first discoverer of the phenomenon (Buff) considered it to consist of silicon. Later Professor Beetz disproved this by experiment, and, with many others, assumed that a sub-oxide of aluminium was formed ; but this has never been demonstrated in a satisfactory manner. By forming a sufficient quantity of the film Dr K. Norden was able to obtain sufficient of the material to make a chemical analysis, and this, revealed the fact that it consists of normal aluminium hydroxide, Al2(OH)6.

According to the facts above stated, one wave of the alternating current produces the insulating film by converting the surface of the aluminium into hydroxide, practically, therefore, blocking its own path very quickly by the creation of this film. If, then, the electromotive force reverses its direction the current immediately flows. According to Dr Norden, the rapid removal of the insulat­ing film is due to the action of the electrolyte corroding or dis­solving the weak points in the coating and thus breaking down its insulating power. The insulating film is therefore a conductor in one direction, but when the current is reversed and flows out of the aluminium plate the insulating film is renewed and is continually being repaired and kept in order. Thus different electrolytes yield aluminium valves having very different efficiencies.

Rectifying cells have been made by Pollak which will bear a voltage of over 140 volts, and which are said to have an efficiency of 75%. The plates, however, must be removed when not in use, otherwise the film of hydroxide is destroyed by the electrolyte. One great practical difficulty in connexion with the aluminium rectifier is the tendency to heat in working.

The historical development of the discovery of this unilateral conductivity of an electrolytic cell with an aluminium electrode is as follows. The effect was first noticed by Buff in 1857, but was not applied technically until 1874, when Ducretet employed it in telegraphy. Beret in 1877 and Streintz in 1887 discussed the theory of the cell and sought for an explanation. In 1891 Hutin and Leblanc, in their study of alternating current, showed its uses in rectifying an alternating current. Pollak and Gratz laboured to give it a practically useful form. Pollak took out patents in 1895, and made a communication to the Academy of Sciences in Paris in June 1897; and Gratz presented a memoir at a meeting of the German Association. of Electrochemists in Munich in 1897. Μ. Blondin has summarized all the work so far done on the aluminium rectifier in two articles in *L'Éclairage électrique* (1898), xiv. 293, and xxviii. 117 (1901). The choice of an electrolyte is of great importance. Buff, Ducretet and Grätz employed dilute sulphuric acid, and the greatest difference of potential which could then be applied to the cell without breaking down its insulation in one direction was 20 volts. Pollak in 1896 found that when aqueous solutions of alkaline salts were used, and when the aluminium was subjected to a preliminary formation, the back electromotive force or what is equivalent to it could be raised to 140 or 200 volts. Pollak found that the best results were given by the use of phosphate of potassium or sodium. It appears, therefore, that the ions of K or Na effect the breaking down of the film of aluminium hydroxide more quickly than the ion of hydrogen. The practical form of aluminium rectifier, according to Pollak, consists of plates of thick aluminium and lead placed in a large deep glass vessel filled with a solution of potassium hydrogen phosphate.

In 1899 Albert Nodon of Paris began experimenting with an electric rectifier which is now on a commercial footing. It is known as the Nodon electric valve, and it is claimed that it will give an efficiency of 75 to 80% when used to transform single or polyphase currents into continuous currents. In the form used for transforming single-phase currents the valve is made up of 4 cells, each consisting of an iron cylinder with an insulating plug at the bottom through which is passed a cylinder formed of an alloy of zinc and aluminium. This cylinder is concentric with the iron tube and provided with a terminal at the lower end. The cell is filled with a saturated solution of ammonium phosphate, and a non­conducting shielding tube can be slid over the aluminium electrode to alter the exposed area.

The valve is shown in section in fig. 12, and the 4 cells are arranged in a Wheatstone’s Bridge fashion, as shown in fig. 13. A and A1 are the terminals to which the alternating current is supplied, C and C1 the terminals from which the continuous current is drawn, off. The electrolytic actions which take place in the cells are as follows: When the alternating current passes in the positive direction from the zinc-alnminium cylinder to the iron cylinder there is formed instantly on the former a film of aluminium hydroxide; this film, presenting an enormous resistance, opposes the passage of the current. On the other hand, if the current passes in the opposite direction the film is reduced instantly and the current now flows. When used with polyphase currents the valve comprises as many times two cells as there are wires in the distribution. The cells must stand a pressure varying from 50 to 140 volts, and for higher pressures two or more valves in series are employed,

The aluminium-iron electrolytic rectifier is not suitable for the rectification of very high frequency currents, because the chemical actions on which it depends involve a time element. It was, however, discovered by J. A. Fleming that an oscillation valve, could be constructed for rectifying electrical oscillations, as follows (see *Proc. Roy. Soc. Lond.,* 1905, 74, p. 476): In a glass bulb similar to that of an incandescent lamp a carbon filament is fixed. Around the carbon filament, but not touching it, is placed a cylinder of nickel con­nected to an external terminal by means of platinum wire sealed through the glass, lf the carbon filament is made incandescent by an insulated battery (and for this purpose it is convenient to have the filament adjusted to be fully incandescent at a pressure of about 12 volts), then the space between the incandescent fila­ment and the embracing cylinder possesses a unilateral conductivity such that negative electricity can pass from the incandescent filament to the cylinder but not in the opposite direction. Hence if the negative terminal of the filament and the terminal attached to the cylinder are connected to an oscillation transformer (see Induction Coil) which supplies a high frequency alternating oscillatory current, the flow of electricity in one direction is cut out and the oscillatory current is therefore converted into a con­tinuous current. Such valves have been employed by Fleming in connexion with wireless telegraphy. Wehnelt discovered that if a platinum wire was covered with oxide of barium or any of the oxides of rare earth metals, it possessed in the same manner, when used in a valve of the above type, an even greater power than incandescent carbon. The explanation of this action is to be sought for in the fact that incandescent carbon in a vacuum or incandescent earthy oxides copiously emit negative electrons.

A rectifier dependent upon the peculiar qualities of mercury vapour has been devised by Cooper-Hewitt for the transformation of polyphase currents into continuous currents. The three-phase transformer is made as follows: A large glass bulb (see fig. 14) has four iron electrodes sealed through the walls as positive electrodes and a negative electrode consisting of a pool of mercury in the bottom of the bulb connected with platinum wires sealed through the glass; the bulb is highly exhausted and contains only mer­cury vapour. The three iron electrodes are connected to the terminals of a star- connected polyphase transformer and one of them to the positive pole of a con­tinuous current starting current, the con­nexions being shown as in fig. 15. The mercury vapour is a non-conductor for low voltages, but if a sufficiently high voltage is placed on the mercury bulb by means of the continuous current it begins to conduct and if the three-phase current is then switched on the mercury vapour will allow the components of the three-phase current to pass when the mercury electrode is negative, not when it is positive. Hence for alternate cur­rent wave of the three-phase, supply is cut down and a continuous current can be drawn by the connexions as shown in fig. 15 for the purposes of supplying secondary batteries, arc lamps, &c.

Owing to the fact that the mercury vapour ceases to conduct when the electromotive force on it falls below a certain critical value the valve will not work with single-phase currents but will work with polyphase currents at all voltage from 100 to 1000 or more and can transform as much as 100 amperes. It is stated to have an efficiency of 88 to 89%. (See *The Electrician,* 1903, 50, p. 510.)