CHAPTER 4
Transmission and Distribution

The quality and complexity of the distribution system depend on the size and capacity of the plant. The main aspects of the distribution system are summarised in Table 4.1 below and described in sections 4.1 to 4.3.

Table 4.1: Recommended Distribution System for MHP Plants

	Small Scheme (Up to 25kW)	Large Scheme (25kW to 50kW)
1. Consumer supply a) Maximum allowable voltage drop at consumption point.	14 %	10 %
b) Maximum allowable over voltage at consumption point.	10 % FOR ALL	
2. Distribution lines	Standard size of either flat twin sheathed solid aluminum conductor cable, or sheathed multi-strand aluminum cable.	Standard size of flat twin sheathed solid aluminum conductor cable in.
3. Distribution poles	Wooden poles	Suitable materials sufficient to support conductors safely (hard wood, steel, RCC)
4. Ground clearance	2.5m between houses,3m in open areas,5.5m next to motorable roads5.8m across motorable road	
5. Lightning arrestor	Mounted in such a way that every consumer is within 500m of an arrestor	

4.1 House Wiring

In general the local populace in remote and underdeveloped mountain areas does not have the skills needed to undertake wiring in houses and provide connections. Therefore,

in such areas the managers or operators of the plant are usually called upon to carry out wiring on the premises of the consumers. The promoters of MMHP recognise this and include house wiring in the training. Therefore some basic details of house wiring are also provided here.

Table 4.2: ACSR Cable Specifications and Current Ratings

Conductor	Diameter (mm)	Area (sq. mm)	Weight (kg/km)	Resistance (Ohms/km)
Squirrel	6.3	21	85	1.374
Gopher	7.1	26.3	106	1.089
Weasel	7.8	31.7	127.7	0.9047
Rabbit	10	53	213.6	0.5404
Dog	14	105	394	0.2722
Service wire	1.8	2.5	66	11.4
Service wire	2.2	4	87	7.2
Service wire	2.7	6	107	4.8

Current ratings (AC) for three and four core 1100 volts armoured or unarmoured cables according to IS: 1554 (I)-1976

Normal cross-sectional area sq. mm	Laid direct in the ground, Amps		In ducts Amps		In air Amps	
	Copper	Alumi-nium	Copper	Alumi-nium	Copper	Alumi-nium
1.5	21	16	17	13	17	13
2.5	27	21	24	19	24	19
4	36	30	30	23	30	23
6	45	35	35	30	39	30
10	60	47	47	39	52	40
16	77	60	60	50	66	51
25	99	77	77	63	90	70
35	120	94	94	77	110	86
50	145	110	110	95	135	105
70	175	135	135	115	165	130
95	210	165	165	140	200	155
120	240	185	185	155	230	180
150	270	210	210	175	265	205

Single circuit single core sheathed and unsheathed clipped direct to a surface on cable tray bunched and unenclosed (Cables provided with coarse-excess current protection)

Cable size	2 cables single phase AC or DC		3 or 4 cables 3 phase AC		No and diameter of wires
No./SWG[1]	Copper Amps	Aluminium Amps	Copper Amps	Aluminium Amps	No.
1/18	12	-	12	-	1/0.44
3/22	14	11	14	11	3/0.029
3/20	19	15	17	13	3/0.036
7/22	24	19	21	16	7/0.029
7/20	31	24	28	22	7/0.036
7/18	40	31	35	27	7/0.044
7/16	64	50	57	44	7/0.64
19/18	73	57	65	51	19/0.44
19/16	120	94	112	87	19/0.064
37/18	114	89	104	81	37/0.044

[1]SWG=standard wire gauge

Installation of wiring in a house involves installing a service junction box; making the connection with the incoming line; installing power outlets and switches at the required locations; and then taking the wires to the necessary locations along beams, poles, and such like. Table 4.3 shows some standard symbols for typical features of the house wiring.

It is recommended that every house have a main switch and a fuse. Black sheathing distribution cable should be used as it protects against the sun's ultraviolet radiation. If the connection to the consumer is not through a wattmeter and the tariff is based on maximum allowable power; a PTC, MCB, or ECC should be installed according to the allowable wattage (power) to prevent consumers from taking too much power.

House wiring should be carried out in accordance with a recognised standard; such as the Electrical Guidelines published by the Intermediate Technology Development Group (ITDG) and the Agricultural Development Bank/Nepal (ADB/N), Nepal. Such guidelines are usually available in every country.

The different types of internal wiring that are suitable for use in rural areas are described in the following.

Batten Wiring

This is the most common and cheapest type of wiring system. The wires are run on wooden battens fixed to the walls or ceiling. The system is classified into two types.

- TRS (tough rubber sheathed) or PVC (polyvinyl chloride) wiring. In this system, TRS or PVC wires are fixed to well-seasoned straight soft timber battens. Batten wiring, particularly with PVC cable, is widely used for indoor installations.
- Metal sheathed wiring. In metal sheathed wiring, the cables used are TRS or PVC insulated wires with an outer metal covering.

This system is suitable in places not exposed to the sun provided no joint of any kind is exposed. The system may be installed in damp places.

Conduit Wiring

This system consists of either VIR (vulcanised Indian rubber) or PVC wires passed through rigid steep conduit pipes. Conduit wiring can be installed on the surface of walls and ceiling or may be concealed under the plaster.

Cleat Wiring

In this type of wiring the cables are run over cleats. A special pattern of cleat may be used in which wires pass around corners so that there is no risk of the wires touching the wall. Where cleat wiring lies over metal, the space between the metal and the porcelain cleats should be filled or varnished.

Cleat wiring should not be employed on damp walls or ceilings.

Wood Casing Wiring

In this type of wiring the cables are run inside a wooden casing with grooves. The casing is then covered with a wooden capping. VIR or PVC insulated cables should be used.

The casing and capping should be of well-seasoned teak wood or other hard wood, free from knots or any other defects.

Ready-made Wiring

The main feature of ready-made wiring is the junction box. The required numbers of power cords of predetermined lengths for different rooms/locations radiate from it, each terminating in a light bulb or power socket. The wires are fastened to wooden columns,

beams, or similar, at appropriate locations, and the bulbs or switches are left hanging but properly secured.

4.1.1 The Most Common Wiring Practices

The houses in mountain areas using MHP are generally one- or two-storey structures with walls made of mud and stone masonry and plastered with mud. The upper floor, supporting columns, and roof are usually made of wood. There may be a very few houses made of bricks and concrete (*pakka* houses) with more durable roofs of corrugated, galvanised iron or even reinforced concrete.

Conventional batten wiring, which looks simple and neat, is commonly used in *pakka* homes with concrete or cement plastered brick walls (Fig. 4.1). However, it is more difficult to install in village homes with mud and stone masonry walls because of the unevenness of the walls and the difficulty of fixing the batten to them. Furthermore, in rural areas the availability of the skills required for house wiring is limited, and the cost of labour for conventional wiring can be significant.

For these reasons, a system of 'ready-made wiring' has been developed in Nepal which is becoming quite popular. Ready-made wiring consists of a current limiter and fuse mounted

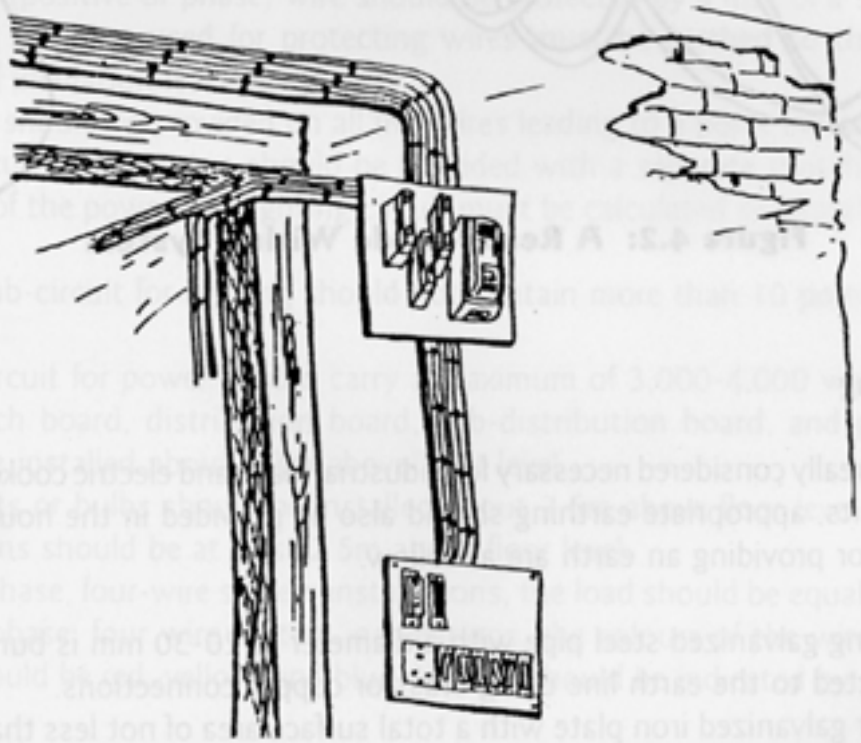


Figure 4.1: A Typical Batten Wiring Arrangement for a Small House

Prepared by DCS - Technology Development, Butwal, Nepal

on a wooden junction box from which radiate a number of good quality, double insulated, power cords, each terminating in a light bulb or power outlet. The junction box may also have some power outlets. The lengths of wires are predetermined according to the house specifications. The lighting fixtures, switches, and power outlets are fixed permanently into walls, supporting posts, or other parts of the house. The tips of stranded conductors are soldered to ensure good connections and eliminate any problems arising from frayed wires. Figure 4.2 shows the major components of a typical ready-made wiring system, and Figure 4.3 shows a line diagram for the same system.

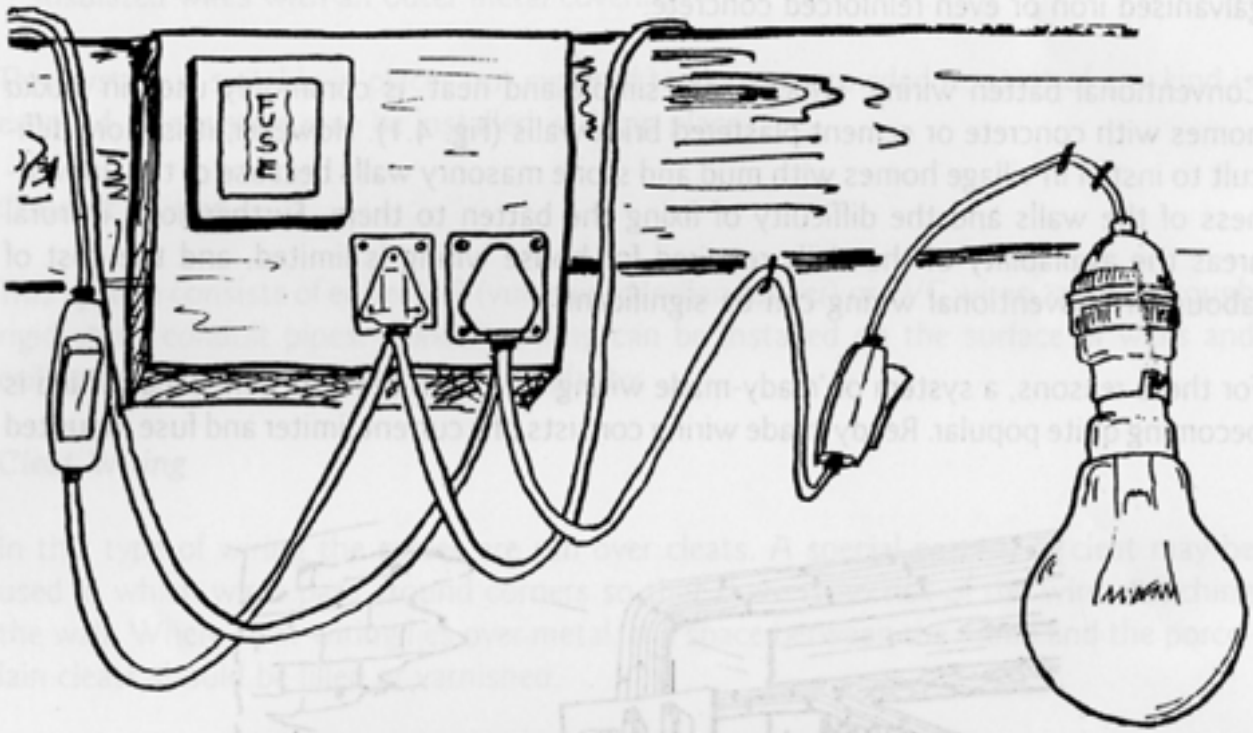


Figure 4.2: A Ready-made Wiring System

4.1.2 Earthing

Earthing is only really considered necessary for industrial loads and electric cookers. However, if funding permits, appropriate earthing should also be provided in the houses. Acceptable methods for providing an earth are as follow.

- A 3-4 m long galvanized steel pipe with a diameter of 20-30 mm is buried vertically and connected to the earth line using brass or copper connections.
- A copper or galvanized iron plate with a total surface area of not less than one sq.m. is buried at a depth of at least two metres and connected to the earth line using brass or copper connections.

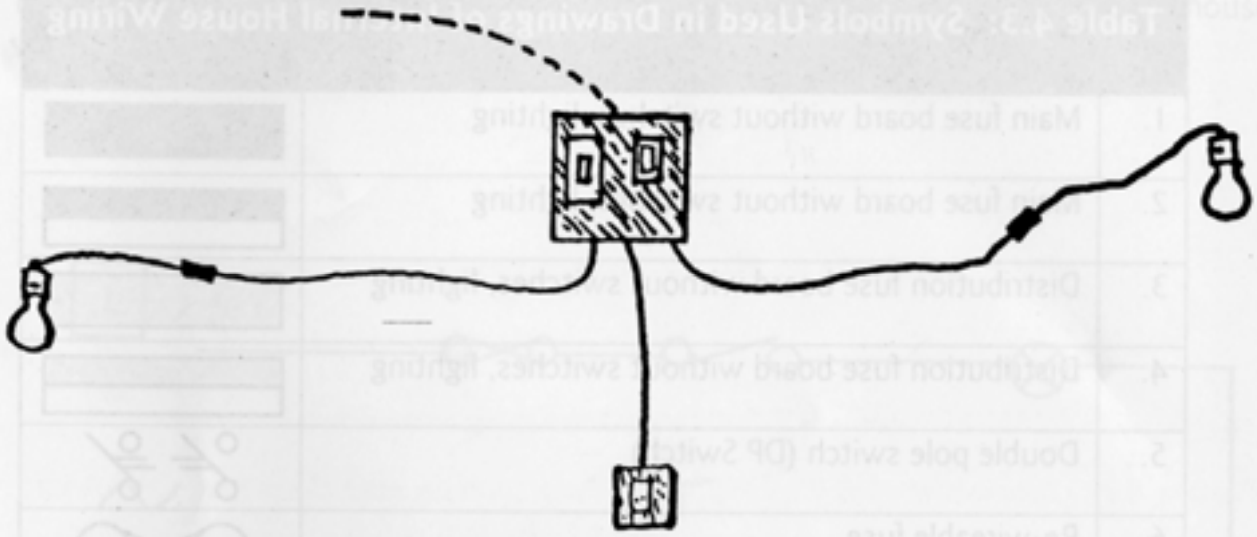
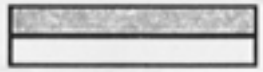
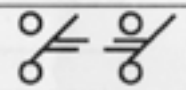
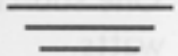


Figure 4.3: Line Diagram for Ready-made Wiring

4.1.3 General Rules for House Wiring

- The current rating of the conductor should be as per the requirement of the load as suggested in Table 4.2.
- Every live (positive or phase) wire should be protected by a fuse of a suitable rating.
- All metal covering used for protecting wires must be earthed so that there is no danger of insulation leakage.
- Switches should be provided on all live wires leading to a point in use.
- Every circuit or apparatus should be provided with a separate switch.
- The size of the power and lighting circuit must be calculated separately according to the load.
  - ♦ One sub-circuit for lighting should not contain more than 10 points or 800 watts.
  - ♦ One circuit for power should carry a maximum of 3,000-4,000 watts.
- The switch board, distribution board, sub-distribution board, and power sockets should be installed about 1.3m above floor level.
- Tube-lights or bulbs should be installed about 2.5m above floor level.
- Ceiling fans should be at least 2.5m above floor level.
- In three phase, four-wire system installations, the load should be equal on all phases.
- In three phase, four wire system installations, the colours of the wires at the main board should be red, yellow, and blue. Neutral should be indicated by green or black.

Table 4.3: Symbols Used in Drawings of Internal House Wiring

1.	Main fuse board without switches, lighting	
2.	Main fuse board without switches, lighting	
3.	Distribution fuse board without switches, lighting	
4.	Distribution fuse board without switches, lighting	
5.	Double pole switch (DP Switch)	
6.	Re-wireable fuse	
7.	Fan	
8.	Incandescent lamp or filament lamp (bulb)	
9.	Fluorescent lamp (tube light)	
10.	Two pin socket	
11.	Three pin socket	
12.	One-way switch	
13.	Two-way switch	
14.	Earthing (earth point)	

The following diagrams (Figures 4.4 to 4.14) show some typical circuits used for house wiring.(L= live; N= neutral)

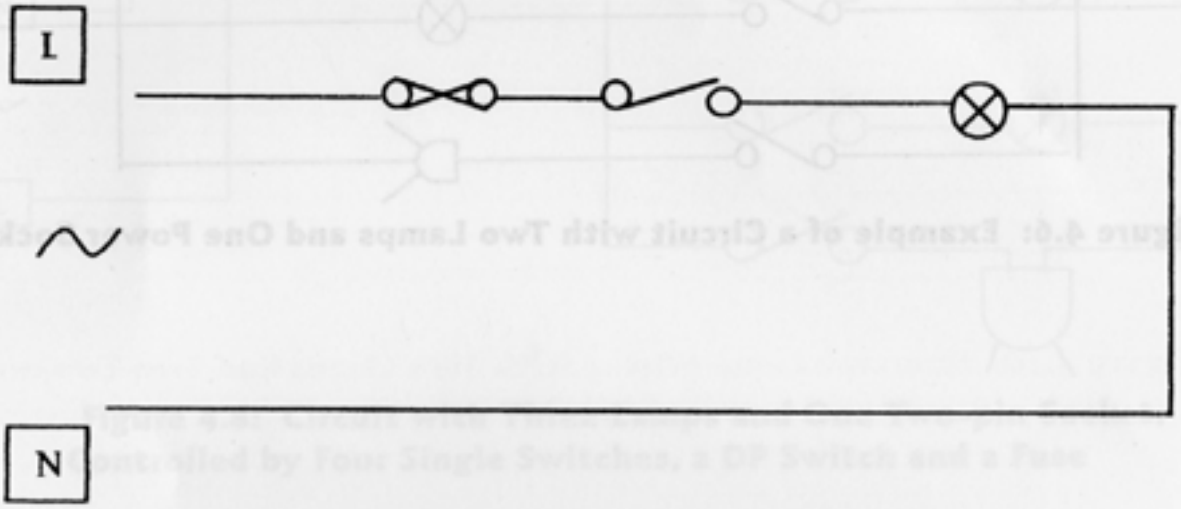


Figure 4.4: Circuit with One Lamp

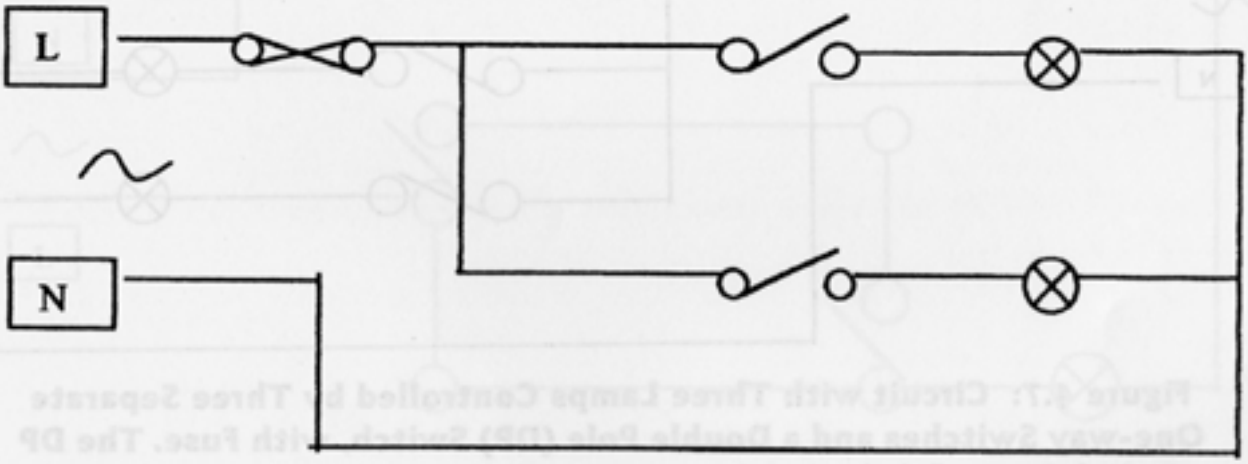


Figure 4.5: Circuit with Two Lamps Controlled by Two One-way Switches with One Fuse

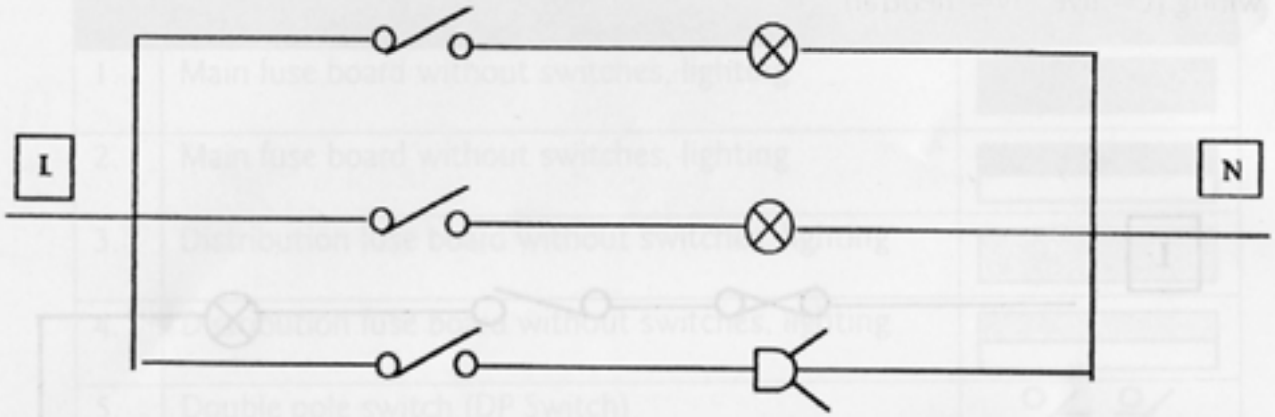


Figure 4.6: Example of a Circuit with Two Lamps and One Power Socket

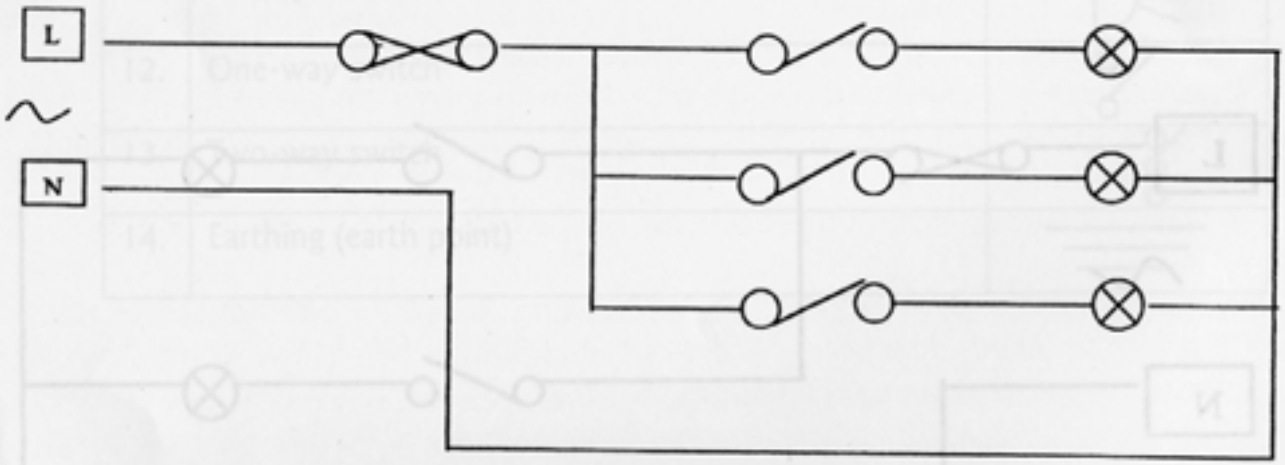


Figure 4.7: Circuit with Three Lamps Controlled by Three Separate One-way Switches and a Double Pole (DP) Switch, with Fuse. The DP Switch is Useful if a Sub-circuit Needs to be Disconnected from a Different Location

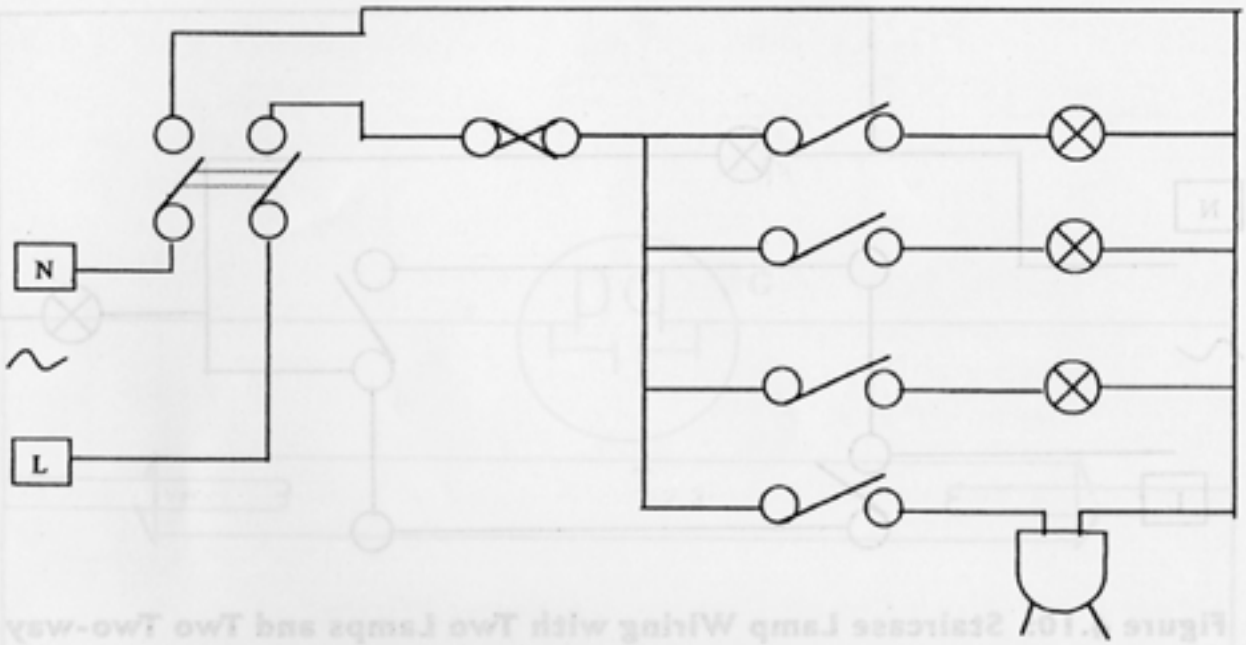


Figure 4.8: Circuit with Three Lamps and One Two-pin Socket, Controlled by Four Single Switches, a DP Switch and a Fuse

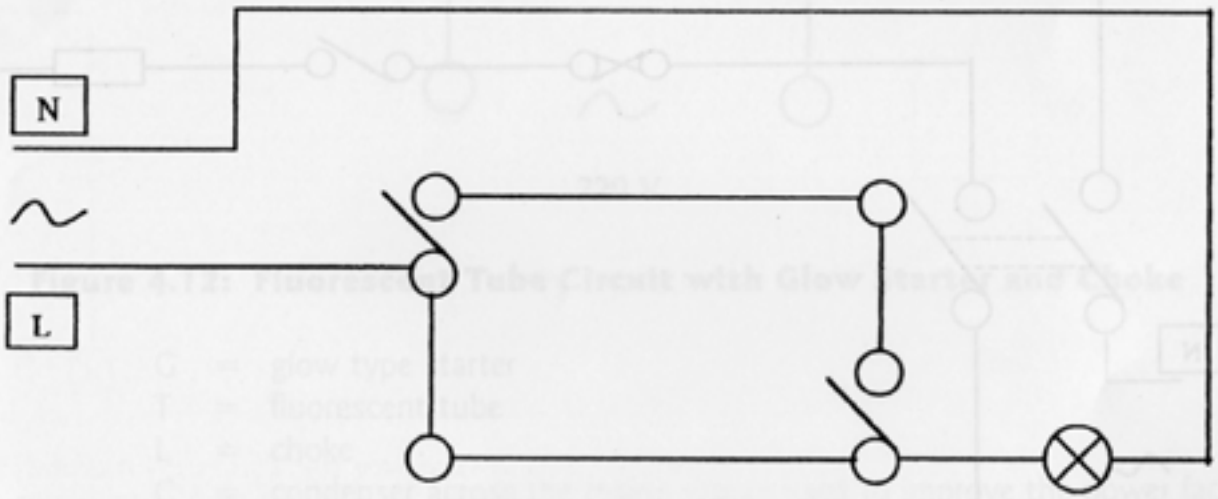


Figure 4.9: Staircase Lamp Wiring with One Lamp and Two Two-way Switches

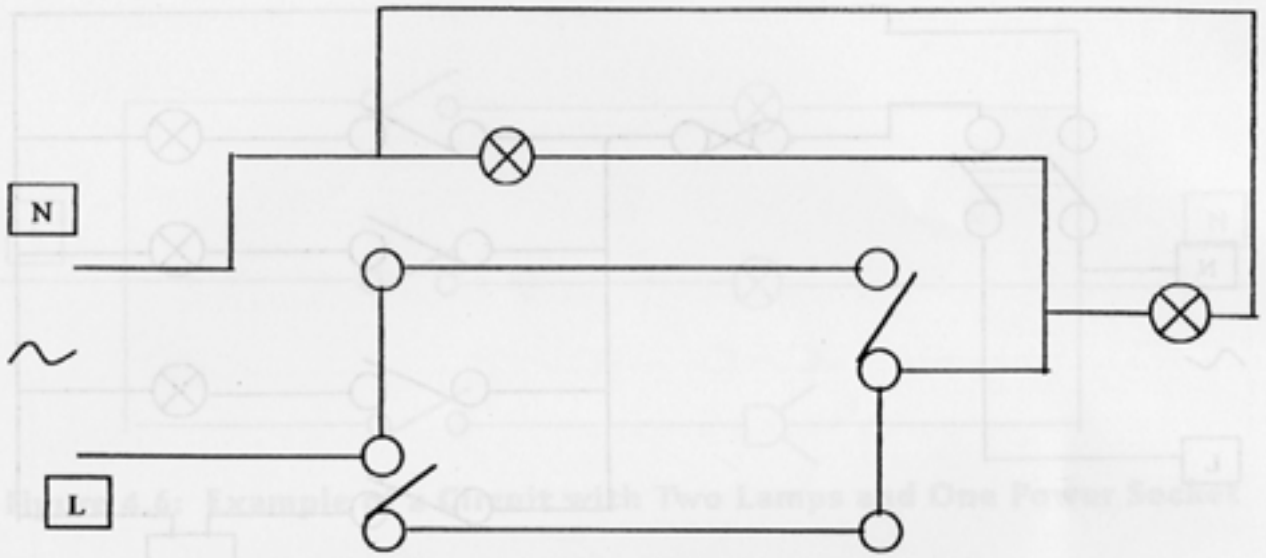


Figure 4.10: Staircase Lamp Wiring with Two Lamps and Two Two-way Switches

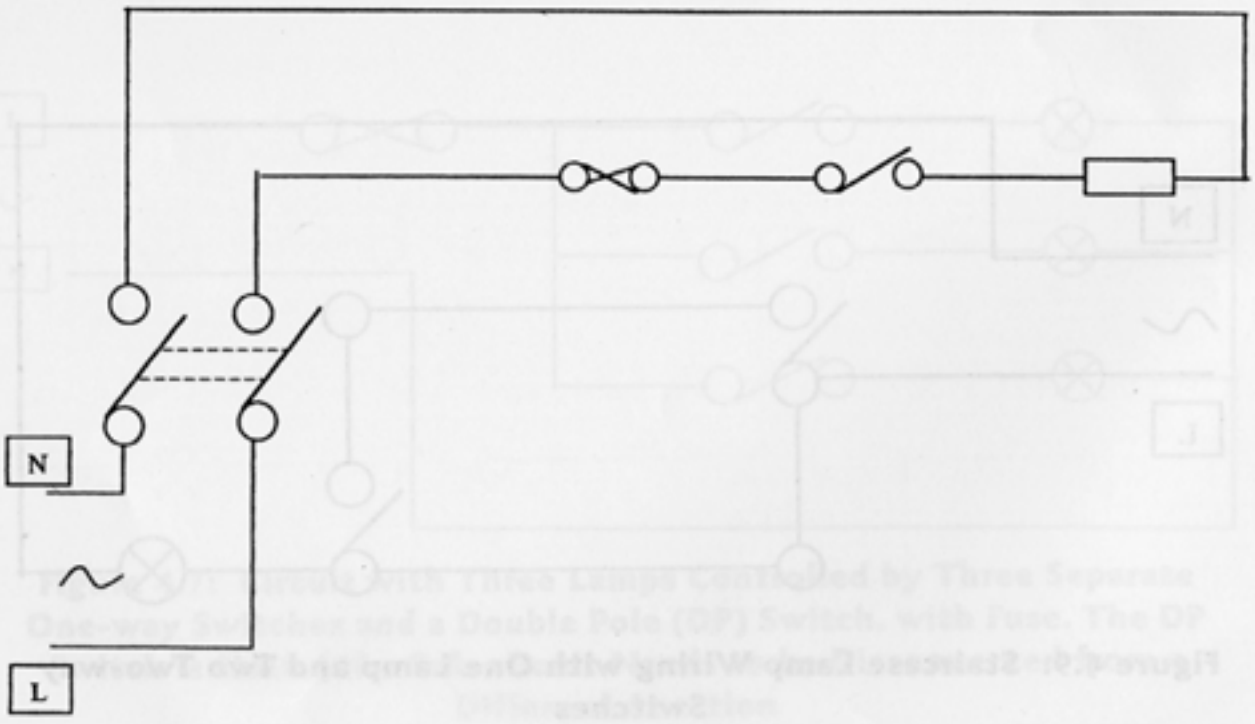


Figure 4.11: Wiring Diagram for a Fluorescent Lamp. The DP Switch is Optional

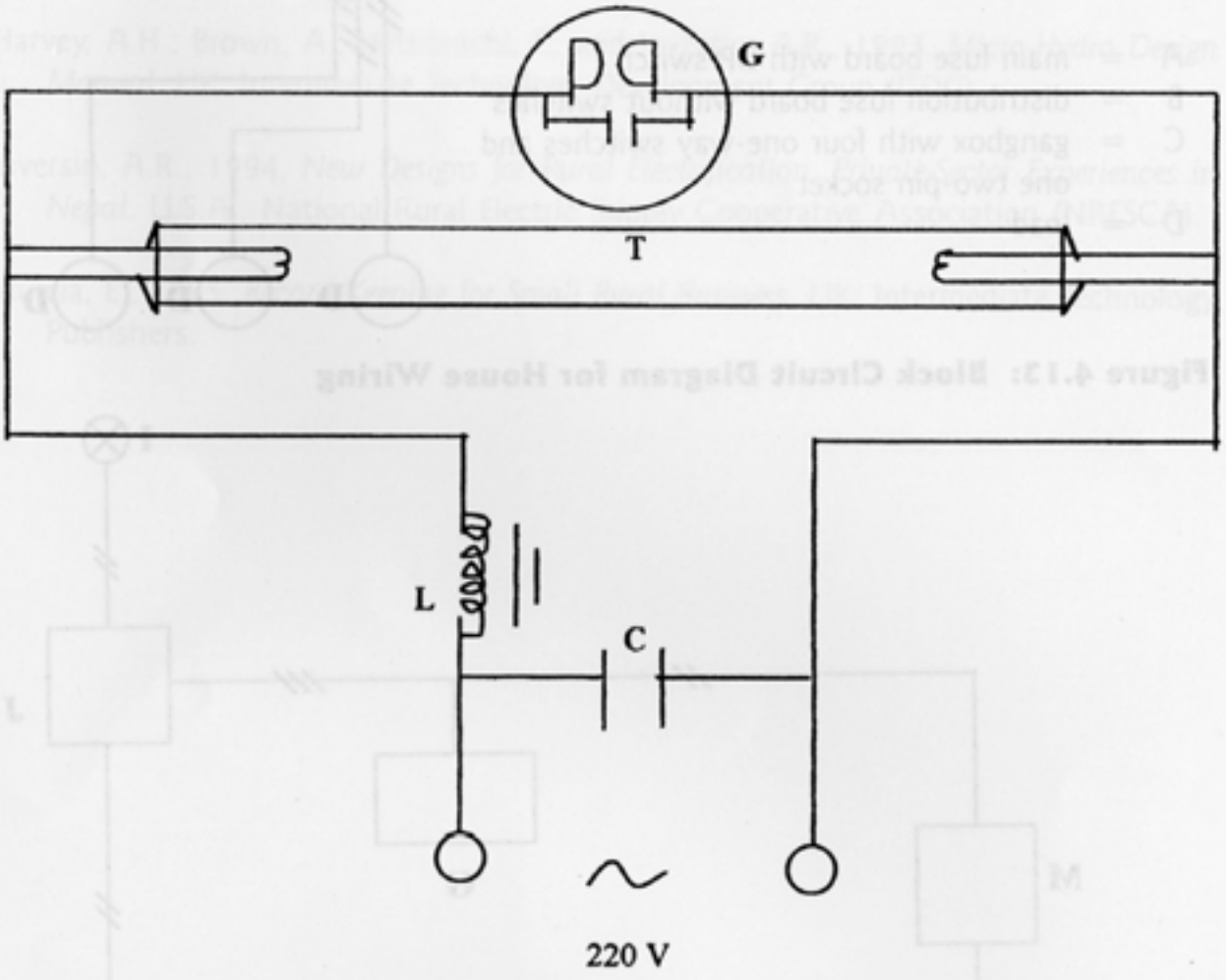
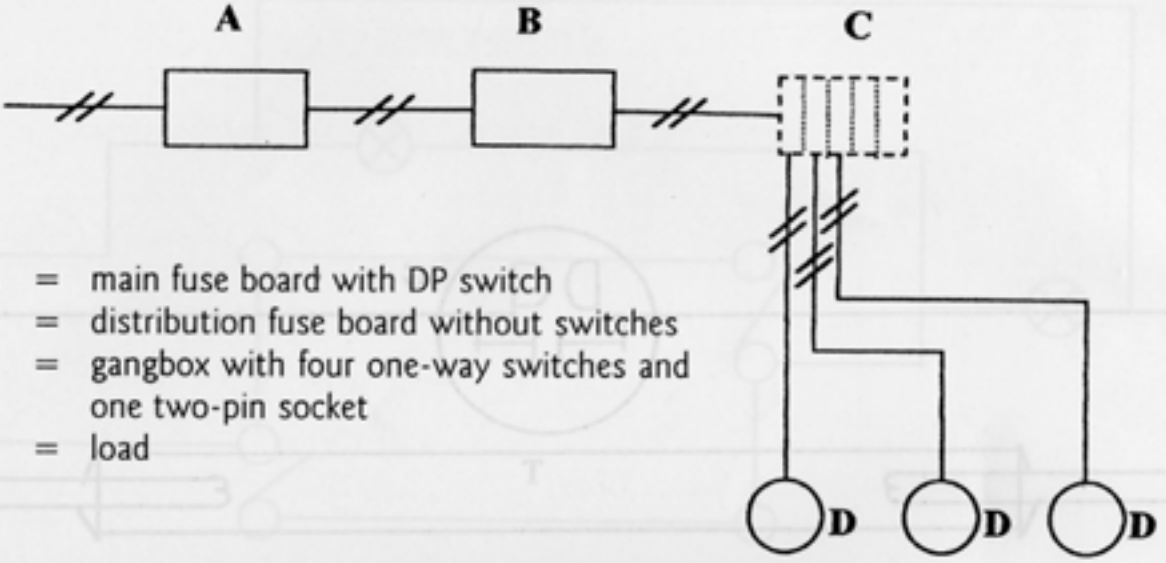


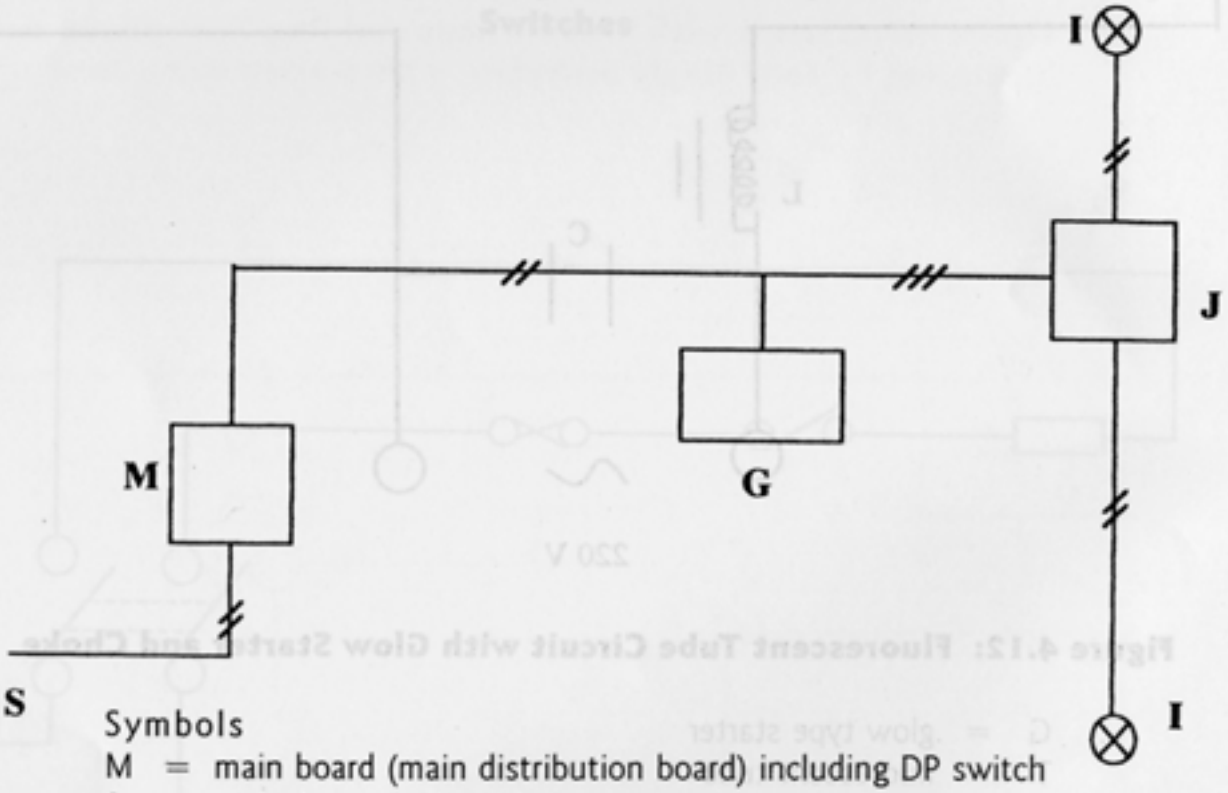
Figure 4.12: Fluorescent Tube Circuit with Glow Starter and Choke

G = glow type starter
T = fluorescent tube
L = choke
C = condenser across the mains supply used to improve the power factor



A = main fuse board with DP switch
B = distribution fuse board without switches
C = gangbox with four one-way switches and one two-pin socket
D = load

Figure 4.13: Block Circuit Diagram for House Wiring



Symbols
M = main board (main distribution board) including DP switch
S = mains' supply (220V)
G = gang box (4 way; 3 one-way switches, one two-pin socket)
J = junction box
I = incandescent lamp with holder

Figure 4.14: Block Circuit Diagram of Circuit with Two Lamps and One Two-pin Socket Controlled by Three One-way Switches, a DP Switch and a Fuse

Participating Countries of the Hindu Kush-Himalayan Region

 Afghanistan

 Bangladesh

 Bhutan

 China

 India

 Myanmar

 Nepal

 Pakistan

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