Neglecting the energy losses in the armature, and assuming that the continuous current side of the transformer is supplied with 100 amperes, the following table, also taken from a paper by S. P. Thompson, shows the effective value of the current on the alternating side put out into each line:—

|  |  |  |  |
| --- | --- | --- | --- |
| Number of slip rings. | Angle between points of connexion to armature. | Type of current generated. | Effective cur­rent put out on each line in amperes. |
| 2 | 180° | Single-phase | 141·4 |
| 3 | 120° | Three-phase | 94·3 |
| 4 | 90° | Two-phase | 70·7 |
| 6 | 60° | Six-phase | 47·2 |

It is obvious that the same results of conversion can be obtained by coupling together two separate machines on the same shaft; thus we might obtain a single-phase alternating current from a continuous current by coupling together mechanically a continuous current motor and a single-phase alternator. Such a combination is generally called a *motor-dynamo.* In this case there are two field magnets and two separate armatures, and the hysteresis eddy current and copper losses are all in duplicate. If, however, the same armature winding is made to serve both purposes, the resulting machine is called a *rotatory* or *rotary converter.* In the former combination the brushes of the continuous current part require to be set with the usual lead or lag according as that part is generator or motor, but in the latter the armature reactions nearly annul each other, and lead or lag is no longer necessary.

*Rectifiers* are devices for transforming an alternating (gener­ally single-phase) current into a continuous but pulsatory current. They may shortly be described as appli­ances for separating out each alternate current flux in an alternating current. An immense number of more or less imperfect methods of doing this have been proposed, and here we shall describe two which may be called respectively the mechanical and the electrolytic methods. Of the first class a good example is the Ferranti rectifier (fig. 11). This consists of a synchronous alternating current motor which is started up and driven in step with the alternator supplying the current. The motor drives a commutator of insulated segments, each alternate segment being connected to two insulated rings, against which press a pair of brushes. Another pair of brushes, so adjusted as to be in contact simultaneously with a pair of adjacent commutator segments, are in connexion with the alternator supplying the current to be commutated. The insulated rings are in connexion with the external circuit. It will easily be seen that when the commutator revolves at proper speed the currents delivered from the insulated rings are unidirectional. The Ferranti rectifier is much employed for rectifying alter­nating current for arc lighting purposes. With this object it is associated with a constant current transformer which converts alternating current supplied at constant potential to one supplied at constant current. This is achieved by taking advantage of the repulsive force existing between the primary and secondary circuits of a transformer. These are wound separately, and so balanced that any increase in the current presses them away from each other and so reduces the secondary current to normal value. Such an appliance is useful for rectifying currents up to 10 or 15 amperes.

The electrolytic rectifier is based upon the fact that if plates of aluminium and carbon are placed in an electrolyte, say a solution of alum or dilute acids which yield oxygen on electro­lysis, it is found that a current can be sent through the liquid from the carbon to the aluminium, but that great counter-electromotive force is created to a current in the opposite direc­tion. Grätz and Pollak (*Elektrotechnische Zeitschrift,* 1897, 25, p. 359), taking advantage of this fact, have constructed a rectifying arrangement by arranging two series of carbon aluminium (CAI) cells with alum or hydro-potassic phosphate solution as electrolyte. In one set the order of the plates is (CA1), (CA1), &c., and in the other series (A1C), (A1C), counting from the same end. These series being connected in parallel, it follows that if an alternating current is sent through the parallel series all the currents in one direction pass through one battery and all those in the opposite direction through the other. Thus the constituents of the alternating current are separated out. By using very large cells so as to reduce the internal resistance, an efficiency of 95 % is said to be obtained.

There are many points in the operation of the electrolytic rectifier which have as yet been imperfectly explained. The action of the aluminium electrolytic rectifier, consisting as it does of an aluminium plate and a lead or carbon plate placed in an aqueous electrolyte, is to oppose a great obstruction to a current passing out of the aluminium plate, but little or no obstruction to the current passing into the aluminium plate, especially if the aluminium has been subjected to a previous treatment called *formation.* This unilateral conductivity is dependent on a certain voltage or potential differ­ence between the plates not being exceeded, but within these limits a plate of carbon and aluminium placed in a solution, say of hydro-sodic phosphate, acts as an electrical *valve,* allowing current to pass in one direction but not in another. An examination of the aluminium plate after it has been so used shows that its appear­ance has changed and that its surface is covered by a thin film, the thickness of which varies with the electrolyte and the time of formation. After a certain period of use this film is seen as a grey, dull coating traversed by dark lines. It is impossible that the unilateral conductivity can be due to a true electrolytic, polariza­tion, because we know of no polarization of this latter kind which exceeds three volts, and the film can be made to resist the flow of a current under an electromotive force of 140 to 200 volts. The resistance of this film has been measured and found to be very high, so high as to be practically an insulation. Light was thrown upon the subject by F. Kohlrausch’s discovery of the polarization capacity of metallic electrodes, and this discovery was applied to develop the theory of the aluminium cell by Streintz (1888), Scott (1899) and others.

This theory was expounded by K. Norden *{Electrician,* xlyiii. 107). According to this view, the deposit covering the aluminium electrode forms the dielectric of a condenser. One plate of the condenser is formed by the aluminium plate and the other by an opposite layer of electrically charged ions in the electrolyte. The dielectric film on the aluminium having been formed, the electro­motive force of the circuit then charges the resulting condenser to the value of its own voltage, but immediately the impressed electro­motive force is removed this condenser discharges itself. This con­denser theory receives support from the behaviour of the aluminium cell when placed in the circuit of an alternating current dynamo, for it is found that in these circumstances the current through the cell is in advance in phase of the difference of potential. The ques­tion then arises, What is the nature of this insulating film? The