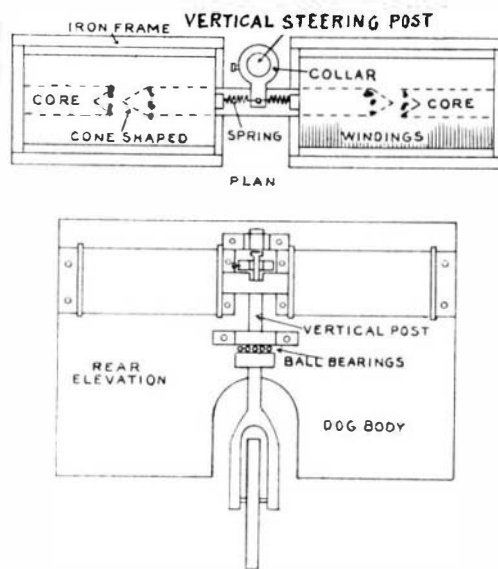
Automatic control of torpedoes has been made possible by the electric dog. Since 1911, when my experiments were materialized into the mechanism here pictured and described, I have developed plans for automatic torpedoes capable of following the sources of a number of different kinds of radiated energy, such as the sound waves resulting from the motion of a ship in the water, and from the ship's machinery, the heat radiated from its funnels, the light waves reflected from its surface. Every known form of energy capable of being radiated through the natural media has been considered in detail. Light waves and selenium were adopted in the present mechanism, because of the availability of suitable apparatus of sufficient sensitivity. I have recently given particular attention to radiant heat as the control energy and have succeeded in developing rugged and extremely sensitive receptive devices by means of which considerable simplification of apparatus and increased reliability are secured.

Although often demonstrated privately before interested scientific men in Gloucester and New York, the electric dog was first shown in public in a lecture-demonstration given by the writer on "Selenium, its Applications and Possibilities in Electrotechnics," before the Indianapolis Lafayette branch of the American Institute Electrical Engineers, at Purdue University, in January, 1915. I have devised numerous other applications of the electric dog principle, a rather novel one being an apparatus which will automatically control the pointing of guns, telescopes, and similar devices. Guns of the larger calibres, when used under the conditions imposed aboard ships, are much in need of some such automatic control. A master controller would effect the control of any or all guns on a ship merely by throwing in the connecting switch at each gun.

The electric dog follows a light, which quite naturally is surrounded by comparative darkness. In the case of the automatic torpedo or gun pointer this condition

is completely reversed, that is, the source of attraction is a dark spot amid slightly brighter surroundings, or amid surroundings which are slightly different in their light-reflecting qualities.

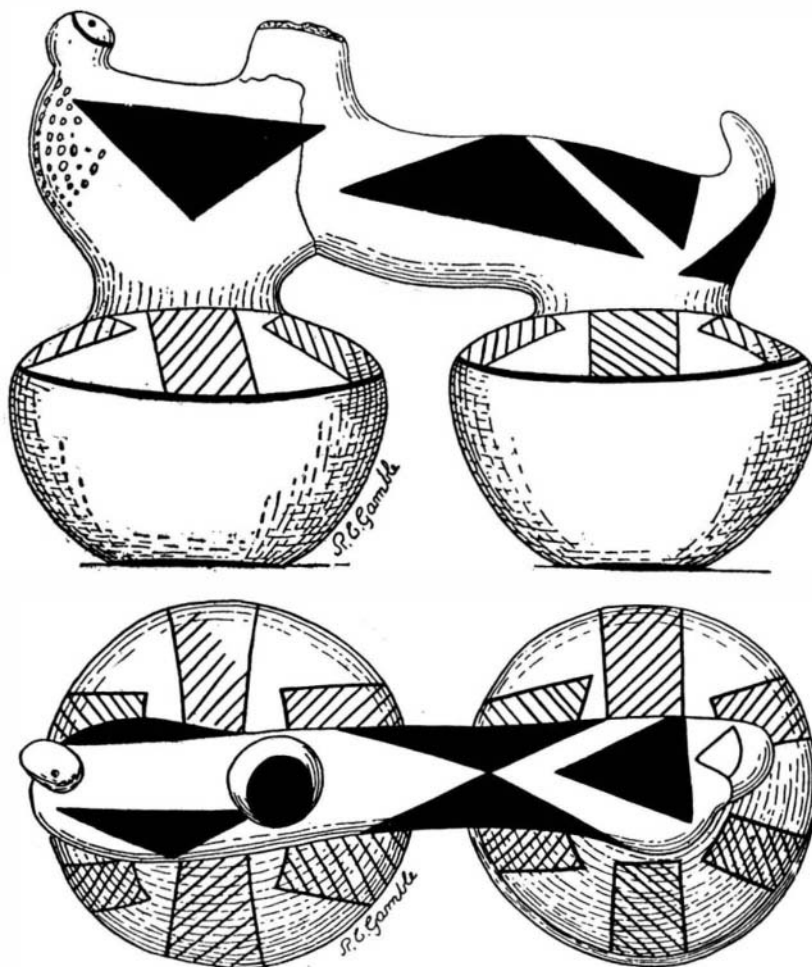
The dog orients itself in a single plane, the horizontal; the gun pointer must be able to orient itself in both the horizontal and vertical planes simultaneously, and so must be provided with two sets of control apparatus, which operate in planes at right angles to one another. By providing telescopic attachments for the



Plan and elevation of the steering-wheel and its connections

selenium cells, the turret-turning and gun elevating motors may be controlled in such a way that the gun will always be pointed in the proper direction for effective firing at the distant target. As with the present system of manual control, the telescopic sights must be set in accordance with the measurements of range finders and spotters.

With such a double orientator a new defense against the submarine becomes possible. Captain K. O. Leon of the Swedish navy has already applied the electric dog principle to the automatic direction of torpedoes,



The double vase described in the text, seen from side and from above

the sound waves sent out through the water from the hull of a ship acting as the attracting stimulus, it is but a step to apply a double orientator of this type to torpedoes that will seek out and destroy any submarines within its range of hearing. This same type of automatic director is suitable for use with aerial torpedoes, explosive-laden mechanical moths, which will sweep down upon the ships of the air with a sting that will blow them into a thousand pieces. The electric dog which now is but an uncanny scientific curiosity may within the very near future become in truth a

real "dog of war," without fear, without heart, without the human element so often susceptible to trickery, with but one purpose; to overtake and slay at the will of its master whatever comes within range of its senses.

A Unique Form of Prehistoric Pottery

THE specimen of pottery here described was found by a farmer in cultivating his field near Dolores, in the southwestern corner of Colorado. The antiquities of this region show that it was inhabited in prehistoric times by a people who had made great advancement in architecture, on which account some of the best known examples of their buildings have been set aside by the Government for the permanent preservation of these remains. Some of the best known of these buildings are the cliff dwellings of the Mesa Verde National Park, but there are many others in form of castles and towers equally instructive situated in canyons and valleys west of this plateau as far as Utah. These skillful builders have left evidence of their superior craft far into New Mexico, at Aztec, and the large buildings along the Chaco Canyon. They characterize what is called the San Juan culture area, the horizon of which has not yet been determined.

This so-called San Juan culture area can be distinguished by ceramic as well as architectural features. Similar varieties of pottery are found over this whole area. In other words pottery and its decoration support architectural evidences of the extent of this culture area. We find the same technique, color, and design throughout. Foremost among the distinctive forms of pottery found in this area are the corrugated and black and white ware, types no longer manufactured and most abundant in early prehistoric times. We rarely find in this area imitations of human and animal figures in relief, a style of ceramic art quite common in northern Mexico and southern Arizona.

Several effigy vases have been collected from this area in the last few years, and it is probable that their numbers will increase year by year. The specimen here considered cannot be called an effigy base, but rather a rare double vase with handle decorated with rude representations of animals. It was plowed up by a farmer, Mr. Littrell, while working on his land near Yellow Jacket Canyon about 5 miles south of Sandstone postoffice, 20 miles west of Dolores, Colo. The exceptional features of this object are shown in the accompanying illustrations. The vessel consists of two vases of equal size united by a handle, modeled in the form of a bird and another animal. The end of this handle to the left of the observer is a rude representation of the head and body of a bird. The orifice of the vase is on the back of this bird. The representation of the bird is very crude, but triangles similar to those generally painted on the sides of the body of birds are sometimes used in pueblo pictures to designate wings. Similar black figures of triangular shape also occur over the whole handle. The head is almost globular with dots representing eyes enclosed in a circle. The breast is spotted with black dots characteristic of bird and butterfly designs among the pueblos. An effigy vase with these symbols, undoubtedly representing a bird, was excavated last summer in a cemetery eight miles west of Sandstone Canyon.

The posterior extremity of the animal represented on the handle of the two bowls could hardly represent the tail feathers of a bird, but might be intended for the tail of another group of animals, as quadrupeds. The handle can be interpreted as portions of the animals united; one of which is a bird and the other nondescript, both with one common body, a condition like that which characterizes some of the figures painted on

the interior of mortuary bowls from prehistoric graves in the Mimbres Valley, New Mexico. In these are round figures of well-drawn fishes combined with an antelope or some nondescript animal combinations. Collections of pottery from Colorado and New Mexico show no designs where double animals are painted or molded.

The orifice of this double vase is situated in almost the middle of the handle, nearer that of the supposed head. It communicates with the cavities of both vases through the hollow handle and suggests that the object

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