Lights in

The Night

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Lights in the Night

[1]Introduction

With the use of aircraft for military and civil purposes, there was need for operations outside normal day light hours. In the case of military operations, the need first arose for a method whereby patrol and bomber aircraft delayed for some reason or other, could land at their base aerodrome after dark. When the technique of night landing had been accomplished, the way was then open for night bombing operations. With civil aircraft, the need for night landing facilities arose in a different way. Certain countries saw value in the aircraft for speeding up the mail delivery service. This method of delivery at first suffered from the fact that aircraft could not be operated at night, and therefore, in some cases, the mail could be carried quicker by train. The need for a means whereby aircraft could be operated at night was urgent, and this was provided for by the use of airport lighting together with light beacons spaced at intervals along the route for the purpose of navigation. Since that time, in the 1920's, the 24 hour operation of aircraft, has become an accepted, and indeed, necessary for the economical operation for modern aircraft.

With the advent of satisfactory radio aids to navigation, the operation of aircraft in conditions when the ground was no longer visible to the pilot because of cloud was then possible, without the danger of an aircraft being lost. However, aircraft could not be operated when poor visibility or fog conditions existed at the aerodrome, and it was not until this problem was largely overcome by the use of radio aids to landing in conjunction with special lighting equipment, that operations could be carried on with any reasonable degree of reliability. In modern Airline operation, the aim is to provide complete reliability of service regardless of weather conditions, not only to ensure economical operations of aircraft but also to maintain the confidence of the travelling public. This reliability could only be achieved with a combination of radio and lighting aids.

[1] Extract and adapted from Commonwealth of Australia Dept of Civil Aviation division of Airways publication Approach and Runway Lighting for Civil Airports 1949

Unlike scientific methods applied to the design of aircraft, the development of lighting equipment for airports has been very haphazard. Each country carried out its own work in technical isolation for many years until flights from one country to another forced co-operation between various countries. Attempts at standardization and co-operation were made with greater enthusiasm as international flights became more common and finally culminated in 1944 in the formation of the International Civil Aviation Organization with a membership of 51 countries. The way for International co-operation with standardization of equipment and methods was the opened on a scale that was once impossible. Regular meetings of the organization are now held to consider and determine standards for all aspects of aircraft design and operation including airport lighting.

[1]Airport Lighting in General

The function Airport Lighting plays in the control & navigation of aircraft

In general terms the function of an Airport Lighting system is to enable a pilot to perform at night, the necessary actions and maneuvers associated with flying an aircraft as easily as could be done during daylight conditions. In other words, it must provide the means of enabling a pilot to taxi an aircraft from a hangar, or tarmac area to a point from which a take-off is made, it should give adequate indication of the area and extent of the land surface available for take-off purposes, and should clearly show any areas or objects to be avoided in the process of taxiing or taking-off. An indication must be given of the wind direction and velocity in order to enable the pilot to correctly plan the take-off.

For an aircraft in the air and about to land, an indication must first be given to the pilot of the location of the airport, then the available landing surface, wind direction and velocity together with areas or objects to be avoided (which in general are identical with those mentioned when taking-off), and finally assistance to enable the plane to taxi back to the tarmac or hanger area.

The lighting system must, therefore, provide the pilot with sufficient references, by means of light properties, color and characteristics, to enable the safe performances of judgment by visual means which is able to be performed during daylight . A complete replacement of all visual references is not physically possible, or even desirable because of the many distracting references existent under daylight conditions, and the aim of the lighting is to provide sufficient satisfactory references in the most economical way.

History and development of Airport Lighting

It is difficult to trace both in time and place, the development and first use of Airport Lighting equipment. It appears however that the first thought of pilots and engineers was to reproduce day time conditions as near as possible (in order that a pilot could use the same techniques for landing and take-off as would be used in day light) by flood lighting the landing area. It must be remembered that in the years 1910 – 1935 the practice was to use an “all- over” field of suitable dimensions and surface (generally grassy) roughly square in shape, in order for the aircraft to land and take-off into wind. Consequently lighting engineers were faced with the task of satisfactory illumination over this area without producing obstructions to aircraft or blinding the pilots landing or taking-off. Associated with this flood lighting the boundary of the aerodrome and any obstructions were illuminated. Identification and guidance to the aerodrome were also provided. Airway routes were also identified by the strategic placement of rotating light beacons and lighted aerodromes along the major air routes.

In The Beginning

Airfield landing surface Illumination

The first attempt was to illuminate the whole surface with one flood light, but the need for accurate vertical beam control to avoid dazzling the pilots soon had engineers using several flood lights at suitable points around the aerodrome, a typical wide- angle flood light is shown in fig. 1

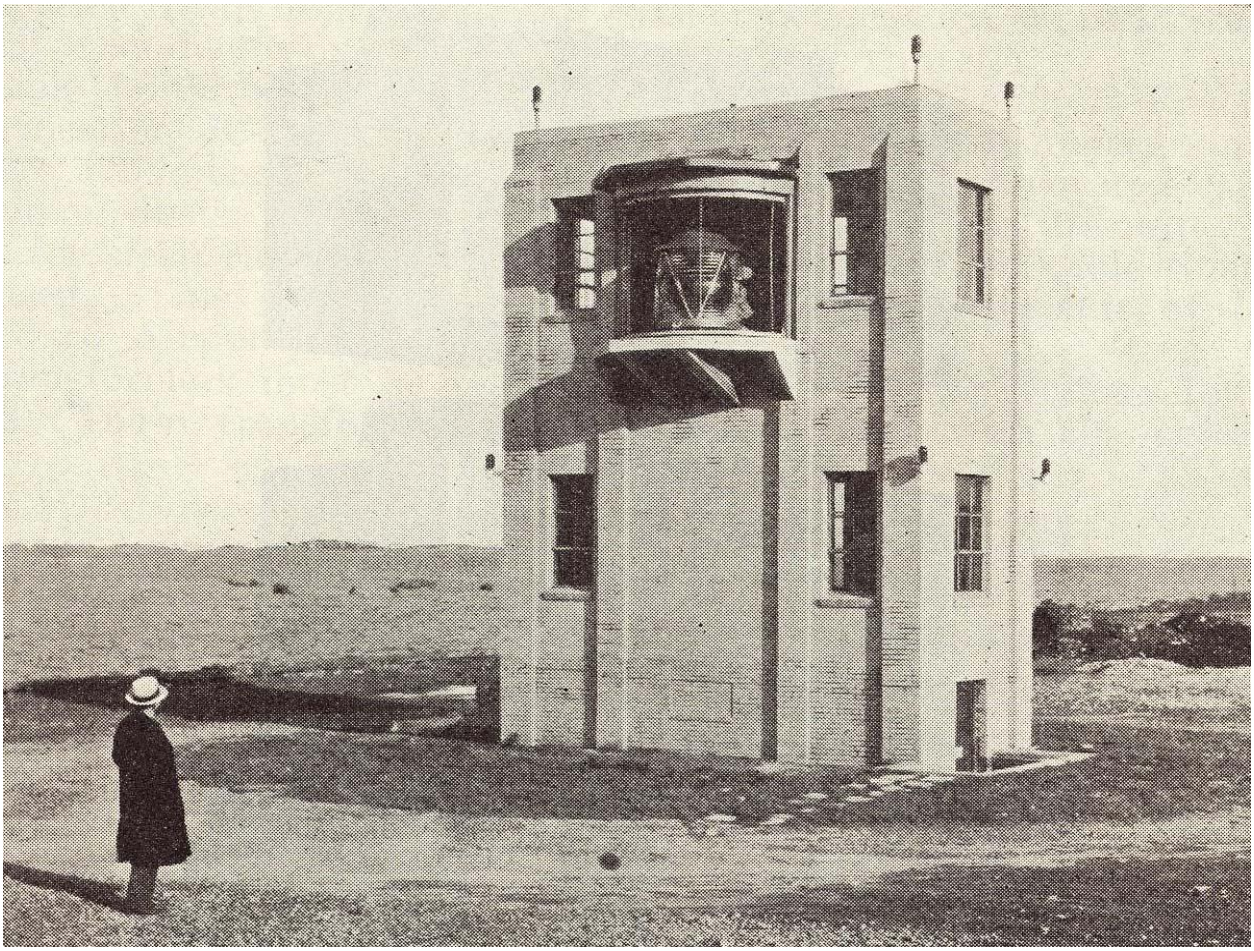

Fig1. Wide angle flood light with 180 degree Fresnel lens

A modification of this idea was the portable flood light which was towed into position dependant on the wind direction and adjusted to illuminate the landing surface up-wind from the light to allow the pilot to land without being dazzled and yet have a well illuminated landing surface, both fixed and portable flood lights were first used in Australia in 1929 for the Perth – Adelaide air –route. Fig 2 shows a portable flood light

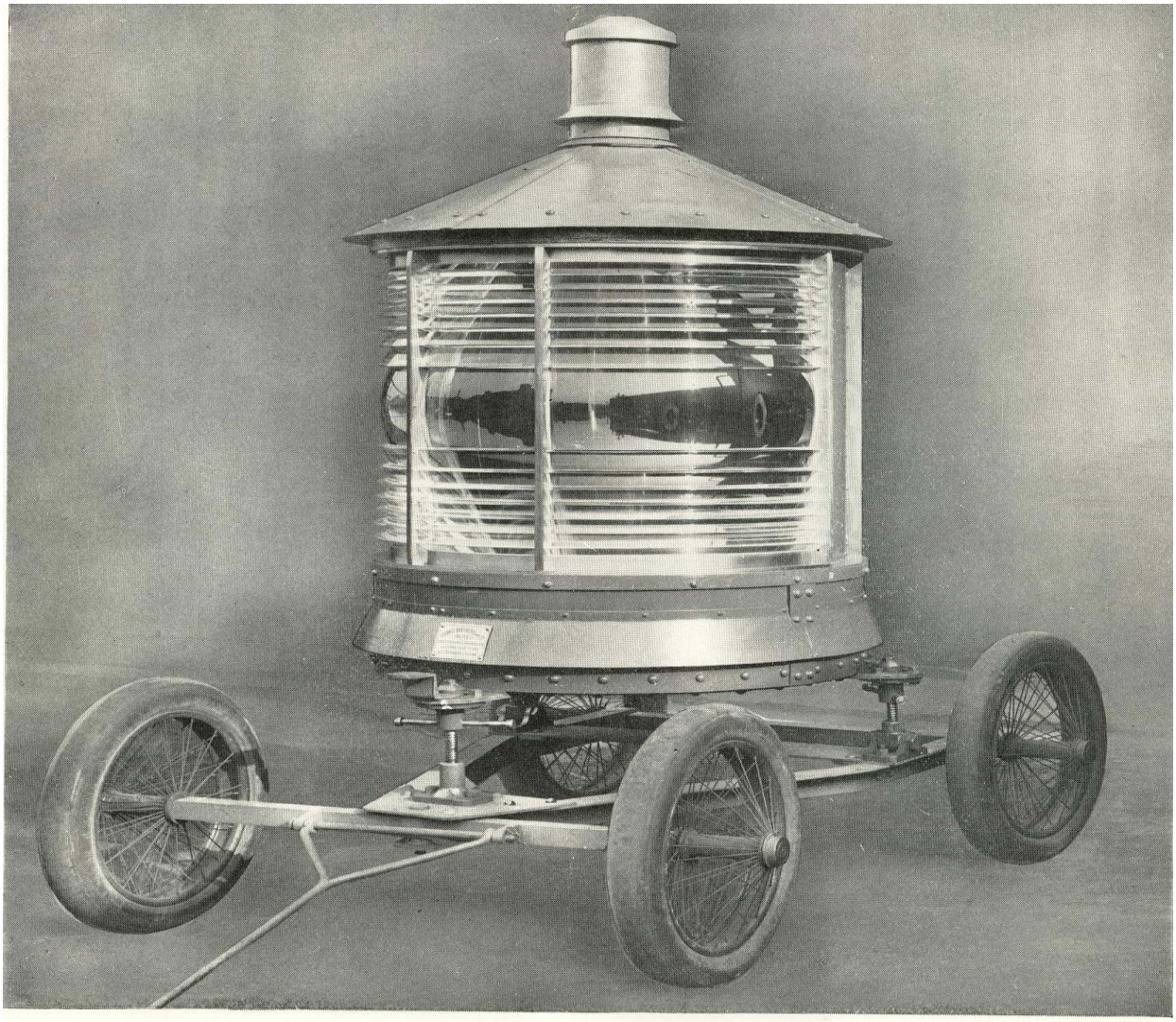

FIGURE 3.
C.500 FLOODLIGHT, as recently supplied to Australia, with vertical bars.

Fig 2. Portable flood light

As aircraft became larger and heavier requiring longer take-off runs, a general realization that perfectly safe landings and take-offs could be accomplished with moderate crosswinds and the knowledge that wind blew predominately from a few well defined directions, take-off and landings were now confined to 3 or 4 directions, and this greatly simplified the illumination of airfields. Narrow beams of light were now used to illuminate the surface from smaller lights located at each end and the sides of the landing surface.

Airfield identification lighting

At the same time as flood lights were being used, it was also considered necessary to indicate the safe extent of the landing surface; this was done by the means of boundary lights. Figure 3 shows a typical aerodrome layout from the early 1920's

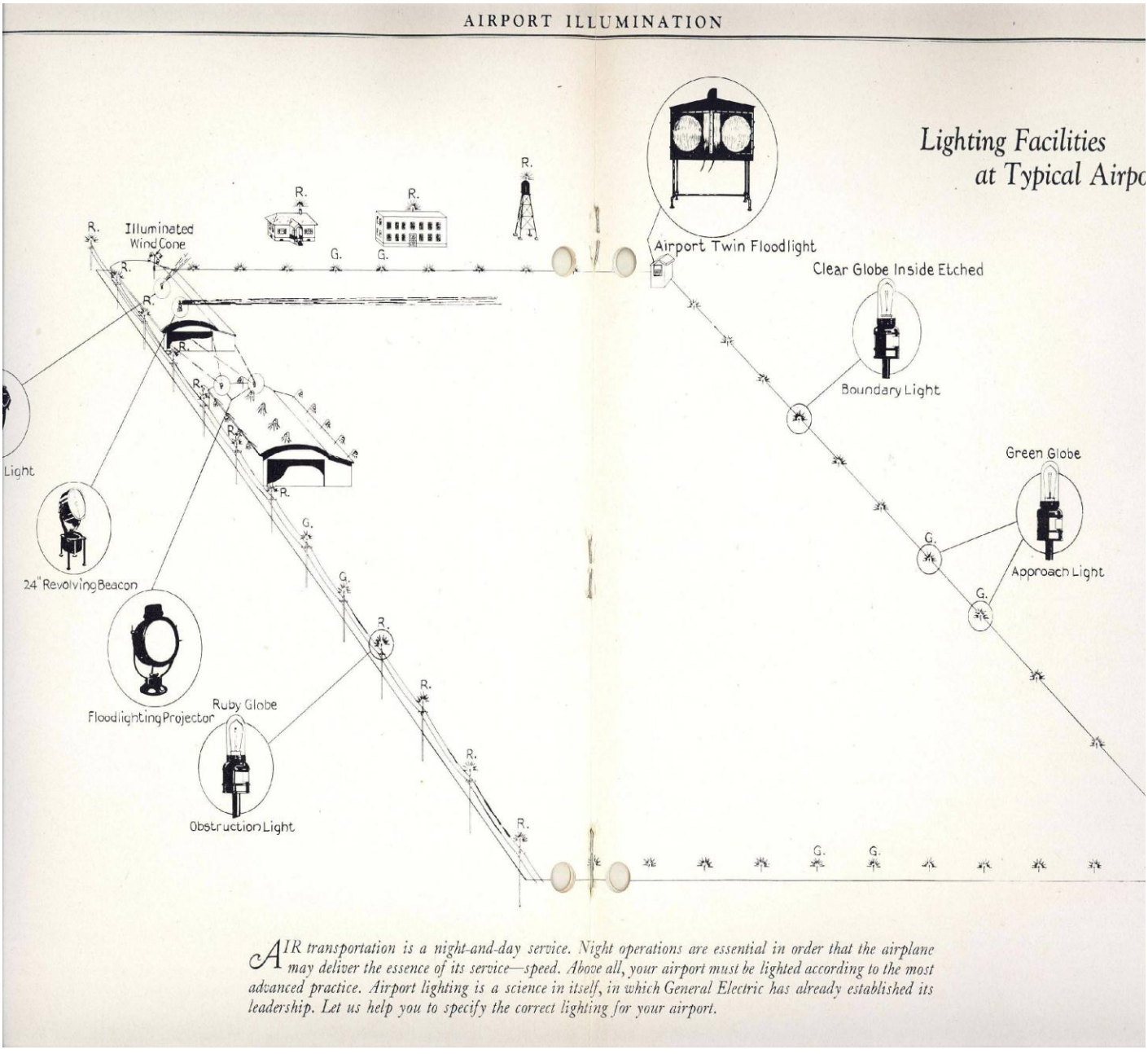

Fig 3

Green lights interspersed with the yellow boundary lights indicated the approach point; ruby lights indicated obstructions either on the boundary or close by i.e. buildings and structures.

The lighting of building roof tops indicating the name of the airfield, distance and direction were also incorporated in the identification.

Around 1930, contact lights were tested by the U.S Army Air Corp at Ohio in the U.S.A; these light units were sunk into the ground flush with the level of the ground along a strip or direction of the prevailing wind at an “all-over” field. The light distribution, whilst ideal for enabling the pilot to locate the aerodrome and align the plane for landing, was entirely unsatisfactory at the critical stage of landing, By 1937-38 a newer design had been developed in which the light unit projected up to 2 inches above the surface of the ground in order to provide greater illumination at the low angle needed for landings

As the use of heavier aircraft restricted operations to strips and where the nature of the ground (load bearing strength) dictated it, to specially prepared surfaces or runways. The contact lights were then used to mark out the extent of these runways, and came in time to be known as runway lights.

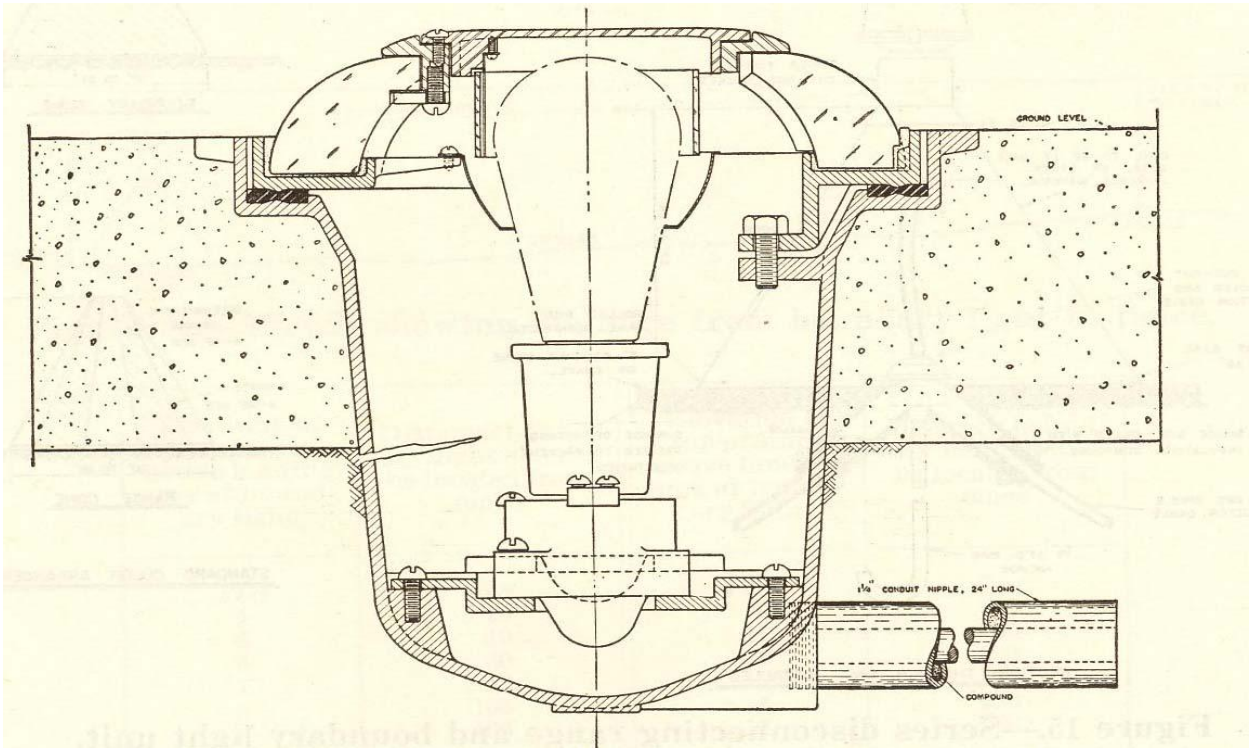

Figure 4. An early contact light.

Besides experimenting with the type and layout of lights to be used, engineers and pilots were experimenting with colors for the various lights – based on the colors used at the time for railway and road signals, red for danger, yellow for caution and green for all clear.

A development which had considerable influence on the design of runway and strip lights is the use of landing lights on aircraft, which are used when landing or taking-off to illuminate the ground in front of the aircraft, these lights were principally responsible for the removal from service of the strip flood lighting.

Range lights were occasionally used as an aid to landing, these were green lights placed some 200 to 300 feet from the ends of the runways on the airport boundary which indicated the preferred landing direction, this type of lighting was eventually replaced in favor of “threshold lighting” which are green lights placed at the end of the runway or threshold to indicate the point beyond which it was safe to land.

Together with the use of preferred directions or strips the use of “leading” or “approach lights” became common. These lights were used to help a pilot to line up the aircraft with the correct landing direction they were placed outside the aerodrome boundary in the direction of the landing direction

In addition other lights which are required for take-off and landing are obstruction lights, airport beacons, identification beacons, landing direction indicators and illuminated wind indicators.

Obstruction lighting

Obstruction Lights are used to mark areas or objects to be avoided during take-off and landing, consisting of two electric lights mounted inside red colored lenses mounted above the highest point they are intend to mark.

Airport Beacons

Airways Beacons or course lights, which were originally designed for use along air-routes not equipped with radio navigation aids, several papers at the fifth International Congress of Aerial Navigation in Le Hay in 1930 discussed the requirements of these lights, Airways Beacons were flashing beacons 6-12 flashes per minute of very high candle power were placed every 15 to 35 miles along the centre of the air route.

Airport Identification Beacons

Were located on aerodromes and identified the location by flashing the name in Morse code. Building roof tops were also illuminates with the name and direction to the aerodrome were illuminated.

Landing direction Indicators

Landing direction indicators or approach lights were provided to assist the pilot in making the approach. In clear weather a simple line of low intensity lights were used, but for approaches in bad weather using radio aids higher intensity lights were used in day light conditions to assist then pilot.

Illuminated wind indicators

These ranged from wind cones illuminated from above, pivoting aero plane shapes with lights on the frame to smoke pots buried in the ground illuminating the smoke from below.

Development of Lighting in Australia

Airway and Aerodrome Lighting

The development of ground installations has made considerable progress and at the present time (date??) facilities for night flying is available on the following air routes.

Darwin – Brisbane: Lighted aerodromes and rotating airway lights at Darwin, Cloncurry and Longreach and intermediate rotating lights at Pine Creek, Kathrine, Dagworth, Winton and Moscow.

Brisbane – Sydney: Lighted aerodromes and rotating lights at Brisbane, Evans Head, Coffs Harbour and Kempsey.

Sydney – Melbourne: Lighted aerodromes and airway rotating lights at Sydney (Kingsford-Smith, Airport), Golbourne, Canberra, Cootamundra, Hollbrook, Benalla, and Melbourne, and intermediate rotating lights at Bowrel, Adelong, Chiltern and Yea.

Melbourne – Hobart: Lighted Aerodrome and rotating lights a Launceston (Western Junction) and Hobart (Cambridge).

Melbourne - Adelaide: Lighted aerodromes and rotating lights at Essendon (Melbourne), Nhill and Tintinara and intermediate rotating lights at Bordertown, Tailem Bend and Mount Lofty.

Adelaide – Perth: Lighted aerodromes and rotating light at Parafield (Adelaide), Forest, Kalgoorlie and Maryland (Perth).

Adelaide – Darwin: Airway rotating light at Oodnadatta.

A rotating light has also been installed on a mine shaft at Wiluna W.A for emergency use by aircraft operating on the Perth-Wiluna-Kalgoorlie air route.

Additional lighting will be installed as soon as possible including the lighting of new landing grounds at Coolangatta (Qld) and Ballarat (Vic) and also the existing aerodrome at Ceduna (S.A).

Installations are contemplated at proposed new landing grounds which are to be established in Newcastle (N.S.W) district and at a location to be selected between Kalgoolarie and Perth W.A.

The standard lighting equipment comprises neon Identification Light; airway rotating light at or in the vicinity of the aerodrome; orange boundary lights spaced at regular intervals around the perimeter of the landing area; red obstruction lights on all buildings or dangerous structures in close proximity to the aerodrome; illuminated wind indicators and landing flood lights or flares.

The rotating airway light is a white light of 1,500,000 candle power rotating at the rate of six revolutions per minute. The beam is elevated slightly above the horizontal and is visible under favorable conditions up to a distance of 80 miles from an altitude of 8,000 feet. The identification beacon is a green neon light mounted on a hanger or other structure on the aerodrome and flashes intermittently the international Morse code symbol for the particular aerodrome, the light is visible for up to 15 miles.

The air route lighting system, although primarily installed for operation of night flying services, has been extensively used for normal air route flying and has amply justified the establishment of lighted intermediate grounds as an essential safety factor.

Visual Ground Aids 1952-1959

Airport Lighting

In the field of airport lighting, the “series” system of power supply to the lights has become standard.

This system depends for its operation on the use of a specifically designed regulator which delivers a constant current to the lighting circuit.

Each lamp is fed from its own transformer which is located beneath the fitting so that if the lamp burns out, the main circuit is still made through the primary winding of the transformer, and the operation of the other lamps are unaffected.

These new systems lend themselves to the control of brightness, and for this purpose a simple, effective and reliable circuit has evolved.

The series systems is basically dependant on the ability of the regulator to deliver constant current, over the years 3 different types have been used, The Department originally purchased 32 regulators based on the moving coil principle and this was followed by the development of the resonant

bridge type which offered many advantages over the older type, including the advantage of having no moving parts. Forty of the resonant bridge types were installed at various aerodromes

A further development has yielded the transductor or magnetic amplifier type of regulator which is technically superior to either of the previous two models and 27 of these have been ordered for future approach light installations

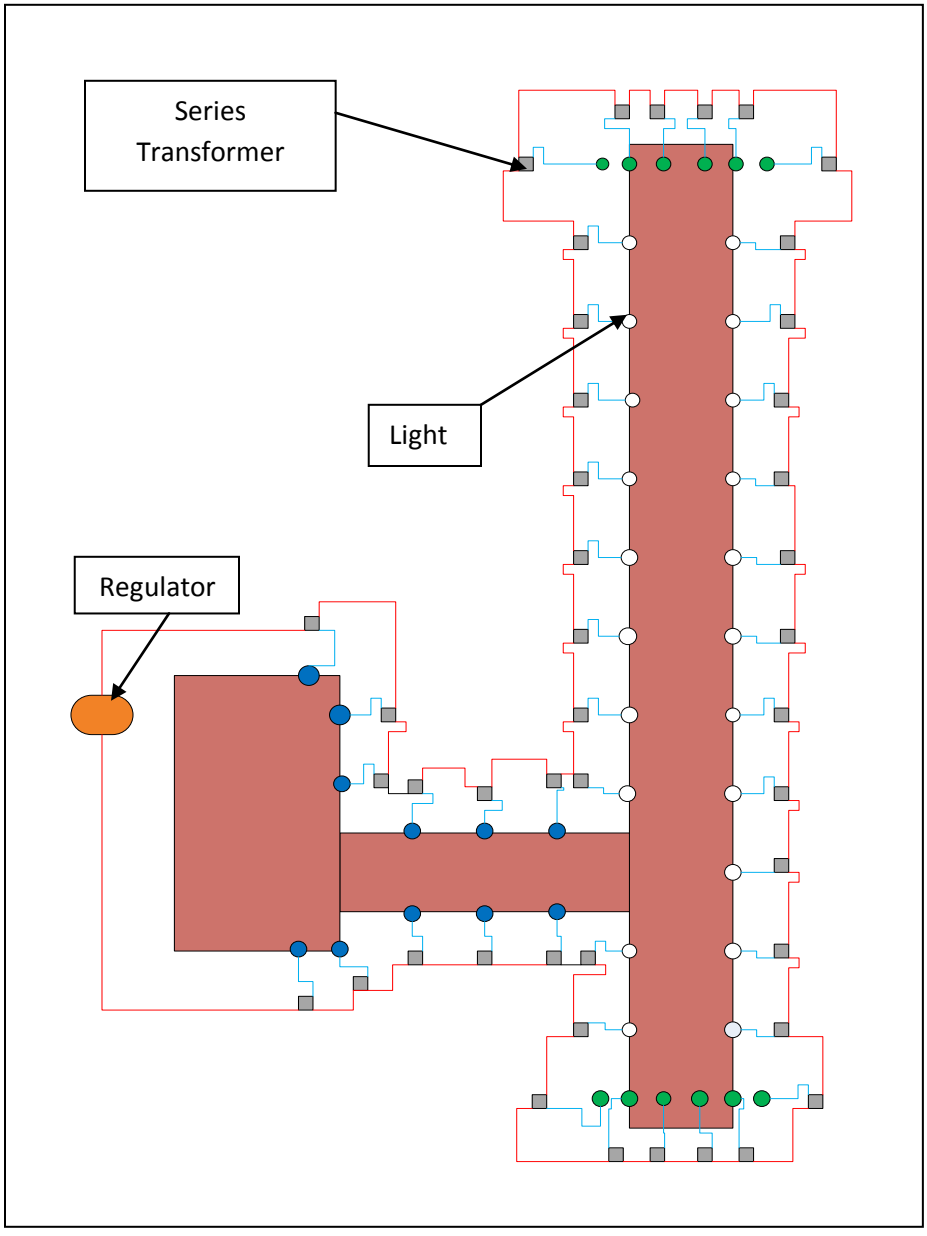

Fig 5 basic series airport lighting circuit

Low intensity Runway Lighting

The original lighting provided at the Department's Aerodromes was of a temporary nature and most of the installations consisted of RAAF type flares interconnected with rubber covered cable laid over the aerodrome surface, at ten aerodromes this type of lighting has been replaced with the more modern "series" type of equipment. A further six old installations have been reinstated with new equipment and extended to cater for additional runway lengths, while nine completely new installations have been made.

The low intensity runway lighting universally adopted has involved the use of elevated fittings mounted on a frangible coupling so that they will collapse readily if struck by aircraft. However, with the introduction of some of the modern aircraft, notably the Viscount, 18 inches proved to be too high an obstruction and the fittings were lowered to 13 inches.

Taxiway Lighting

In 1952 it was decided that centre line taxiway lighting would be installed – a decision that conformed to an ICAO recommended practice.

Centre line taxiway lighting has now been provided for Sydney, Melbourne, and Adelaide, Brisbane and Hobart Airports and the fitting of these lights at country aerodromes is planned for the future.

High Intensity Runway Lighting

The high intensity runway lighting system is an addition to the instrument landing system. It is an independent lighting system to that of the low intensity system, its intensity like that of the newer low intensity systems (at some aerodromes) can be controlled from the control tower, typical intensity levels in the low intensity system are stages 1 to 3 and stages 4 to 6 are in the high intensity light system, the low and high intensity lights are never on together.

High intensity light fittings direct light along the runway in the direction the aircraft are approaching from.

High intensity runway lighting has been provided at Melbourne, Sydney and Hobart Airports and seven other aerodromes are to be equipped with special "ball beam" light fittings obtained from Holland. This is a light unit constructed in a spherical form to that it will roll away if struck by an aircraft wheel.

Cattle grid type threshold lights have been installed on the threshold of the runway below ground level in conjunction with the ball beam edge lights.

Visual Ground Aids 1959- onwards

Development of newer types of airport lighting fittings and up graded standards has kept pace with today's larger jet aircraft. Aerodrome lighting standards today in Australia are controlled by the Civil Aviation Authority in their document, Manual of Standards chapter 9 which has 22 sections and 144 pages pertaining to airport lighting for aerodromes.

Airport lighting fitting design and manufacture has developed enormously with some of today's light fittings using Light Emitting diode technology (LED), individually controlled in all manner via computer local area networking technology .

The big light fitting manufactures have their own airport lighting installation companies that can do small country installations to the major capital city airports around the world, all light fittings and systems must comply with the relevant ICAO standards for light output and characteristics and thus look very similar in construction and have similar installation requirement and light control processes.