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Nobel Prize in Physics 1912

Nils Gustaf Dalén

The Nobel Prize in Physics 1912 was awarded to Gustaf Dalén *"for his invention of automatic regulators for use in conjunction with gas accumulators for illuminating lighthouses and buoys"*.

RESEARCH INFORMATION:

The Royal Academy of Sciences believes it is acting in strict accordance with Alfred Nobel's will in awarding the Physics Prize to Chief Engineer Gustaf Dalén in recognition of his remarkable invention of automatic valves designed to be used in combination with gas accumulators in lighthouses and light-buoys.

The ever-growing use of maritime communication creates an increased demand for navigational safety devices. Amongst these devices lighthouses and light-buoys are of great importance, and their number has become several times greater during the last few decades. At the same time efforts have been made to find ways of making their lights more powerful and their different lights more easily distinguishable. As far as possible, work has been directed towards finding a system which would regulate these lights automatically. This is a very important point, for no country is wealthy enough to maintain a continuous inspection of all its necessary lighting equipment.

In Sweden, a country with a long coastline and large archipelagos, the problem of a reliable and fairly inexpensive lighting organisation has for a long time been more pressing than elsewhere.

About 1895, for the first time it was discovered how to prepare acetylene from calcium carbide on a commercial scale. Acetylene is a gaseous hydrocarbon which, when burnt, produces an extremely bright and white light.

The first attempt to use this gas for lighting in lighthouses did not have very satisfactory results. The petroleum gas in use for similar purposes up to this time had been compressed and enclosed in large iron containers. It was found extremely dangerous to treat acetylene in the same manner, as this gas, when under the pressure of one or more atmospheres, explodes at the slightest shock. It was also attempted to store calcium carbide in lightbuoys and to let the acetylene escape under the action of water supplied automatically. Unfortunately this method proved to be inconvenient, not very reliable, and unusable in cold weather.

In 1896, two French chemists, Claude and Hess, discovered that acetone possesses the property of dissolving large quantities of acetylene. This solution is not explosive. However, it cannot be used as it is to store acetylene, because, even if the container is filled to the brim with a saturated solution under high pressure, the volume of the liquid is reduced by consumption or by cooling, and explosive acetylene gas is produced in the space above the surface of the liquid.

It was then discovered that its explosive nature disappears if the acetylene solution is compressed in a porous mass. Numerous unsuccessful attempts were made to prepare such a porous mass which would be sufficiently resistant and elastic to withstand the shocks encountered in transportation, without cracking and crumbling and thus producing cavities filled with explosive acetylene gas.

The credit for the eventual discovery of such a mass, called aga or porous substance, belongs to Gustaf Dalén.

By a complicated and carefully developed process, this substance is enclosed in steel containers which thus become practical accumulators for the acetylene gas. The porous mass in the container is half-filled with acetone, and acetylene is then introduced by compressing it to a pressure of ten atmospheres. Under this pressure, and at a temperature of 15° C, the container contains one hundred times its own volume of acetylene. The container is then ready for supplying to a lighthouse or light-buoy the acetylene necessary for lighting.

The advantage of this arrangement would not be great if the acetylene light had to burn uninterruptedly. On the one hand, this form of lighting would be quite costly, and, on the other hand, it would be difficult to distinguish the lights of various lighthouses from one another and from other lightsources. True, several methods of producing an intermittent light were already known. For example, the flame can be surrounded by moving screens, or the lighting device itself can be made to rotate. But such arrangements need continual inspection and consequently involve considerable expense.

Where compressed petroleum gas was used as the source of light, eclipsing or flashing lighting devices had also been constructed using the escaping gas as motive power. The flashes lasted 5 to 7 seconds, which was perhaps necessary because of the weak light output of petroleum gas. But with the intense brightness of acetylene light, such a long flash becomes unnecessary. Furthermore, long flashes offer insufficient variation of the signal. Accordingly the big lighthouses have generally replaced them with lights giving flashes lasting from 1/10 to 3/10 of a second.

It was about 1904 that Dalén started to study this problem. With a petroleum gas apparatus it was impossible to divide one litre of gas into more than fifty flashes. So Dalén constructed an apparatus, based on an entirely new principle, which by instantaneous opening and closing of the gas pipe, enabled one litre of gas to provide several thousand very rapid but distinct flashes. After a considerable trial period, this ingenious device proved to be extremely reliable. Dalén then provided a brilliant solution for the supplementary problems arising from the use of aga light in the lighthouse service, and an

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ever increasing number of lighthouses and light-buoys in Sweden have been adapted to this form of lighting. The burner is fitted with a small permanent flame which, in the most usual arrangement, lights a flash every three seconds lasting 3/10 of a second.

In 1907 Dalén crowned his achievement with a further refinement by designing a kind of valve, called the "solar valve", which extinguishes the light at sunrise and relights it when night falls. This valve is controlled by four metal rods enclosed in a glass tube. The lower one is blackened, while the others are gilded and highly polished. Daylight is absorbed by the blackened rod which is heated and consequently expands, closing the gas valve. As the daylight decreases, the black rod reaches the temperature of the other three rods: it contracts and allows the gas valve to reopen.

The device can be regulated in such a way as to act with more or less sensitivity. To be on the safe side, it is usually regulated so that it lights as soon as mist or clouds cover the sun.

The solar valve combined with an intermittent light produces a saving of gas of 93 per cent, and even greater economy might be achieved by prolonging the periods between the flashes.

The use of aga light facilitates the placing of lighthouses and lightbuoys in the most inaccessible places such as archipelagos and seas with dangerous reefs. With the use of one or more of the easily transportable gas accumulators, such lights can give their warning or guiding signals for a whole year or more without the need of inspection or the fear of failure.

The result is an entirely new standard of safety in navigation and an enormous economy. For example, one shoal in Swedish waters previously required a lightship costing approximately 200,000 Kronor and maintained at a cost of about 25,000 Kronor a year. Now, in many cases, navigation is adequately served by establishing an aga buoy with optical and audiosignalling apparatus, the cost of which is 9,000 Kronor, and the annual maintenance of which costs about 60 Kronor.

Most of the maritime nations have now started to install these Dalén devices, and they are to be found operating from Spitzberg, the Varanger Fjord, Iceland and Alaska in the north, to the Straits of Magellan and Kerguelen Island in the south. The annual benefit to navigation can be expressed in terms of saving of thousands of human lives and of hundreds of millions of Kronor.

The aga flame has proved to be extremely useful in other fields, such as the lighting ofrailway coaches, railway signalling apparatus, car head-lights, soldering, the casting and cutting of metals and so on.

The Academy of Sciences recognizes the true value of all these applications and wishes to emphasize those which contribute to the progress of navigation, because it is uncontestably these that have rendered the greatest benefit to humanity.

The sciences that were especially favoured in the will of the great explosives technician Alfred Nobel, i.e. Physics, Chemistry, and Medicine, have one common feature of involving and sometimes demanding the sacrifice of the experimenter's personal safety. We all know that this year's Physics Prize winner was the victim of a serious accident which prevents him from being here to receive the award from the hands of his King.

He is represented by his brother, Professor Albin Dalén, of the Caroline Institute. Professor, when handing over to your brother the medal and the diploma, I beg you also to convey to him from the Royal Academy of Sciences, our sincere congratulations on the distinction he has merited, and our best wishes for a complete and speedy recovery.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1912/press.html