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STARTLING OF BIRDS BY LIGHT, EXPERIMENTAL DEVICES, CURRENT RESEARCH

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STARTLING OF BIRDS BY LIGHT: EXPERIMENTAL MEASURES; CURRENT RESEARCH

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In conjunction with, and under the instructions of, the "Service Technique de la Navigation Aerienne", the main airport of Marseille - Marignane has established a Research Laboratory which has for several years been carrying out studies on appropriate methods of scaring birds from the airports and keeping them away from the paths of aircraft.

This report states the progress which has been made in current studies and describes two installations. One is designed solely for the protection of airports. The other could fulfil two functions: self-protection of aircraft in flight and the safety of airports. In both cases we attempted to cause the birds to fly off as a result of light sensations.

Before describing the two installations used in the experiments, let us recall some aspects of the anatomy of the eye and of the physiology of vision in birds.

Visually, colours are seen as a result of action by radiation in solar light on the retina. Each colour is distinguished only when a specific intensity of light is obtained: the visual perception of light precedes that of colour.

Birds possess a retina combining both cone-shaped and rod-shaped visual cells.

The rod-shaped cells contain the visual purple; the conic cells enclose at their peak a pattern of oily droplets, whose predominant colours, red, orange and yellow, seem to signify filtration by absorption of short-wave radiation before light penetrates the cones.

The proportion of these types of cells in the retina varies according to the species of bird. Generally, diurnal birds possess a cone-type retina whereas the rod-type retina is usually more prevalent in nocturnal species.

The discolouring capacity of the various radiations in the spectrum with respect to purple differs according to the length of the wave and decreases from red radiations which discolour slowly and poorly to blue-violet radiations which discolour rapidly and completely. The sensitivity of the retina to light seems to be precisely a function of the discolouring chemical action of the various radiations in relation to purple: the more a radiation discolours purple the greater the effect on the retina.

Research has shown that the retina of a bird acts not only as a receiver but also as a centre which can carry out complicated processes of analysis of sensorial messages. The optical nerve seems to be a means of inter-central association and not simply a means of transmitting the single nerve influx.

The presence of transversal as well as longitudinal organisation has been found in the retina of birds. If the activity of the nerve cells which make up the retina is recorded in a pigeon, it can be seen that they do not all have the same properties but that six different groups are present.

The first group acts as a "vertical detector". These cells are sensitive to the vertical limits present in their field of vision. The cell responds to the image which it forms on the retina if the object has a vertical component. These cells are not stimulated by changes in light or by small objects.

The second group of cells functions as a "horizontal detector". These cells respond if an object with a horizontal component lies in their field of vision but they do not react to small objects or to diffused light.

The cells in the third group are "form detectors". They are brought into play by the edge of the object no matter what its shape.

The fourth group of cells are "detectors of direction of movement". They give a maximum response if the edge of an object moves in a determined direction in the receiving field.

The fifth group comprises cells which react if a convex object moves in the receiving field. These cells are "detectors of convex forms".

The sixth group of cells are "light detectors". Their activity is continuous and proportional to the intensity of the light. These cells are active in the perception of colours.

The cells in the first five groups only respond to contrasts of light in their visual fields according to horizontal, vertical or convex limits. These cells do not respond to uniform light in the whole of the field.

The ganglion cells of a bird's retina transform this quantitative information to qualitative information by means of the optical nerve to the visual areas of the encephalus. Thus they have an analysing role and transmit an interpretation of the image and not the image itself to the cortex.

METHODS CURRENTLY UNDER EXPERIMENTATION

At first we tried to assess the reaction of the birds when near flashing lights which were similar to or more powerful than those used on aircraft.

For this purpose we used a 65cm diameter parabolic reflector at whose focal point we placed 2 xenon stroboscopic flash tubes. These provided a flash of 30,000 watts each in 1/20000 of a second. The light is white, but each of these lamps can be covered by a coloured filter. Each flash light is controlled by an independent mechanism which varies the flicker speed. A multivibrator regulates the speed of passing from one tube to the other.

After numerous tests had been carried out on the ground on a household refuse tip and at Marignane airport by the Etang de Berre, we noted that the birds flew off only at a distance not exceeding 40 metres when the colour blue was used. Red and white seemed much less effective. The frequency of the flashes had not to be more than 100 cycles per second.

The birds which flew off in this way were herring gulls and jackdaws. It is possible that other species of bird may have reacted differently.

Following on this first experiment we worked on producing a piece of equipment capable of generating a high degree of light energy which would reach birds at a distance of about 1 kilometres over a field of several dozen metres to either side. To this purpose we used a "barrel" type parabolic reflector which gave out a beam approaching the form of a square cosecant.

The pinpoint source of light impulses consists of 2 tungsten electrodes, open to the air, which are placed around an auxiliary electrode designed to ionise the inter-electrode area.

To control the moment of discharge, the electrodes are placed at a distance from one another in such a way that the disruptive voltage is greater than the load voltage of the condensers; the spark will occur when a sudden and very high over-voltage is applied to the auxiliary electrode.

The very short and intense flash of light given out by the sudden release of energy is accompanied by sound waves and infra-sonic and ultra-sonic waves as a result of the abrupt expansion of the air surrounding the spark. This acoustic radiation can greatly affect the behaviour of the birds; its effect should probably be added to that of the light beam. By rendering sensitive the 2 main distance perception faculties of the bird, this method could make it possible to act simultaneously on the pschovisual part of the brain via the visual area, the thalamus and the optical nerve, and on the psycho-auditive sector; the birds can be induced to fly away by a combined action on the motor projection areas.

After about 100 tests it became evident that the equipment described above caused birds to fly off from the ground up to a distance of 800 metres using 300 Joules energy in 3 microseconds. The total power radiated in the ultra-violet and in the visible range was about 2MW.

We are now experimenting with independent testing of the effects of deflagration and of light.

If this equipment proves effective, it could automatically ensure protection against birds in certain active areas of airports.

In order to ensure the self-protection of an aircraft in flight, the speed of the aircraft must be borne in mind. One possible solution would be to give the bird sufficient advance warning; that is at a great enough distance ahead, so that it has time to get out of the path of the aircraft before it strikes him. For this to happen, the bird must treat the signal sent out by the plane as a forerunner of the "aircraft danger" and the signal must induce the bird to react accordingly and fly away from the impending dangerous object. This is, in a way, what happened with the piston-engine planes the noise of whose engines greatly preceded the aircraft itself. The perception distance of this aural signal gave the bird enough time to locate the danger visually and to prepare to take the appropriate avoiding action. Many collissions must have been avoided in this way thanks to the fact that the birds took avoiding action.

The speed of modern aircraft makes it difficult to use a sonic signal in flight to warn birds of the approaching danger. However, a means of generating a light beam before the aircraft could cause the bird to adopt evasion tactics similar to those used before with slow noisy planes.

We have construed such a piece of equipment experimentally and are testing it in real conditions.

A laser beam is projected on to a mobile plane mirror oscillating around its axis in the vertical plane. The reflected beam sweeps vertically 1000 times per second a line 100 metres long at a distance of 1 kilometre from the laser. This vertical sweep is taken up by a second mobile plane mirror in the horizontal plane. A sinusoid is obtained which, if observed from a distance of 1 km from the laser/mirror assembly, registers in a square 100m x 100m. The sinusoid, which is composed of the vertical and horizontal sweep, crosses a semi-reflecting mirror. Some of the energy is deflected to a plane mirror arranged in such a way that the reflected beam interrupts at each laser impulse the part of the beam that has crossed the semi-reflecting mirror.

The distance at which the interference occurs is a function of the angle of the semi-reflecting mirror and of the plane mirror.

This "cine-interferometer" device could, if placed in the nose of the aircraft, materialise over an area of about a hectare, with a luminous figure in the form of a sinusoid made up from points of light moving at the speed of the aircraft and preceding it.

The production of visible interferences could have two effects on the bird:

<u>Firstly</u>. When they are far from the plane, by acting on the five groups of retina cells which direct influxes registered by the horizontal, vertical, form, direction, movement and displacement detectors towards the intercentral association channels;

<u>Secondly</u>. When they are in the area of the pyramid caused by the sweep, birds would receive the laser beam. The retinal cells of the sixth group, the light detectors, would then be made sensitive.

Given that most birds have a monocular and a binocular field of vision the sum of whose sectors is near to 360° it is possible that the figures produced by interferometry could be seen and analysed from all directions. The aircraft would then efficiently notify the birds of its presence long before its appearance.

At our present stage of developments only experiments in the field will allow us to note the reaction of different species of birds on seeing such a mobile luminous figure in space.