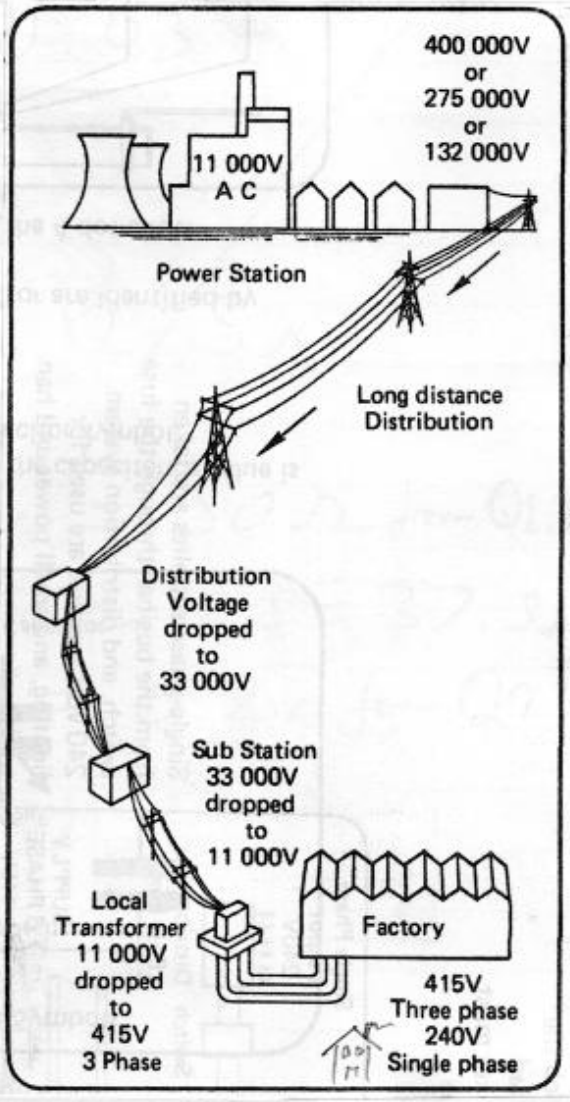
3 phase

Electricity

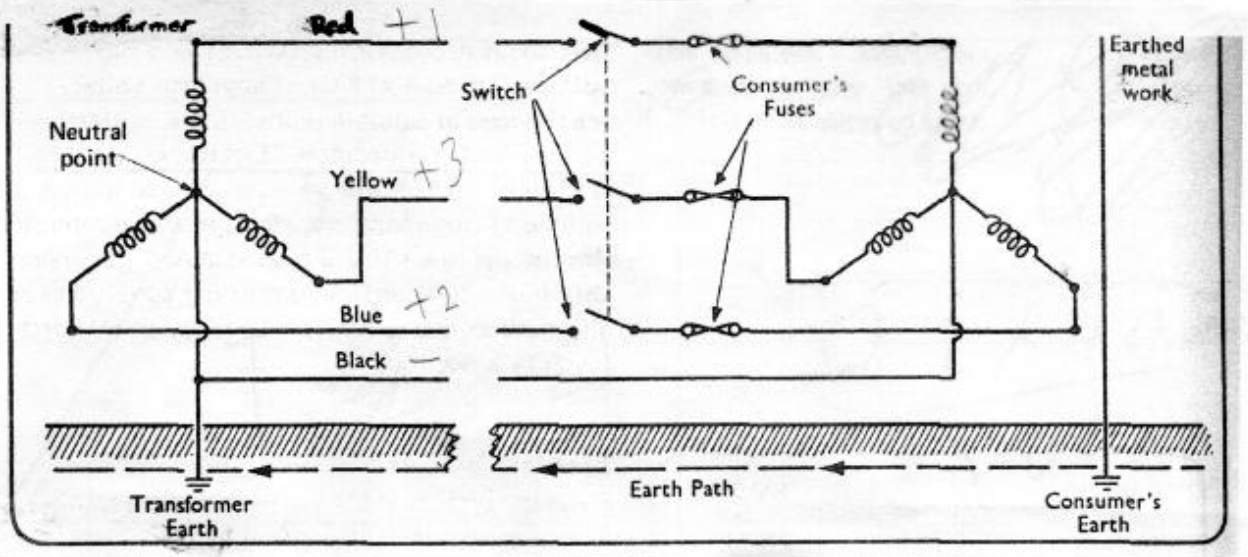


General Information
Electric power is distributed from power stations over the National Grid system at very high voltages (up to 400 KV). These high voltages are reduced at suitable points to lower voltages by means of transformers. Electric power which is supplied to factories, workshops and houses is supplied from a local transformer which reduces the voltage to a 415V 3 phase supply. In Great Britain the standard electric power supply has an alternating voltage with a frequency of 50 hertz (cycles per second).

Electric Power
Electric power for driving machines is supplied from a local transformer which gives a three-phase output, 415 volts 50 hertz. The power is supplied to the plant by an electric cable which contains four insulated conductors, colour-coded* red, yellow, blue and black. The black wire is called the neutral and is added to enable a single phase supply at 240 volts to be distributed.

*Refer to the latest version of BS7671 for the latest electrical colour code.

Earthing the Mains Supply
The black wire is taken to the neutral point of the local transformer where it is earthed.



Map showing the Complete Scheme of the

MAIN GRID TRANSMISSION LINES

Scale of Miles

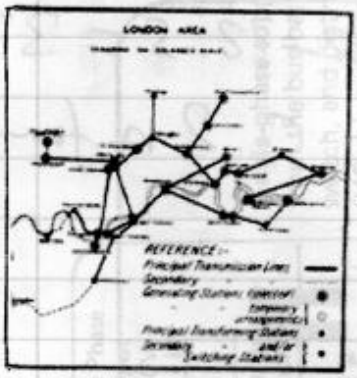
REFERENCE :-

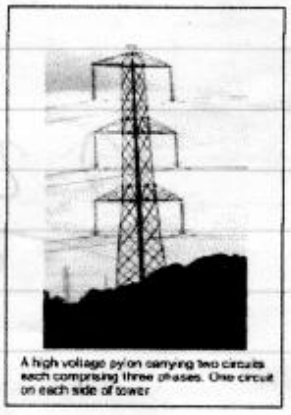
- Primary Stations
- Secondary "
- 132-kilovolt Transformer Stations
- Hydro-electric "
- Main Transmission Lines

N O R T H S E A

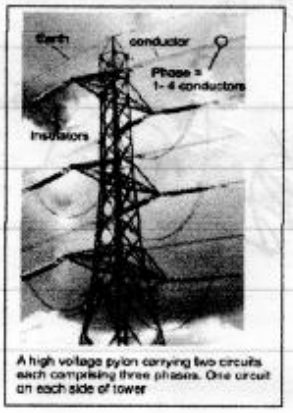
I R I S H S E A

E N G L I S H C H A N N E L





A high voltage pylon carrying two circuits each comprising three phases. One circuit on each side of tower



A high voltage pylon carrying two circuits each comprising three phases. One circuit on each side of tower

3 phase pylons.

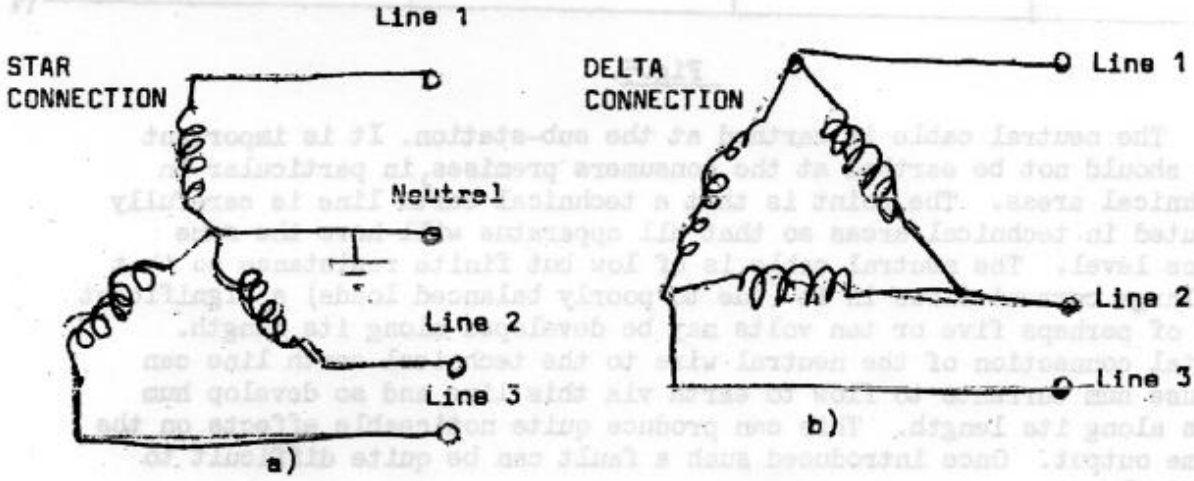
3PHASE POWER

THE BRITISH BROADCASTING CORPORATION ENGINEERING TRAINING DEPARTMENT

INFORMATION SHEET

THREE PHASE

Most electrical power generated in this country is distributed by a three phase system which can be shown to be more economic in many respects than a single phase system. Fig. 1 illustrates basically a three phase generator. In this there is relative movement between the three separate coils and the magnetic field so that three sinusoidal voltages, mutually distributed by 120° (as illustrated in Fig.3) are generated. The three coils may be represented as in Fig.2 which shows each supplying its own load. In this arrangement six wires are required to distribute the electrical power from the machine. In practice two other arrangements which are far more convenient and economical than that shown in Fig.2 are normally used.



Delta connection is the least common and is not discussed further. Star connection is widely used. In this the three voltages induced in the coils are available between the three lines and the neutral wire. In addition, three more voltages, also mutually at 120° are available between the three available pairs of lines. The voltage between any one line and neutral is called the phase voltage and is typically 230V. The voltage between any pair of lines is called the line voltage and is typically 400V. The line voltage is always equal to the phase voltage multiplied by 1.73($\sqrt{3}$). Thus star connection makes two different voltages simultaneously available.

Electrical power is normally generated and distributed at very high voltage by a three phase system. The voltage is reduced by a three phase transformer at the area sub-station from which it is distributed for industrial use as three phase and for domestic use as single phase. A single phase supply is obtained by taking any of the three available phase voltages. Fig. 5 illustrates how domestic dwellings may be supplied. The object is to balance the loads on the three lines as this permits an economy in the size of the neutral cable.

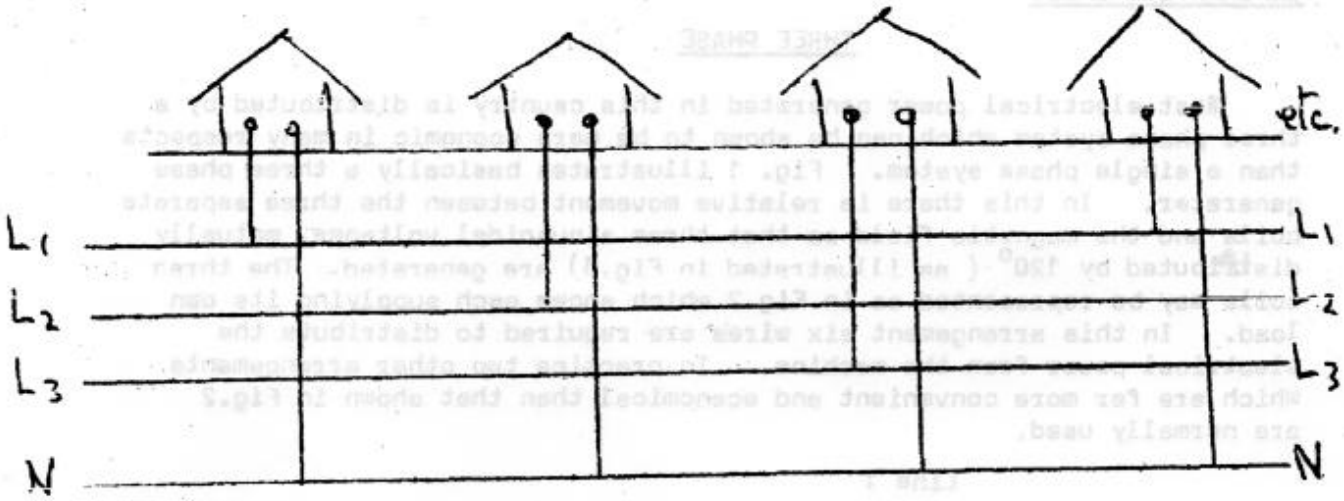


Fig.5.

The neutral cable is earthed at the sub-station. It is important that it should not be earthed at the consumers premises, in particular in BBC technical areas. The point is that a technical earth line is carefully distributed in technical areas so that all apparatus will have the same reference level. The neutral cable is of low but finite resistance so that when a large current flows in it (due to poorly balanced loads) a significant voltage of perhaps five or ten volts may be developed along its length. Accidental connection of the neutral wire to the technical earth line can then cause hum currents to flow to earth via this line and so develop hum voltages along its length. This can produce quite noticeable effects on the programme output. Once introduced such a fault can be quite difficult to trace and clear.

The Isolating Transformer

This device is used to safely connect to mains supplies, electrical apparatus which is to be used in Corporation Studios but which is not under the direct control of Corporation Engineers. Fig.6 illustrates the dangerous condition which exists if an apparatus without a proper earth connection is connected to the mains supply.

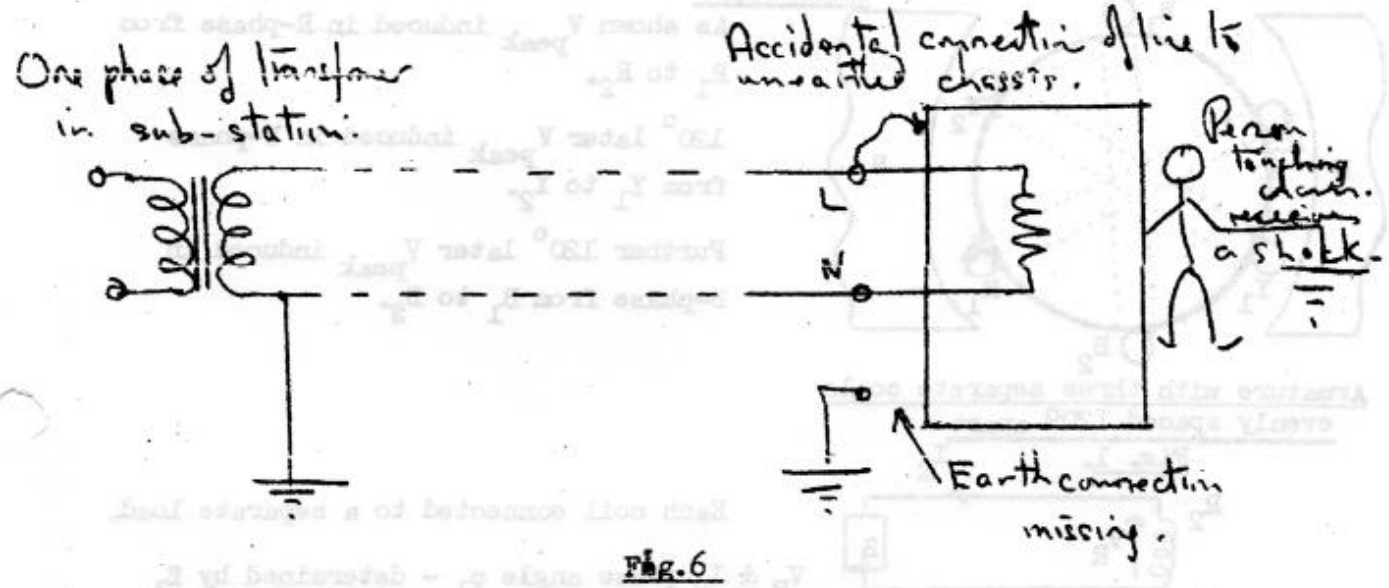


Fig.6

Correctly a faulty connection of the a.c. line wire to chassis should produce a large current to earth and blow the mains fuse. If, as shown, the equipment is not properly earthed the chassis remains live and no fuse blows. A person simultaneously touching the chassis and earth then receives an electric shock which might be fatal. To prevent this the isolating transformer is interposed between the supply and the load as in Fig.7. There is then no complete circuit available through a person who touches such a faulty chassis and earth and the person therefore remains unharmed.

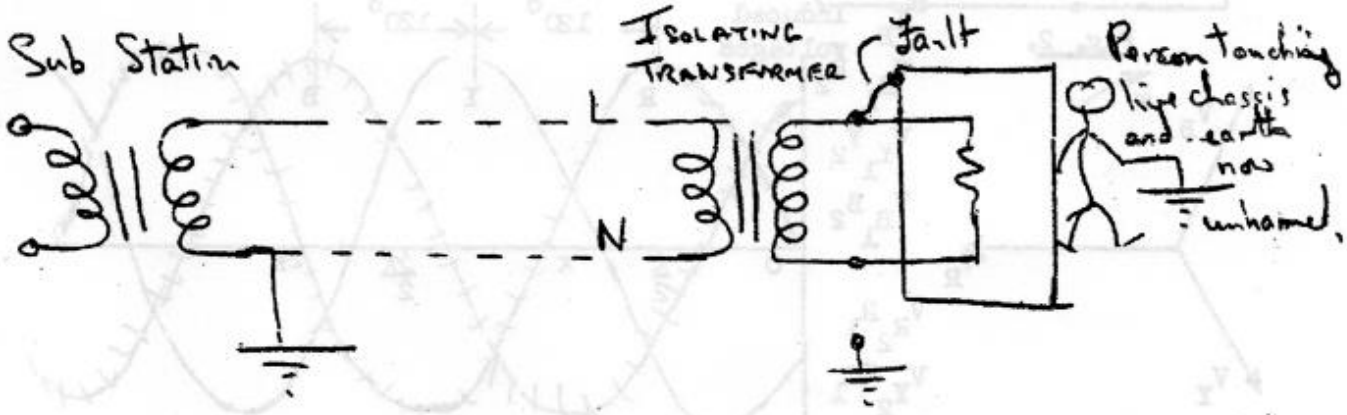
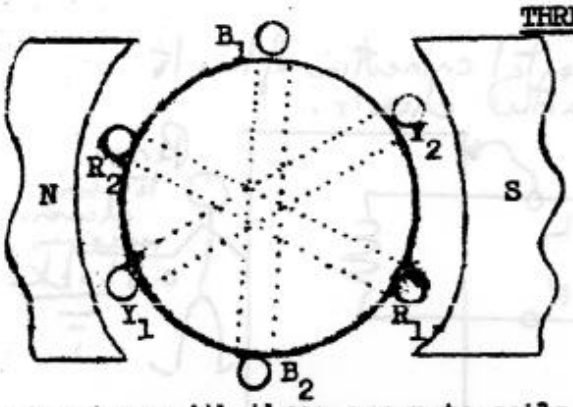


Fig.7.

JHB/DF
6.11.64

Fundamentals Section

THREE-PHASE



Armature with three separate coils evenly spaced 120° apart

Fig. 1.

As shown V_{peak} induced in R-phase from R_1 to R_2.

120° later V_{peak} induced in Y-phase from Y_1 to Y_2.

Further 120° later V_{peak} induced in B-phase from B_1 to B_2.

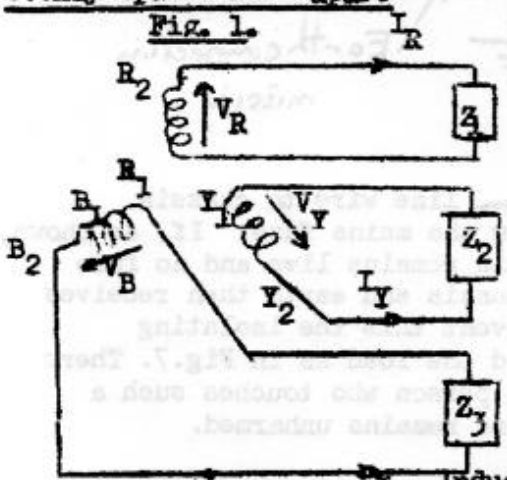


Fig. 2.

Each coil connected to a separate load.

V_R & I_R phase angle φ_1 - determined by Z_1

V_Y & I_Y phase angle φ_2 - determined by Z_2

V_B & I_B phase angle φ_3 - determined by Z_3

Each voltage may be represented by a rotating vector or drawn on an angular axis (or time axis) as shown below.

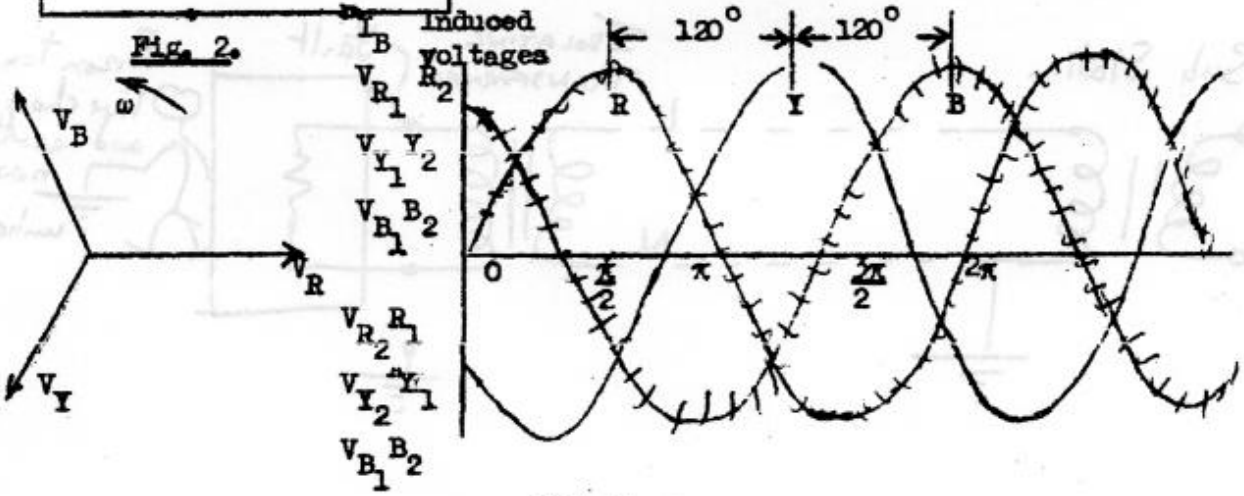


Fig. 3.

PHB/RAS
10.2.65.