mirror a piece of glass and near it a piece of aluminium alloy are placed together in a large airtight enclosure. A high vacuum is then produced, the pressure in the chamber being reduced to one ten-millionth of its former value. The alloy is then electrically heated to a very high temperature, and readily evaporates into the extremely rarefied air. The metallic vapors find a rather free and unobstructed path over to the cool glass, where they condense to form a brilliant mirror.

This new type of reflector is known as the "pancro" mirror because it reflects all colors alike. What is more, the mirror reflects light with approximately 93 per cent efficiency. The common silver mirror, when operated from the metal side gives approximately the same efficiency with red light, but only 81 per cent with violet light. Viewed through glass, still lower efficiency is observed. The alloyed metal of the pancro mirror, which is amenable to a special heat treatment, thereby acquires great resistance to deterioration without appreciable loss in power of reflection. The open surface, unhampered by the usual glass refractions and absorption, gives properly colored, realistic images not seen hitherto by ordinary mirror gazers.

A CATHODE-RAY DIRECTION-FINDER FOR COLLISION PREVENTION

(Extract from the Report of the Radio Research Board for the period 1st January 1932 to 30th September 1933, H.M. Stationery Office, London, 1934, page 81).

The cathode-ray oscillograph has been used as the indicating element of a directional receiver. A notable advantage arising out of the instantaneity of response of the cathode-ray direction-finder is the facility which is offered for the directional reception of signals of very brief duration. This type of apparatus offers advantages in conjunction with beacon transmitters and other radio accessories to navigation and safety of life at sea. A particular application of the use of such short signals lies in the use of the arrangement as a direction-finder for short impulse signals for the prevention of collision at sea in conditions of fog and low visibility generally.

In the practical realisation of the scheme, which has not yet been tried at sea, it would be necessary that all ships in a fog area should emit every fifteen seconds, or at some similar widely-spaced interval, a short 600-metre signal, lasting not necessarily longer than 1/100 second. Such a signal could be emitted automatically and could, indeed, be superimposed on any other traffic sent out from the same ship. A ship fitted with a cathode-ray direction finder of simple type, limited range and fixed tune — located preferably in the chart room — could then receive such signals. During fog the receiver would be switched on and a more or less continuous watch kept on its indications. Signals received would cause sudden lines to appear on the oscillograph screen giving, by their directions on the screen protractor, the relative bearings of all emitting-ships within range of the receiver. In these conditions, if it is seen that the one transmitting ship produces a line *of constant direction and increasing length* (assuming both ships to be on steady courses at constant speeds), the two ships will collide unless course is changed to prevent it.

Since the duration of signals is so short and the times of emission from different ships bear no fixed relation to each other, two signals will not often coincide and, even in the presence of a considerable number of ships emitting such signals, the bearing of each source will be readily determinable. In the very rare case of exact coincidence between two signal impulses, the indication would be in the form of a parallelogram whose sides give the directions of the two ships.

Signals of this type would cause entirely negligible interference with communication on the same wavelength, being comparable to atmospherics of low numerical frequency of occurrence. The arrangement would thus afford a direct indication of possible collision in a form which could be easily observed, and would call for no interpretation or interpolation other than observation that a visible recurrent signal maintained a constant bearing and increased in length.

From the essential nature of this application it is clear that apparatus for the purpose must be small and light, easily accommodated and simple in operation. An appropriate specification of its performance is that it should produce a deflection, on the screen, of 4 cm. length when receiving an i.c.w. signal from a ship at 10 miles distance transmitting with a current of 10 A in an aerial 120 ft. high above sea-level, this corresponding to a received field-strength of 8 mV/m. The selectivity should be such that the deflection does not decrease by more than half the above value over a wavelength range of 590 to 610 metres.

A special experimental receiver for this purpose has been designed and built at the Radio Research Station at Slough. It occupies a space of only 20 ½ in. by 10 ½ in., and weighs 30 lbs., and the weight at least can probably be reduced by revision in design. The oscillograph is also contained within the length and height stated.

In order to simplify design for this purpose it was thought desirable to depart from the practice of frequency-conversion used in other receivers, e.g. conversion to the 2.5 kc/sec. used in the standard receiver or to the 100 kc/sec. as used in the pulse polarisation analyser. The signal frequency of 500 kc/sec. is thus directly amplified and applied to the oscillograph. Using commercial oscillographs the only difficulties that have been experienced are that:

(*a*) Inter-plate capacity-coupling is not negligible at this frequency, but can be compensated by using a differential condenser as used in connection with the pulse polarisation analyser.

(*b*) The focus of the spot at this frequency is not as sharp as at lower frequencies, e.g. 100 kc/sec. or lower. This may be corrected or at least improved by using an oscillograph tube pumped to a pressure critically related to this frequency. The pressure may, at the worst, be adjusted with the jet actually subjected to deflection at this frequency during the process of pumping.

The requirements of sensitivity and band-width made it necessary to use a three-stage amplifier employing screened-grid valves. The components are arranged symmetrically on each side of the central line of the box, the "Fore and Aft" amplifier being above the partition and the "Athwartships" amplifier below. (In considering a ship installation "Forward" is substituted for North, "Aft" for South, "Starboard" for East, and "Port" for West).

The potential of the screen of the first valve is controlled by a potentiometer, which can be used as an "installing" adjustment to adjust the two amplifiers to equality. Alternatively it can be used for the correction of quadrantal error by reducing the gain of the Fore-and-Aft amplifier to compensate for the superior effective pick-up of this frame.

Adjustment of gain for purposes of observation is provided by resistances which can be applied across the frames. One of three sets of resistances can be introduced by means of a spring-loaded switch, which returns to its normal position when released, giving losses of 12, 24 and 36 db. in its respective positions. The provision of this control is of particular importance in this application, preventing overloading at the last valve with the large signal-voltages (as compared with those existing in normal aural receivers) necessary to give adequate deflection on the cathode-ray oscillograph. With an accelerating voltage of 700, a deflection of 4 cm. (end-to-end) requires a peak potential of 43 V output to the tube. The high-frequency pentode was found by trial to offer the best solution, and was therefore used despite the disadvantage of requiring 1 A at 4 V for its cathode heating.