THE GOLDSCHMIDT HIGH FREQUENCY ALTERNATOR.

The diagram of connections of a small 7 k.w. Alternator is shown in Plate No. XV., and Explanatory Flux diagrams to describe the action of the Alternator are given in Plate No. XVI.

The Alternator contains a fixed field and a rotating Armature of the ordinary type with non-salient poles. Both the Stator and the Rotor are built up from very finely laminated iron, and they have a large number of poles; in the case of the 7 k.w. machine, described in Wireless Appendix to "Annual Report of 1912," there are 60 pairs of poles. The Alternator produces an alternating current having a frequency of 11,500 cycles per second. This alternating current is stepped up in frequency by inter-actions between the Stator and Rotor to 46,000 cycles, and alternating current of this frequency is applied to the aerial. The inter-actions between the Stator and Rotor are a little complicated, and in order to explain them it would be well, in the first instance, to examine the following theoretical consideration of Magnetic Fluxes.

Turning to the lower part of Plate No. XVI., we can represent the Magnetic Flux across the air gap between the Rotor and Stator, particulars of which are shown at the bottom of the Plate, by the diagram immediately above; in this diagram the abscissae represent the position in the air gap, and the ordinates the strength of the Flux. Using this notation, and referring to the diagram in the upper part of Plate XVI., assuming two equal and constant Magnetic Fluxes, *a* and *b*, moving at constant speed, Flux *a* to the left and Flux *b* to the right. Let $\frac{1}{2}T$ be the time taken for either Flux to move through the distance between poles. If now at the time $t = 0$, the two Fluxes coincide, as shown in the first diagram, then at this moment the resultant Flux *c*, found by adding the other two Fluxes together, will be shown in the diagram, and have a strength, at any point, equal to twice the strength of either *a* or *b* at this point.

A little later, at the time $t = \frac{1}{12}T$, the positions of *a* and *b* will be as shown in the second diagram, *a* will have moved through one-sixth of the distance between poles to the left, and *b* the same distance to the right; the resultant Flux *c*, found by adding *a* and *b* together, will now be less than before. Still later, at a time $t = \frac{2}{12}T$, *a* and *b* will be as in the third diagram, and the resultant c will be still less. Still later, at the time $t = \frac{3}{12} T$, a and b will be in opposition, as shown in the fourth diagram, and their resultant c will therefore be zero. A little later, at the time $t = \frac{4}{12} T$, a and b will be as shown in the fifth diagram, their resultant c will now be reversed in direction, and the North pole will appear where the South pole was before. At the time $t = \frac{5}{12} T$, the resultant c will be greater. At the time $t = \frac{6}{12} T$, a and b will again coincide, and their resultant c will again reach a maximum equal to the maximum at the time $t = 0$, but the North and South poles will be interchanged. Eventually, at a time $t = \frac{12}{12} T$, a and b will again coincide, as shown in the first diagram, and c again reaches its maximum as at the time $t = 0$.

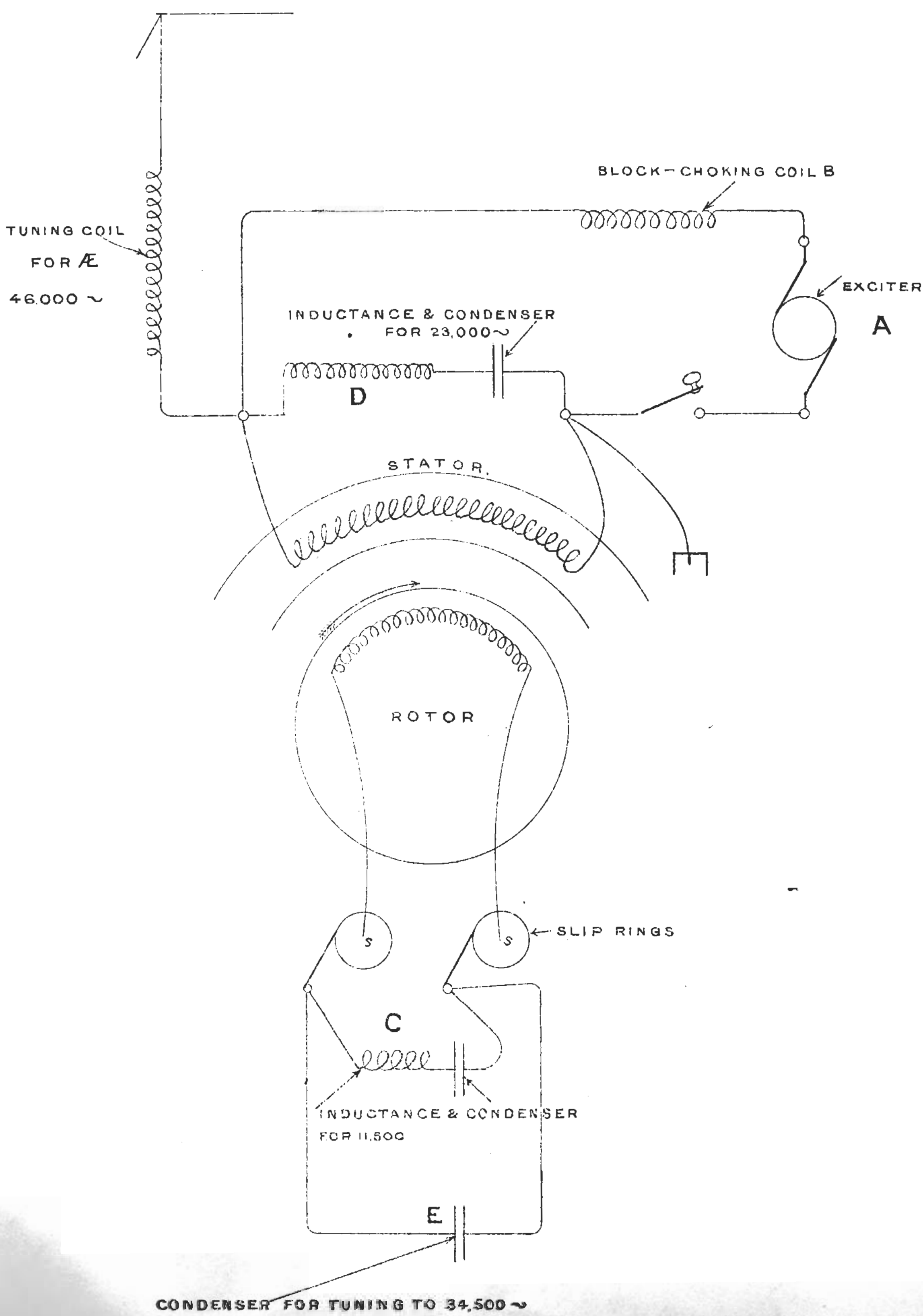
Examining these diagrams, it will be seen that the Flux c is stationary and does not move, but varies in strength, and that the periodic time of its variation is T. It will also be seen that, if the Fluxes a and b have a sine wave form distribution, the resultant c will have a sine wave form, also that its maximum value will vary with time in a sine curve. Hence we see that two equal constant Fluxes moving at constant speed in opposite directions combine together to form a stationary Flux, and that the periodic time of the variations of this stationary Flux is equal to twice the time taken for either of the moving Fluxes to move through the distance between the poles.

Conversely, if we have a stationary Flux c of varying strength, we can split it up and consider it composed of two constant Fluxes a and b, each of constant and equal strength, moving in opposite directions with such a velocity that the time taken to move from one pole to the next is equal to one-half the periodic time of the variations in strength of the Flux c. This fact will be used to explain the action of the Goldschmidt Alternator.

Referring to Plate No. XV., the stator winding of the Alternator is excited with direct current from the Exciter A. This direct current produces a number of poles round the stator, and as the rotor rotates these poles produce an alternating e.m.f. in the rotor winding. If now we short-circuit the rotor windings an alternating current will flow in it of a frequency determined by the number of poles and the speed of the machine. In the case under consideration, where there are 60 pairs of poles and the r.p.m. are 11,500, the frequency of the alternating current will therefore be 11,500 cycles per second. The rotor is short circuited with the inductance and condenser C, and the condenser is adjusted to form, with the inductance and the self-induction of the rotor, an acceptor for a frequency of 11,500. The rotor now has an alternating current flowing through it, and this alternating current will produce an alternating flux, a flux which will be stationary as far as the rotor is concerned, but vary in strength as a sine wave, approximately. Now we have seen that such an alternating current flux can be split up into two moving fluxes of constant strength. Of these moving fluxes, one will move relative to the rotor clockwise and the other relative to the rotor anti-clockwise. Now to find the rate of movement of these moving fluxes we see that the periodic time of the alternating current in the rotor is equal to the time taken for any given conductor in the rotor to move from one pole, produced by the stator, to the next pole, *i.e.*, it is equal to twice the time taken for the conductor to move from one pole to the next, also we have seen that the rate of movement of the two component constant fluxes a and b, composing the flux c, is such that they move through the distance between poles in half the periodic time of the flux c; hence the rate of movement of these fluxes relative to the rotor will be the same as the rate of movement of the rotor in space. Now the flux that moves clockwise, moves relative to the rotor with a speed equal to the speed of the rotor, hence it will, in space, move clockwise with twice the speed of the rotor: and the flux that moves anti-clockwise, moves relative to the rotor with a speed equal to the speed of the rotor, hence it will, in space, be stationary. Consider this stationary flux first of all; it is a constant flux and stationary, its action on the stator will be merely to distort the stator field produced by the direct current from the Exciter A, and we can neglect it. The other constant flux, however, that is moving round clockwise with twice the speed of the rotor will produce an e.m.f. in the stator winding, and as the speed of rotation of the constant poles produced by this flux is twice the speed of the rotor, the frequency of the e.m.f. produced in the stator will be twice as great as the e.m.f. originally produced in the rotor, *i.e.*, it will have a frequency of 23,000 periods per second. If now we place a large choking coil B in the connections coming from the Exciter A, to choke out the alternating current e.m.f. from the exciter, and if we short-circuit the stator terminals with an inductance and condenser D arranged to form, with the self-induction of the stator, an acceptor for a frequency of 23,000 cycles, we get an alternating current of this frequency, through the stator, in the same way as we obtained an alternating current of 11,500 cycles in the rotor. As before, we can consider the flux produced by this alternating current in the stator as split up into two constant fluxes. It will be seen that one of these fluxes will move round relative to the stator clockwise, with a speed equal to twice the speed of the rotor, and that the other constant flux will move round relatively to the stator anti-clockwise with a speed equal to twice the speed of the rotor. As far as the rotor is concerned, the flux that moves round clockwise will tend merely to distort the flux that we were considering in the last paragraph, which produced the 23,000 cycle e.m.f. in the stator. The other flux, however, that moves round anti-clockwise will be moving relative to the rotor, anti-clockwise, with three times the speed of the rotor. It will therefore produce in the rotor an e.m.f. of 34,500 cycles, and if we place a condenser E across the rotor terminals to form with the self-induction of the rotor an acceptor for 34,500 cycles, we shall obtain in the rotor, an alternating current flux which we can split up inlo two constant fluxes, both of which will move round relative to the rotor with a speed of three times the speed of the rotor, one moving clockwise and the other moving anti-clockwise. The flux that moves round clockwise will move in space at four times the speed of the rotor, it will therefore produce in the stator an e.m.f. of 46,000 cycles, and if we place aerial and earth connections across the terminals of the stator and put a suitable tuning inductance in the aerial to tune the whole circuit through the stator winding to a frequency of 46,000 cycles, this e.m.f. will produce a current of this frequency in the aerial.

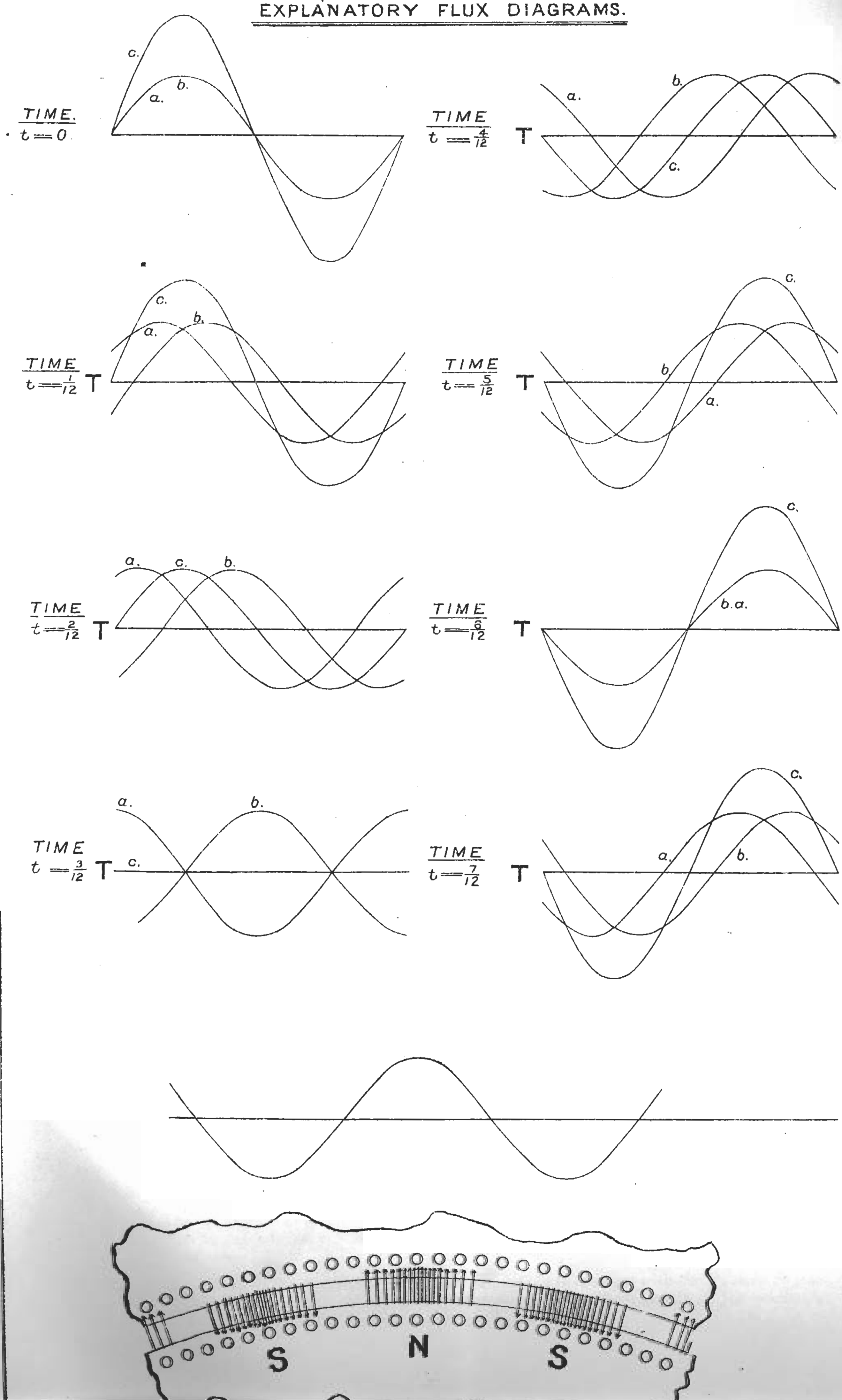
GOLDSCHMIDT ALTERNATOR.

DIAGRAM OF CONNECTIONS.



GOLDSCHMIDT ALTERNATOR.

EXPLANATORY FLUX DIAGRAMS.



It would be possible to go on making use of further inter-actions and thus obtain a higher frequency and therefore a shorter wave, but each step up in frequency results in a reduction in the power given out and an increase in the power lost in the machine and its attendant circuits. It is found that a step up of one to four in frequency is about the practical limit at present.