TRADE TRAINING II

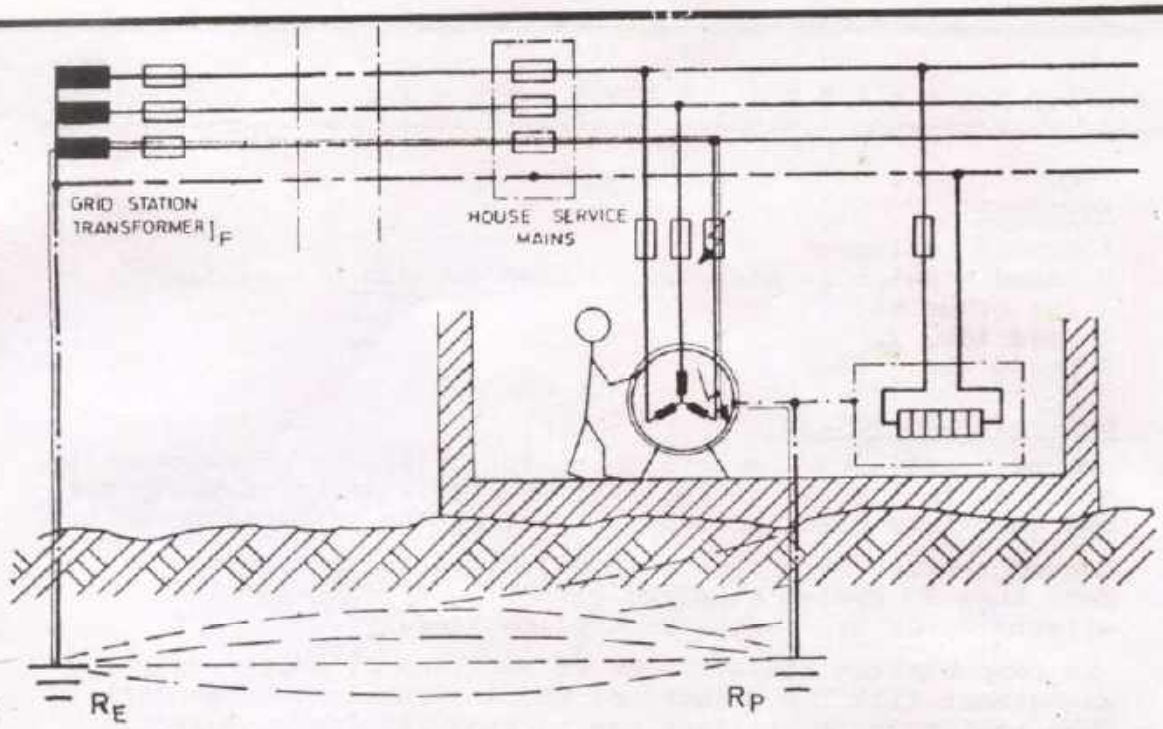
TTC PROGRAMME

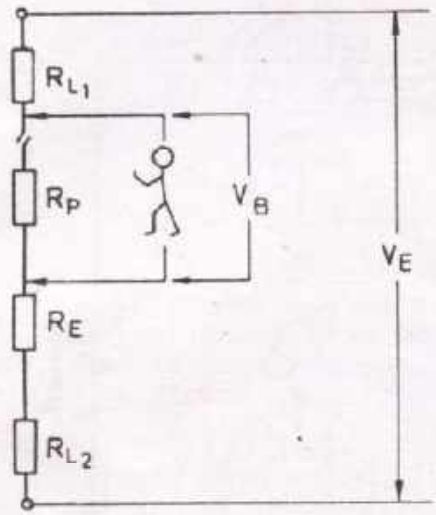
ELECTRICIAN GENERAL

GOVERNMENT OF THE PUNJAB
TECHNICAL EDUCATION & VOCATIONAL TRAINING AUTHORITY
PUNJAB BOARD OF TECHNICAL EDUCATION
TRADE TESTING CELL, LAHORE.

T.T.P. Series No.34

Price Rs. 44/-





R_E	TRANSFORMER-NEUTRAL EARTH
R_P	PROTECTIVE EARTH WIRING
I_F	FAULT CURRENT
I_{off}	CUT-OUT CURRENT
I_N	NOMINAL FUSE CURRENT
k	FACTOR for diff. FUSE TYPES
V_B	CONTACT VOLTAGE (TOUCH)
V_E	VOLTAGE AGAINST EARTH
R_{L1+2}	RESISTANCE in the LINE (conductor)
R_{loop}	LOOP RESISTANCE

$$I_{off} = I_N \times k \qquad R_{loop} = \frac{V_E}{I_{off}} \qquad R_P = \frac{65\ V}{I_{off}}$$

Protective earthing,

is intended to prevent the persistence of excessive touch voltage V_B on conducting parts of the installation not forming part of the working circuit. It is effected by connecting the parts of the installation to be protected to an earth electrode. The protected earth resistance R_P at apparatus to be protected shall not exceed the resistance calculated out of highest permissible touch voltage V_B = 65V divided by I_{off} the cut-out current of the fuse.

PROTECTIVE EARTHING

EP 2.3/3.5.1/1

Measuring

MEASURING OF EARTH RESISTANCE

1. Equipment:

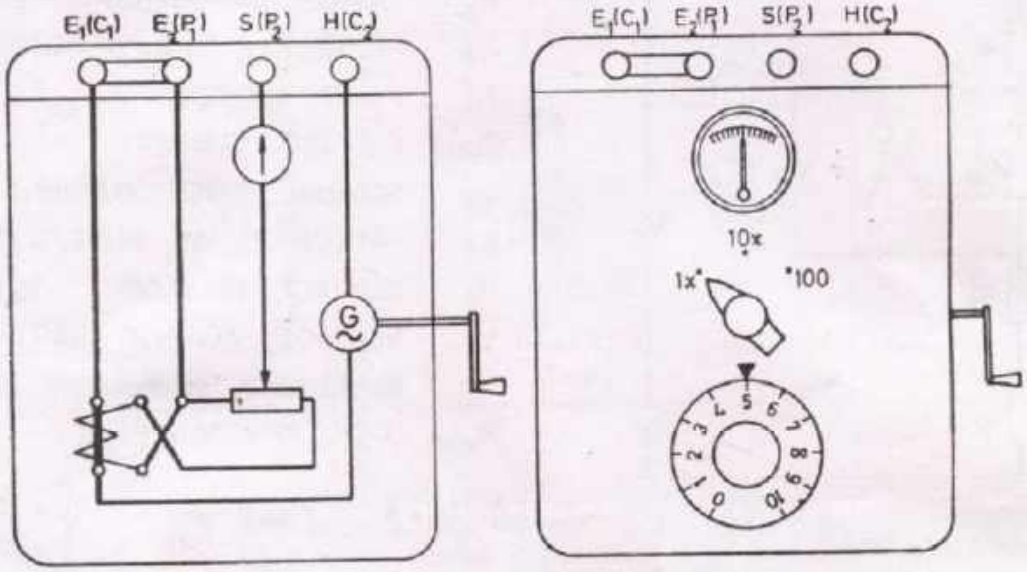
   1 Ground tester
   2 Round steel bars with one pointed end and a terminal at the other end
   1 Lead (ca. 2m)
   3 Leads (20 - 25m)

2. General Information:

   Ground testers work according to the principle of compensating bridges. Thus it is given, that the resistances of the probe and auxiliary electrodes do not affect the measuring result.

   Ground testers work with an A.C. voltage of a frequency of more than 50 cycles supplied either by a crank-operated alternator or by a battery-supplied vibrator.

   The compensating resistor can be adjusted by coarse and fine adjustment till the pointer of the instrument goes to zero. Then the ground resistance can be read off from the setting of the compensating resistor.



E_1 E_2 S H - German Symbols

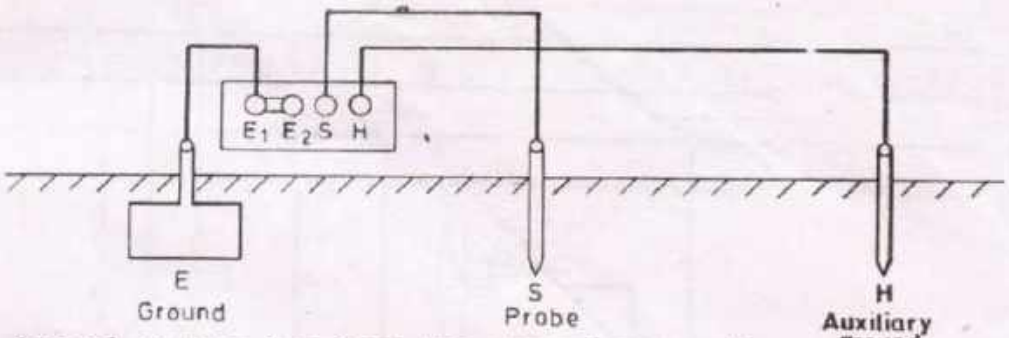
(C_1 P_1 P_2 C_2 - English Symbols)

E - Ground S - Probe H - Auxiliary ground

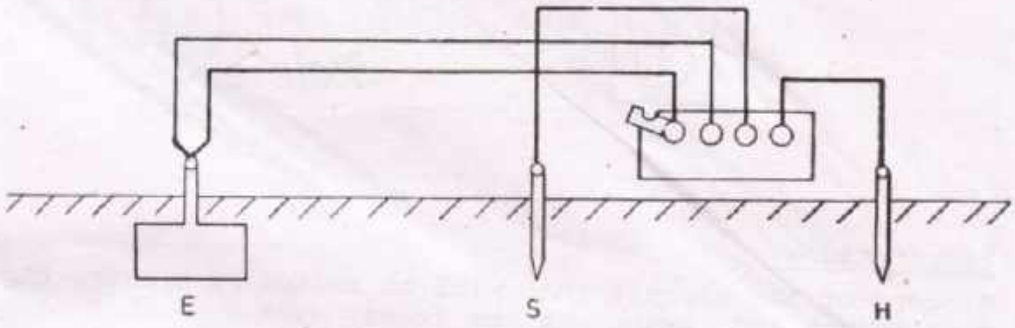
	EARTH RESISTANCE	EP.2.3/3.5.1/2 Measuring
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL

3. Connection Diagrams:

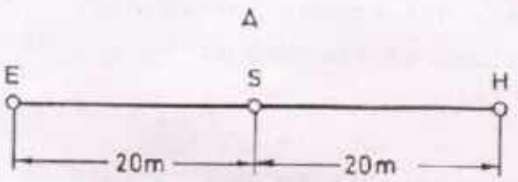
3.1 Ground tester close to the ground connection:

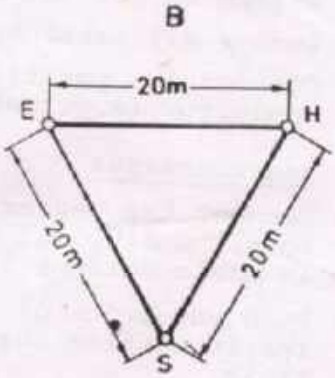


3.2 Ground tester far from the ground connection:

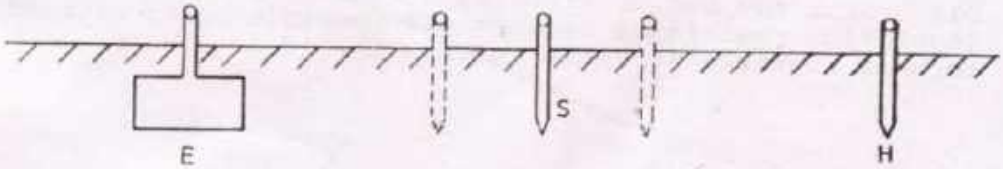


3.3 Distribution of probe and auxiliary ground electrodes:

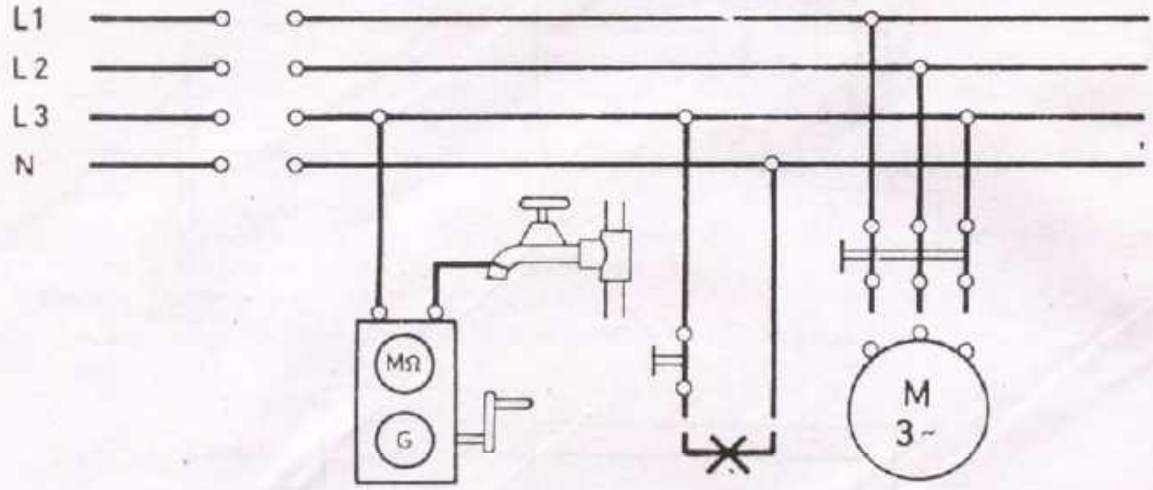




3.4 Variation of probe position:



3. Connection Diagram:



4. Preparations:

4.1 Disconnect the circuit that will be tested by opening the main switch and taking out the fuses. Make sure that nobody can switch ON during your measurements (e.g. by taking the fuses with you).

4.2 Switch ON all switches within the circuits to be checked.

4.3 Remove all lamps and tubes, disconnect motors etc.

4.4 Connect the positive terminal of the megger to a good ground-conductor (e.g. water pipe).

5. Measurements:

5.1 Connect the megger tester according to the connection diagram to all individual conductors, one after the other as required in Table Columns 1 to 4.

5.2 Turn the crank of the megger in a steady medium speed. Read off the insulation resistance and enter the results into the table.

5.3 Disconnect the megger from the ground wire and measure the insulation resistance between all possible pairs of conductors as required in Table columns 5 - 10.

6. Table:

1	2	3	4	5	6	7	8	9	10
E-N	E-L1	E-L2	E-L3	N-L1	N-L2	N-L3	L1-L2	L1-L3	L2-L3

7. Results:

Give a report on the measuring results.
(Are the insulation resistances sufficient?
If there are faulty circuits, where are they?)

4. Preparations:

4.1 Put the ground tester in operating position as close to the earth plate as possible.

4.2 Check the zero position of the pointer and adjust it if necessary.

4.3 Place the probe and auxiliary ground electrodes as shown in 3.3 (either A or B). See that the electrodes have good contact with wet soil.

4.4 Connect up with the ground tester according to the connection shown in 3.1.

4.5 Disconnect the earth plate being tested from all other parts of the installation and connect it to the ground tester according to 3.1.

4.6 If the distance between ground plate and tester is large, remove the link between E_1 (C_1) and E_2 (P_1). Make a separate connection from E_2 (P_1) to the ground plate.

5. Measurements:

5.1 Select a suitable coarse measuring range.

5.2 Adjust with the fine adjustment till there is no deflection of the pointer.

5.3 Read the setting of the fine adjustment knob, multiply by the factor of the coarse adjustment and enter the result into the table below.

5.4 Alter the position of the probe electrode about 6m in direction towards the ground plate as shown in 3.4.
Repeat the measuring according to 5.1 to 5.3.

5.5 Alter the position of the probe electrode about 6m from the original position, away from the ground plate (see 3.4).
Repeat the measuring according to 5.1 to 5.3.

5.6 If there are major differences between the three results, increase the distance of the auxiliary ground electrode from the ground plate or go in a different direction.
Repeat the measuring according to 5.1 to 5.5.

6. Table:

		1	2	3	4
		Positions of probe			Mean
1	R_E				
1	R_E				

7. Result:

If the measuring results in columns 1 - 3 are substantially in agreement, take the mean value of the three readings and enter the result into column 4. This is to be taken as the resistance of the ground electrode.

MEASURING INSULATION RESISTANCE

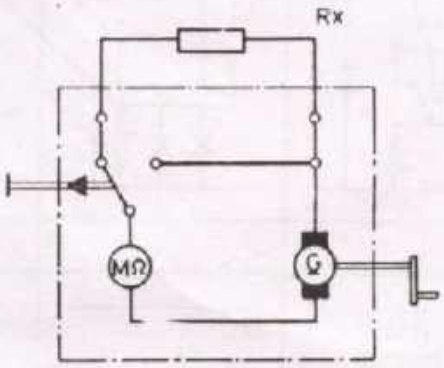
1. Equipment:

   1 Megger tester
   2 Leads with alligator clips

2. General Information:

   Under normal operations all live wires of electric circuits or machinery winding are insulated against each other and against the ground. This has to be checked after completion of a new electrical installation and later on from time to time.

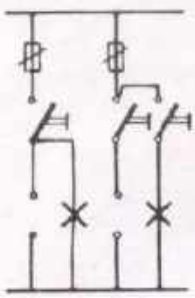
   For checking the insulation resistance a megger tester has to be used. This is a hand-driven DC generator providing a test voltage of about 500V. In the same tester there is a meter connected in series to the generator. This meter, which actually is a milli-ammeter, is calibrated in M Ω (meg ohms) and shows the insulation resistance of the tested circuit.



   For a measuring object, the electrical wiring of any workshop or other room can be used, provided it is possible to disconnect this circuit (or circuits) from the main supply during the time of measuring. To test the complete wiring, all appliances have to be disconnected (i.e. lamps and tubes taken out, motors etc. disconnected) and all switches have to be closed.

   If a faulty insulation should be found while measuring at the main switchboard, this fault can be traced by disconnecting and checking all individual circuits. When the faulty circuit is found, the measurements are repeated from junction-box to junction-box till the damaged or worn out part is detected.

   As a general rule the insulation resistance can be called sufficient when the measurement shows 1000 Ω for each volt of the rated voltage. That means for the voltage of 400V a minimum insulation resistance of 400 000 Ω or 0.4 M Ω.



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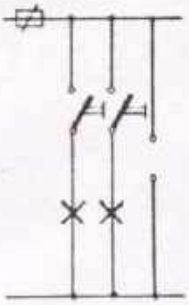

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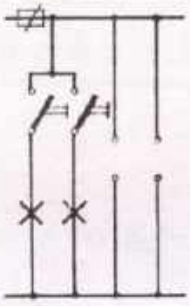

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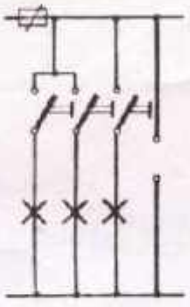

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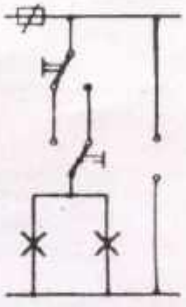

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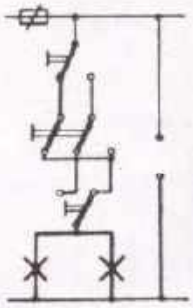

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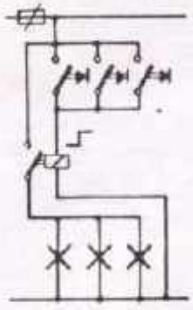

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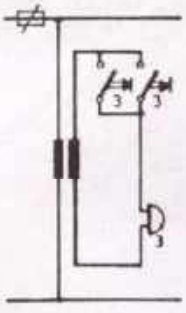

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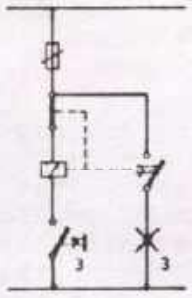

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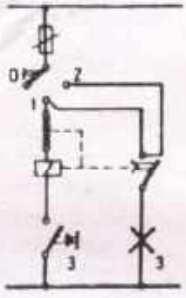

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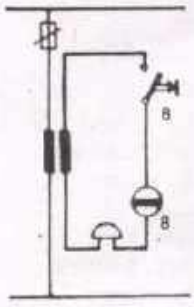

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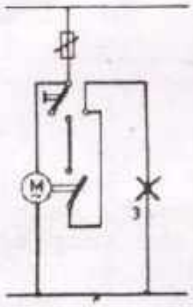

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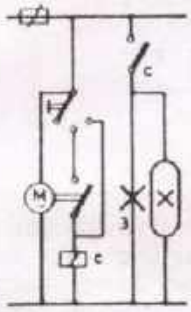
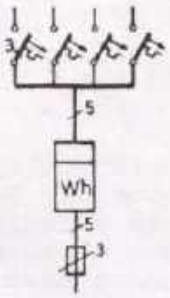


12→ 13



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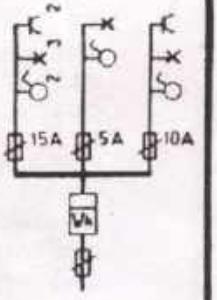

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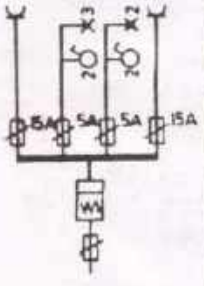


16

In continuation of course Circuits I course Circuits II is meant to further improve trainees' knowledge about circuits and their connections. It runs parallel with the practical course Installation II. This course however puts emphasis on the correct wiring of up-to-date and sophisticated installation elements. Circuit drawings in mostly three representations, namely wiring diagram, current path diagram and installation layout have to be completed by the trainee as a drawing exercise.

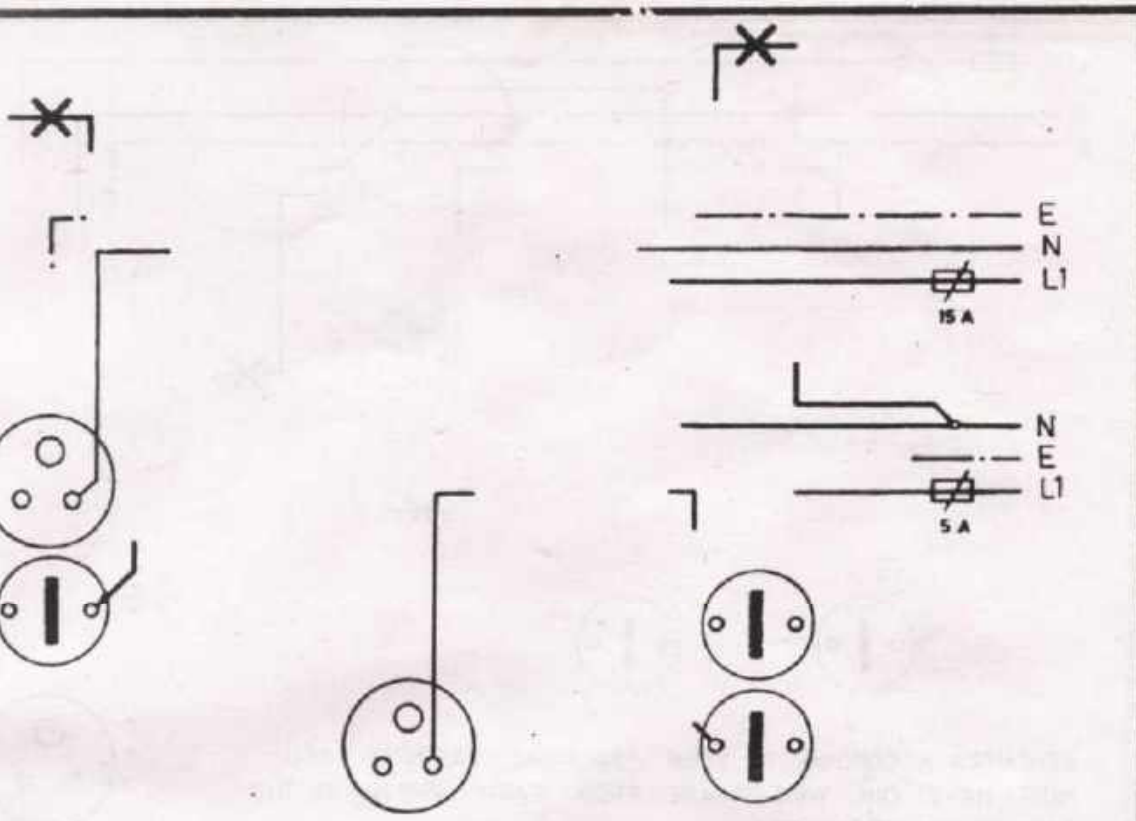
LAYOUT

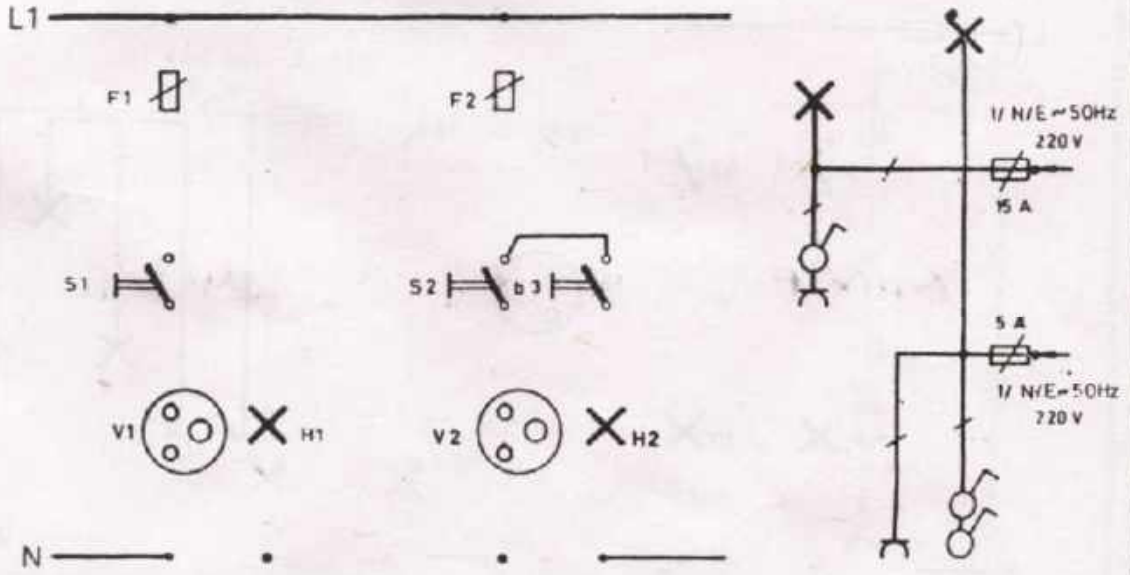
EP.2.1/3.5.2/
Circuits II

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

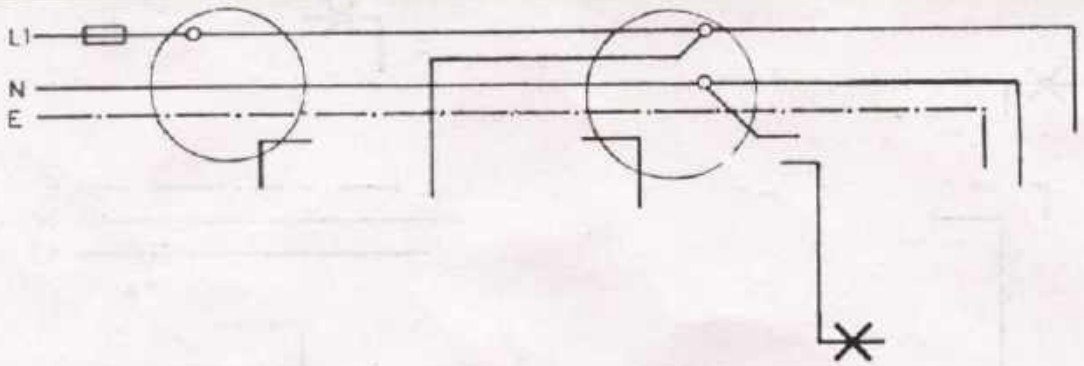
ELECTRICIAN
GENERAL

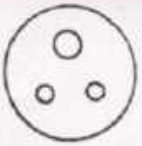




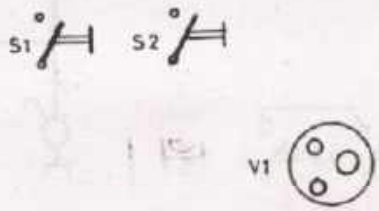
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

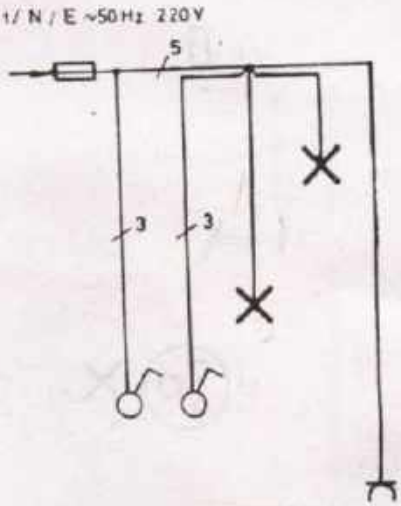
	TWO DIFFERENT CIRCUITS-INSTALLATION	EP.2.3/3.5.2/1 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL





REMEMBER, ACCORDING TO YOUR PRACTICAL EXERCISE YOU MUST HAVE ONE WIRE SPARE FROM EACH SWITCH TO THE SECOND JUNCTION BOX





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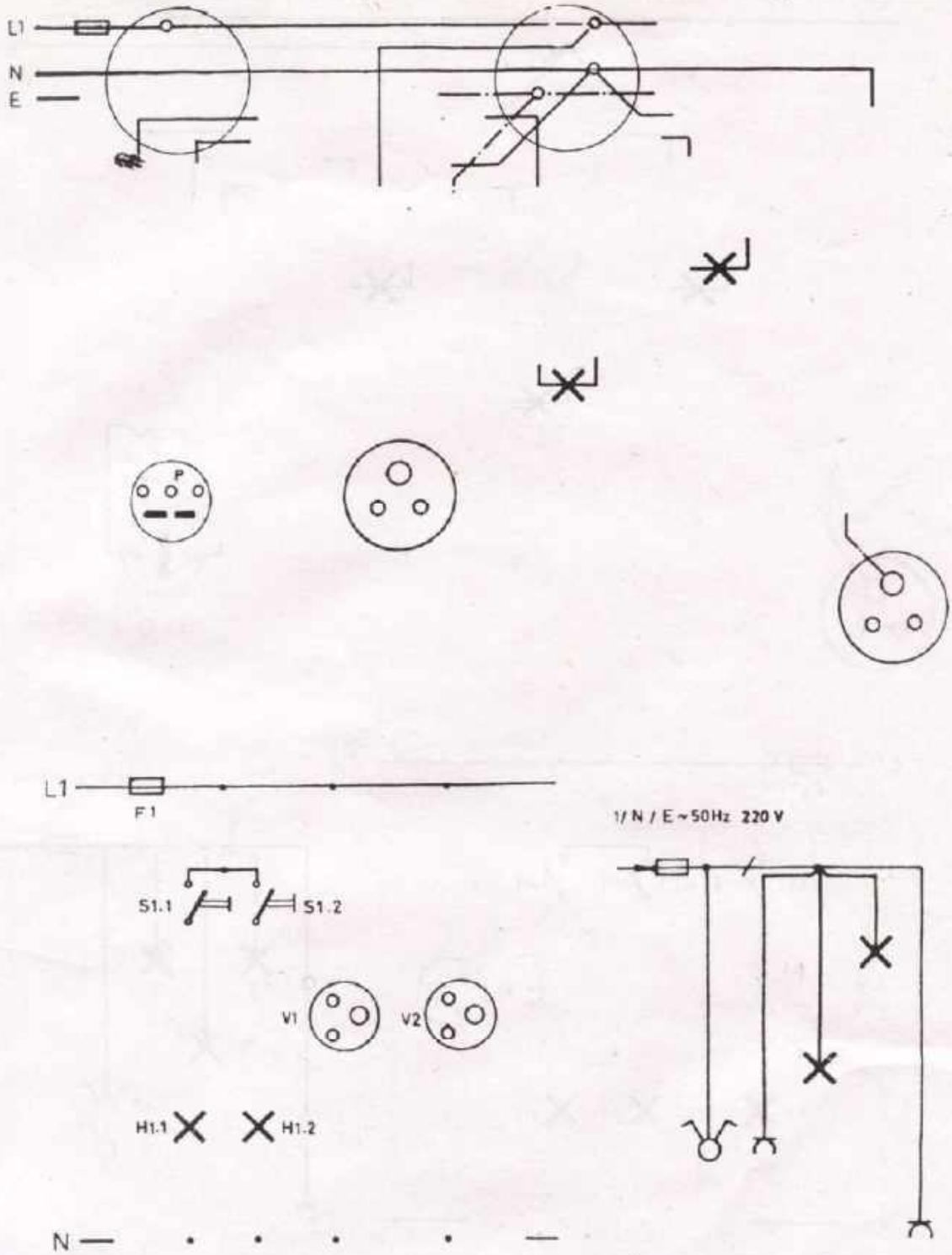
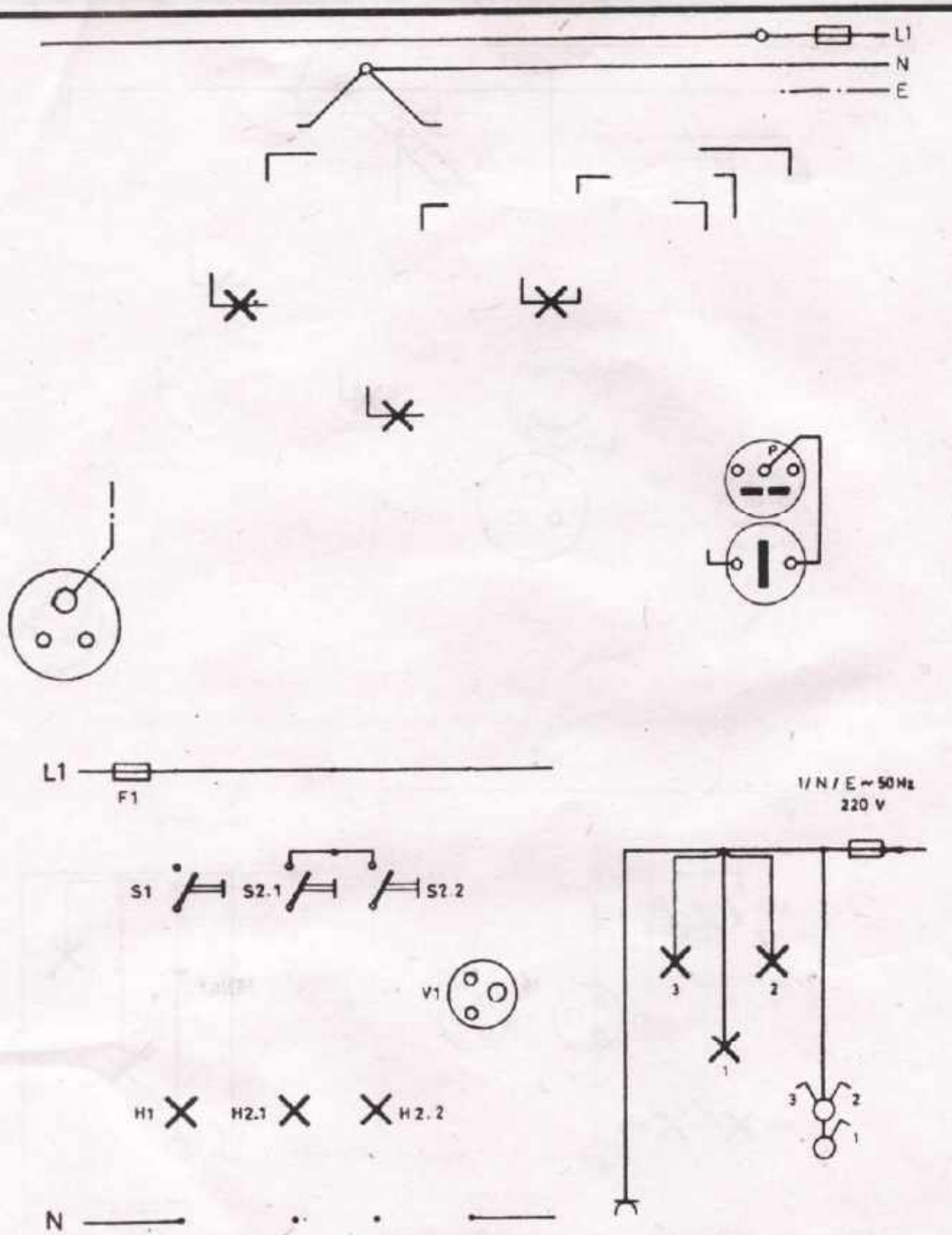
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

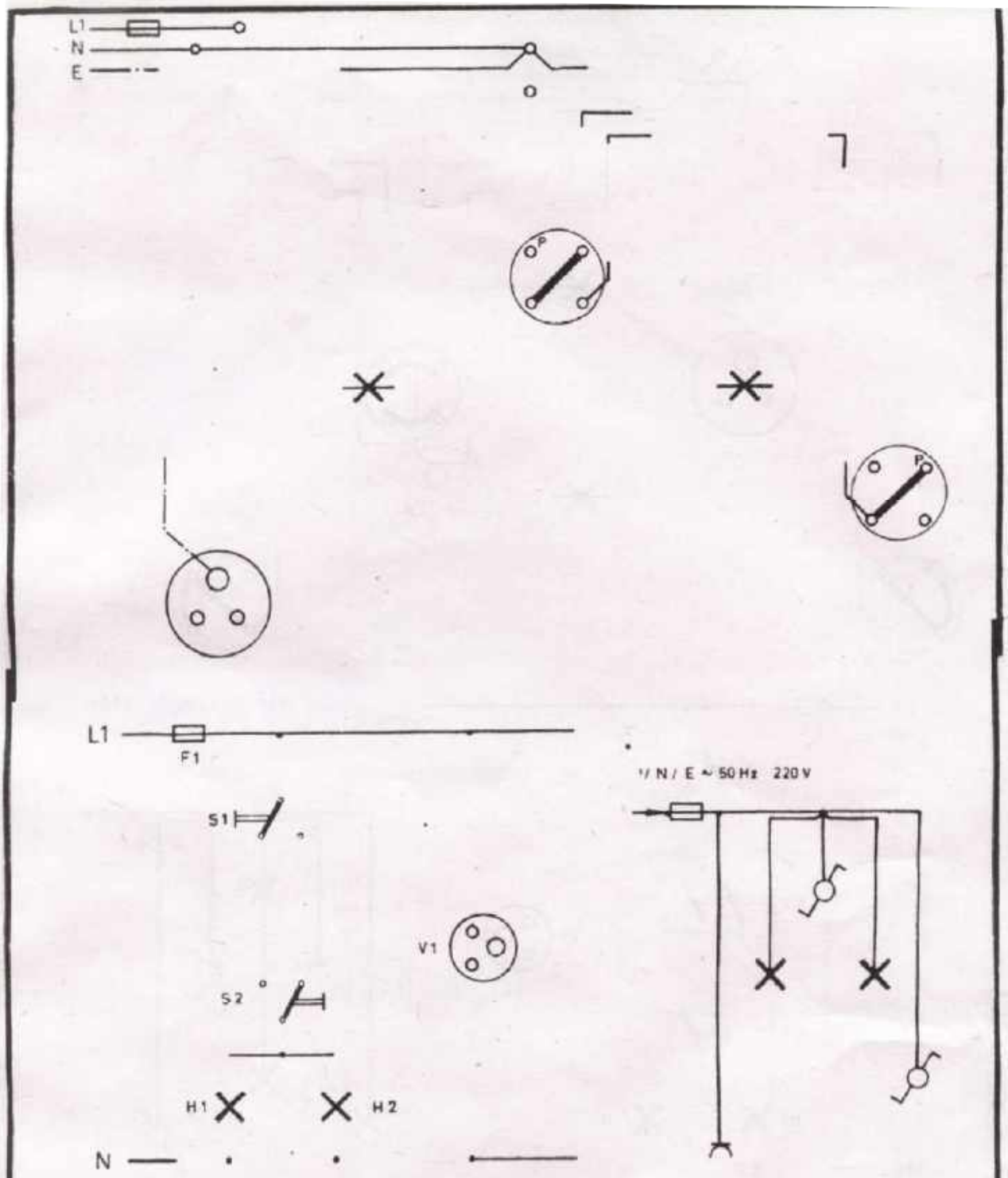


ff	KITCHEN INSTALLATION	EP.2.3/3.5.2/3 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



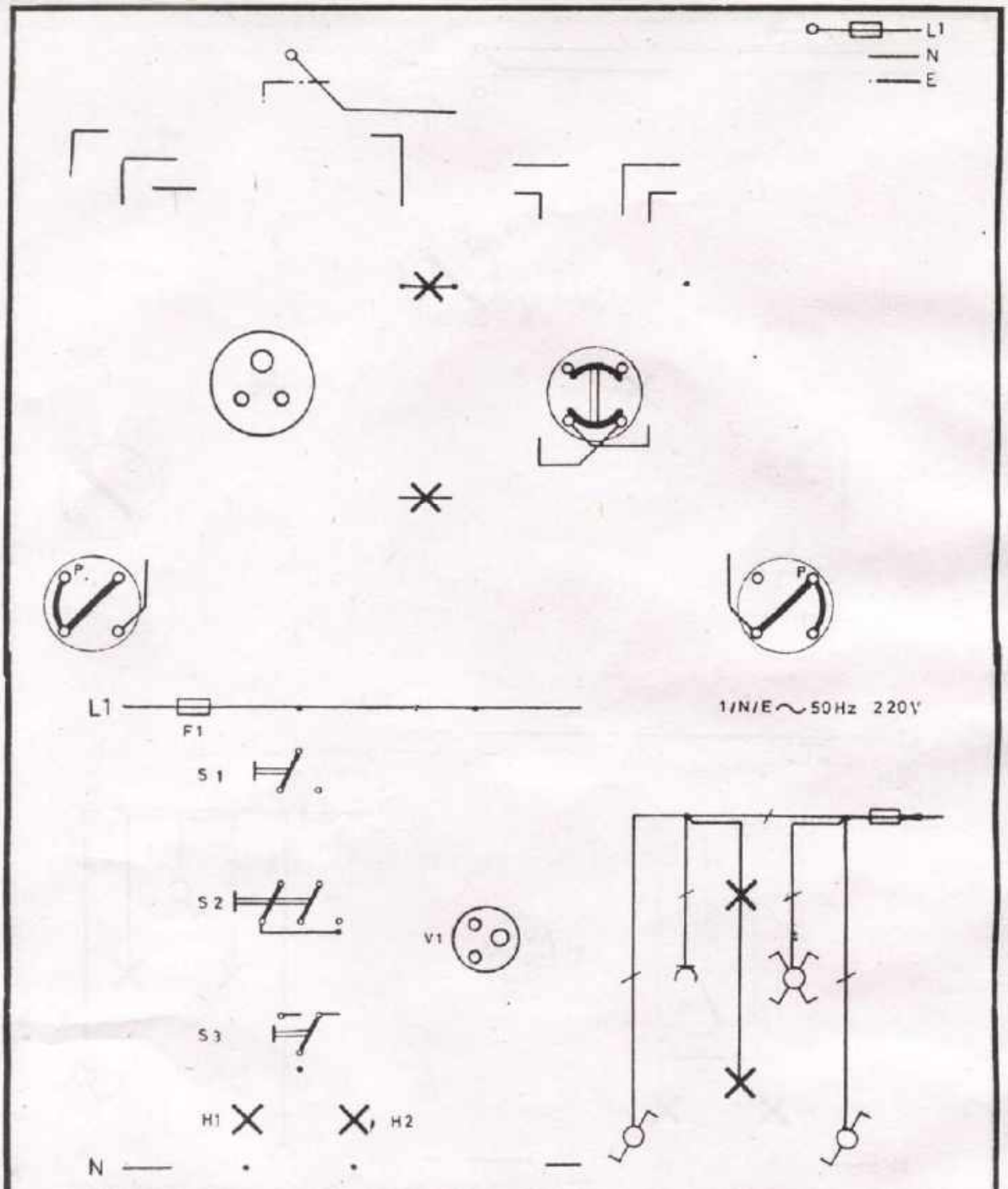
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

	DRAWING-LIVING ROOM INSTALLATION	EP. 2.3/3.5.2/4 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



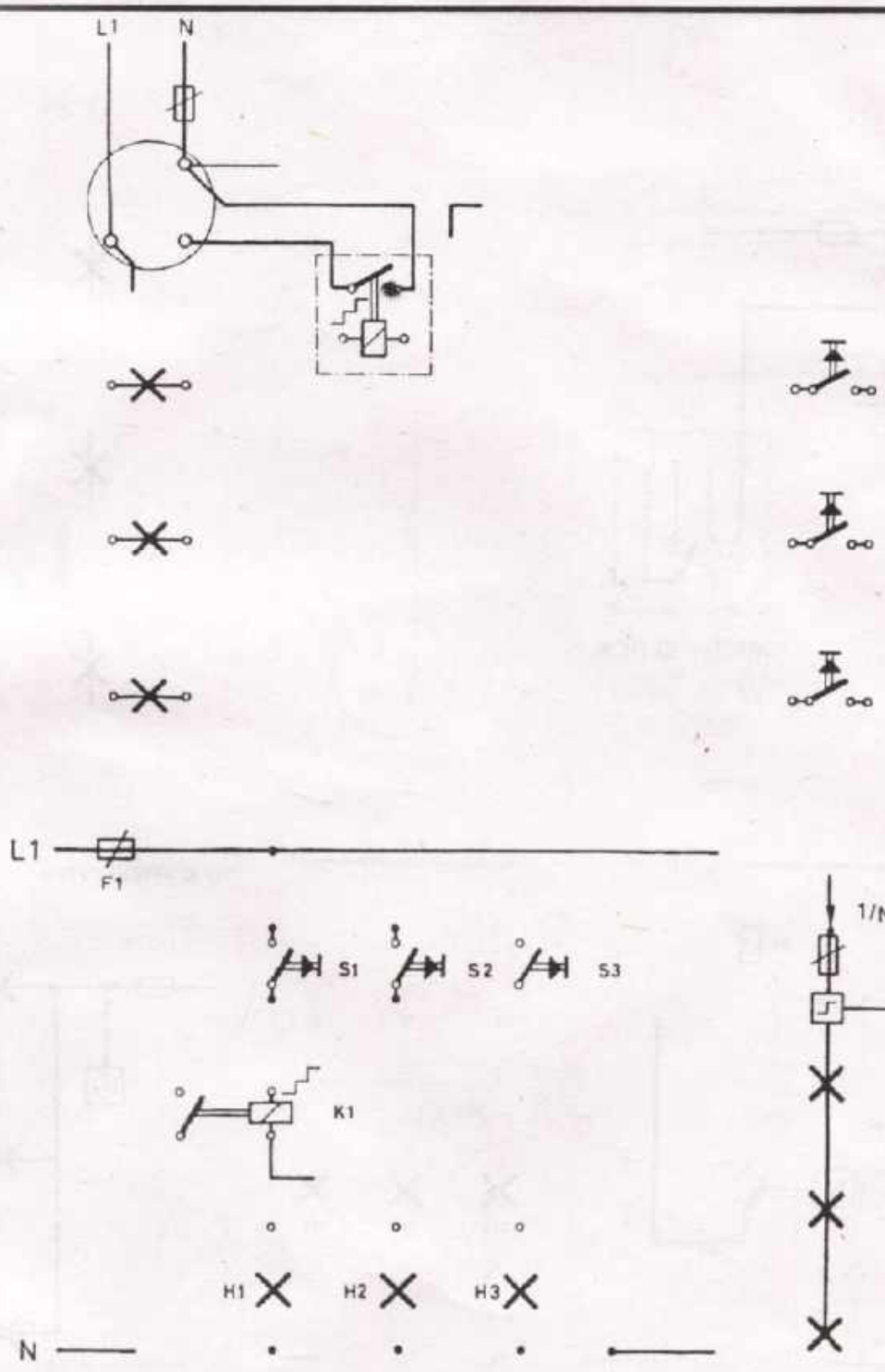
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

	SLEEPING ROOM INSTALLATION	EP.2.3/3.5.2/5 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



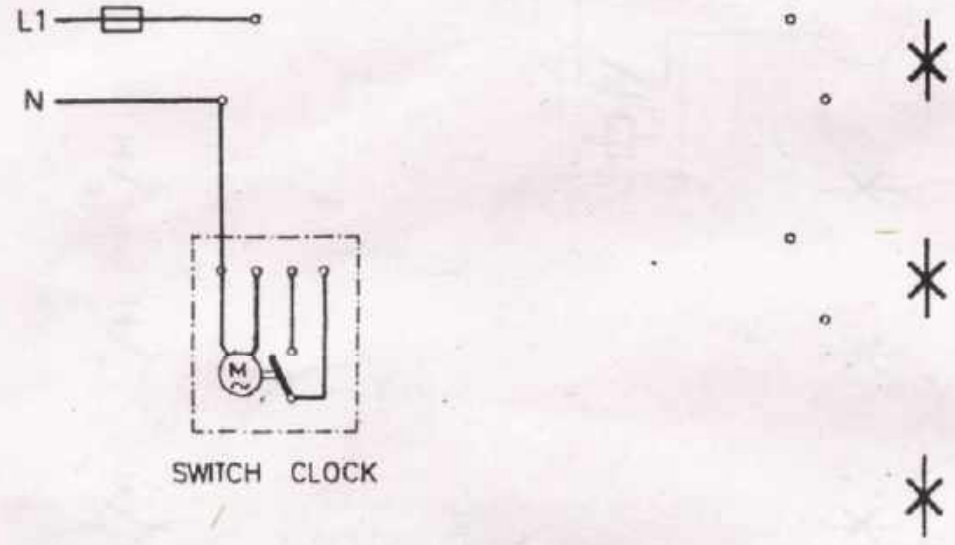
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES
If intermediate switch is not available then perform practical exercise of Drg.No. EP/2.3/3.5.2/17

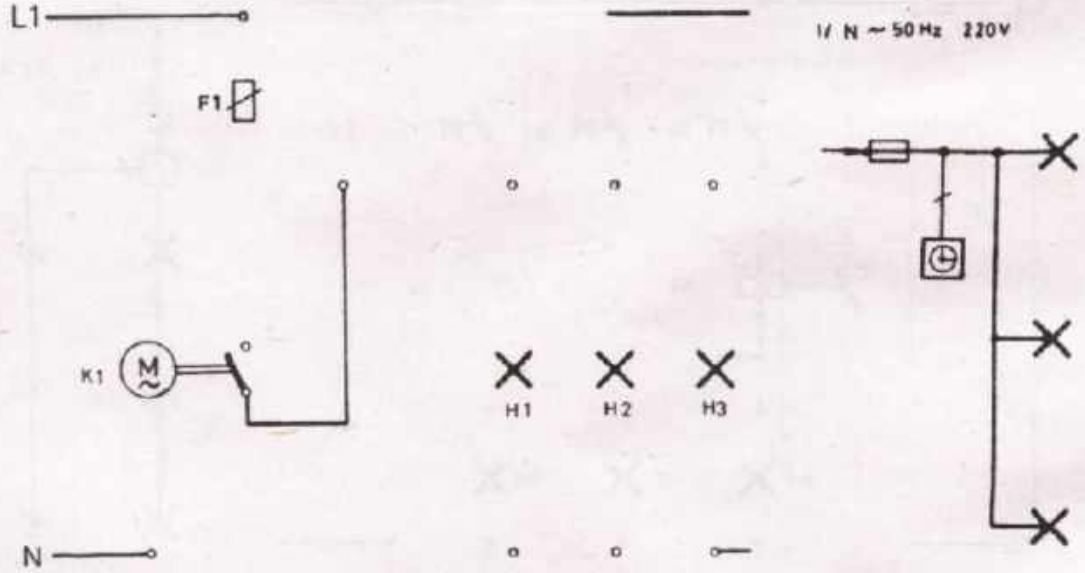
	HALL INSTALLATION	EP.2.3/3.5.2/6 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES
If impulse switch is not available then perform practical exercise of Drg.No. EP/2.3/3.5.2/18

1	IMPULSE SWITCH INSTALLATION	EP. 2. 3/3. 5. 2/7 Circuits II

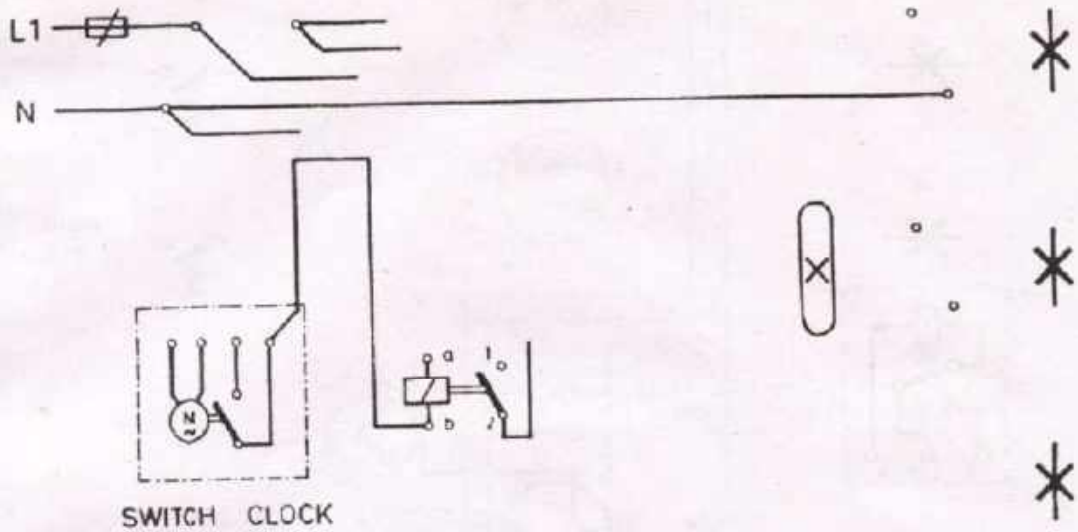


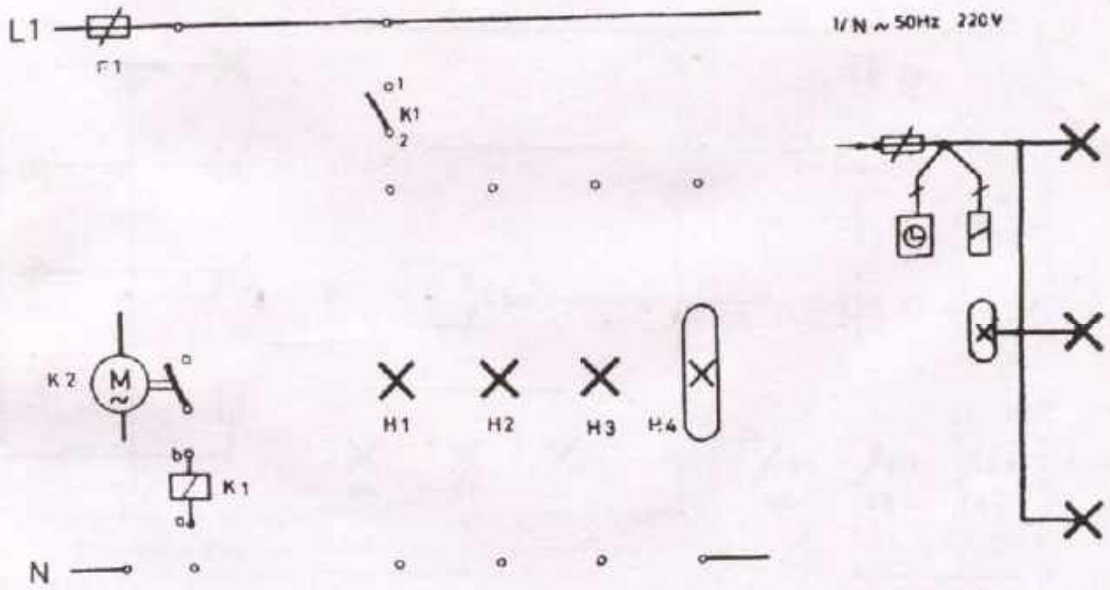


COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

	TIMING SWITCH INSTALLATION (SWITCH CLOCK)	EP.2.3/3.5.2/12 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL

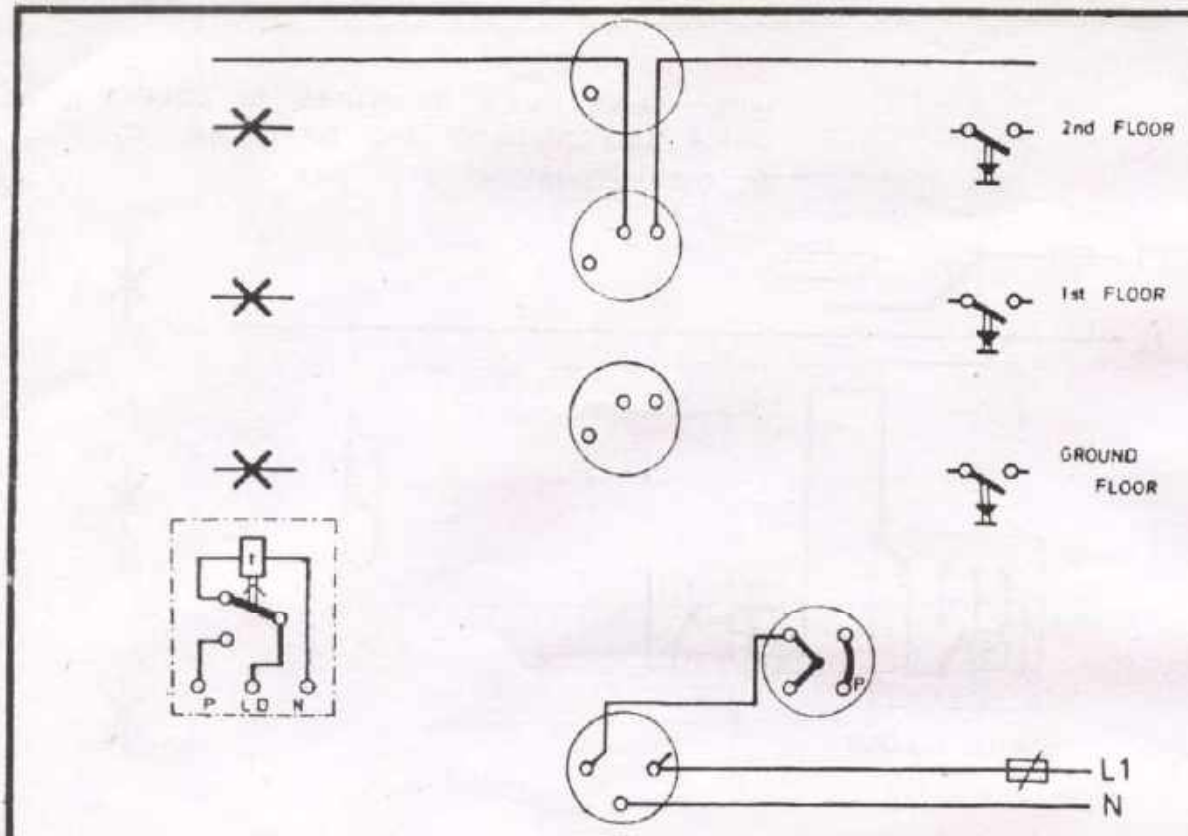
NOTE: VARIOUS OTHER POSSIBILITIES TO CONNECT SWITCH CLOCK, CONTACTOR AND SUPPLY ARE TO BE DISCUSSED IN THE SHOP TALK !

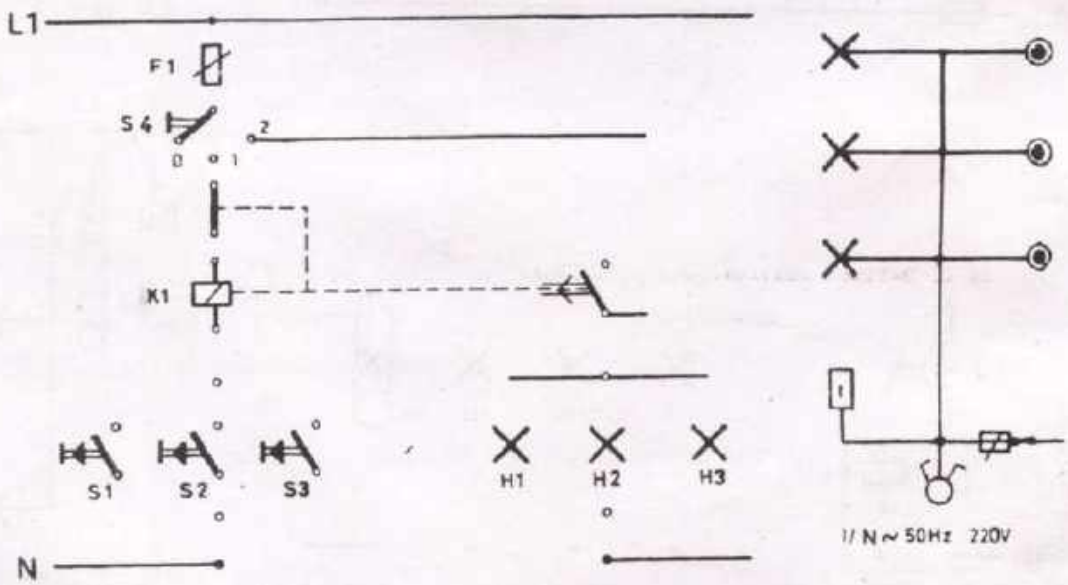




COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

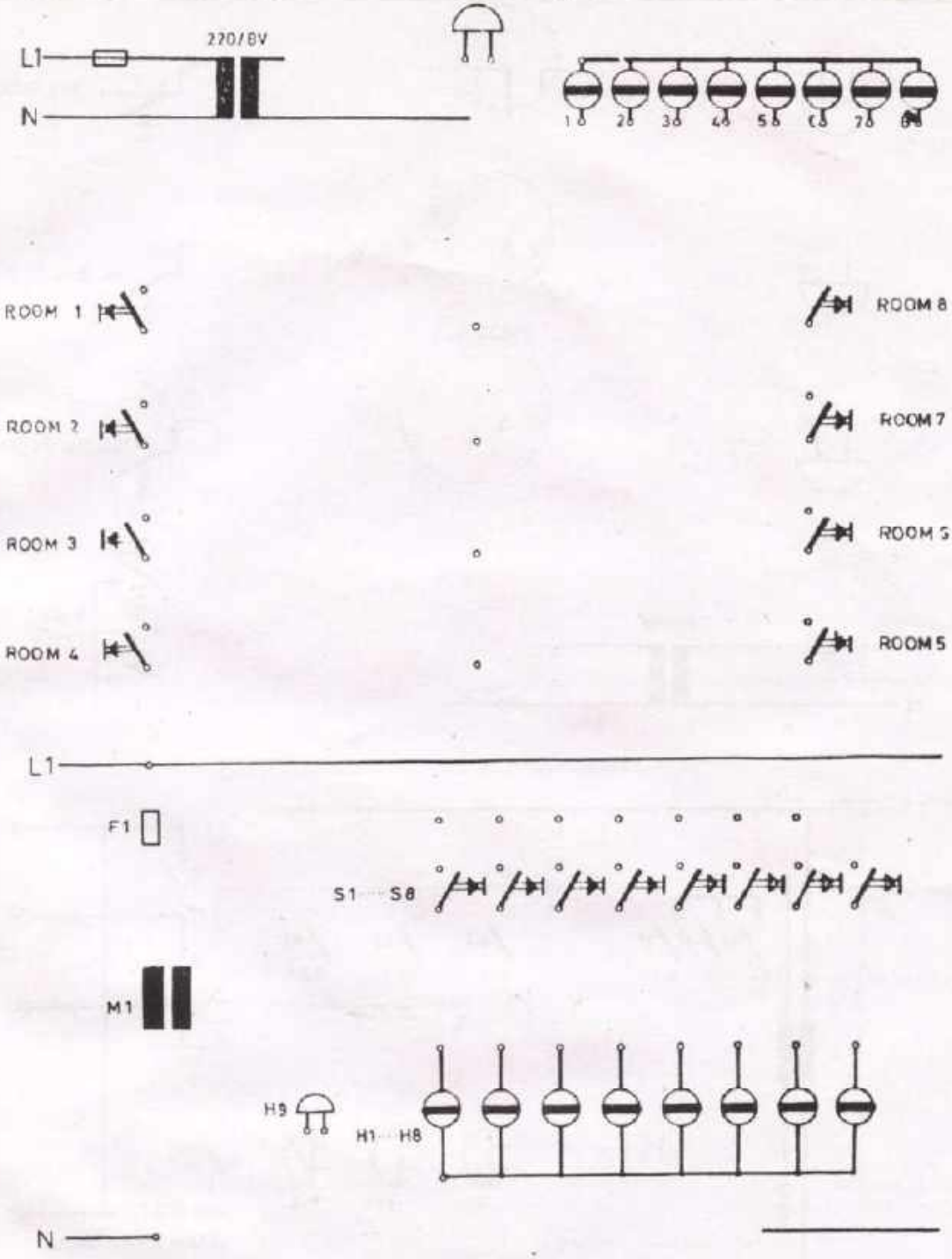
	TIMING SWITCH INSTALLATION (SWITCH CLOCK) EXTENTION	EP.2.3/3.5.2/13 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL





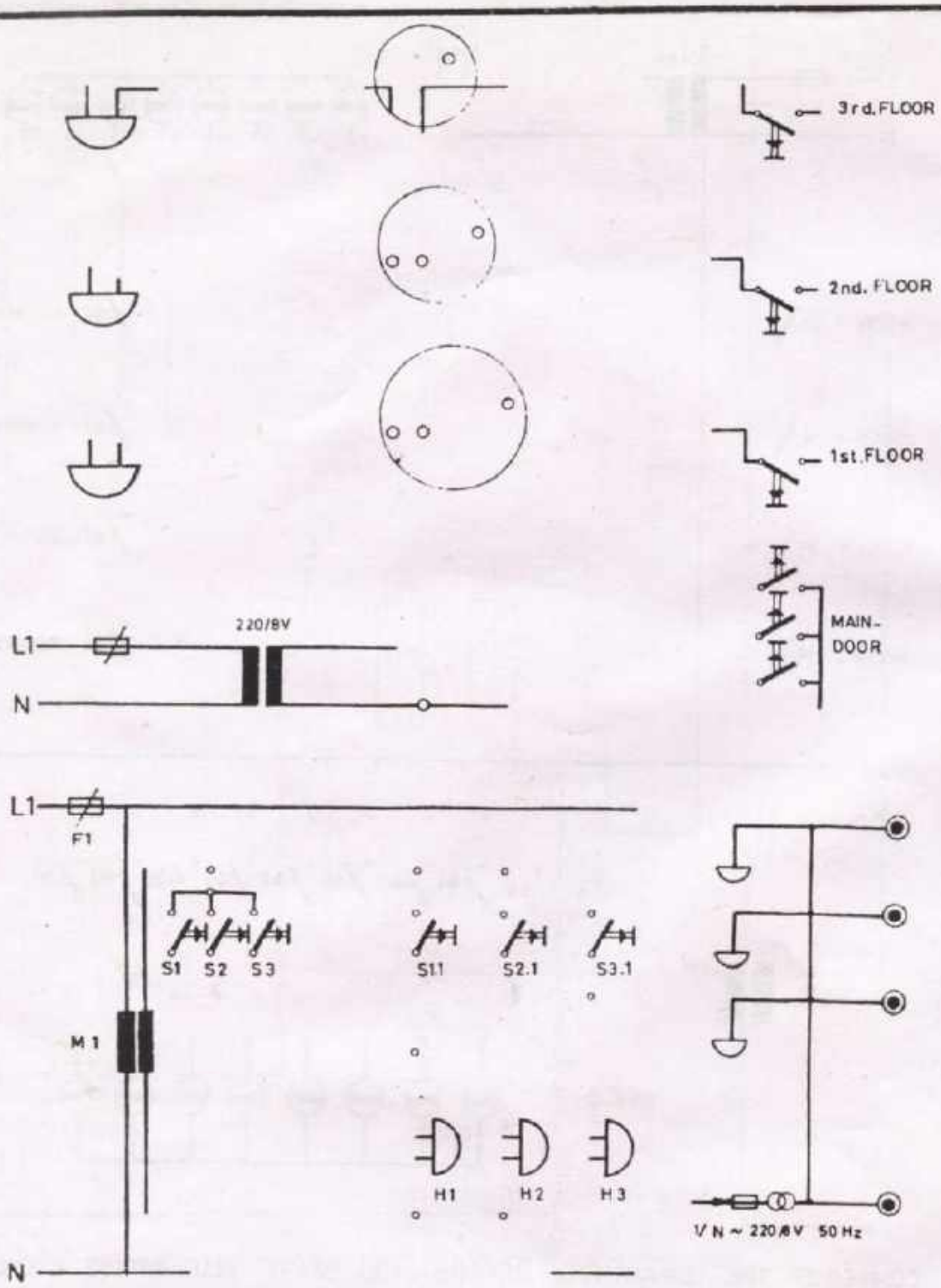
COMPLETE THE DRAWING BEFORE YOU START PLUG-WIRING EXERCISES

	EXTENDED TIME SWITCH, STAIRCASE INSTALLATION	EP 2.3/3.52/10 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



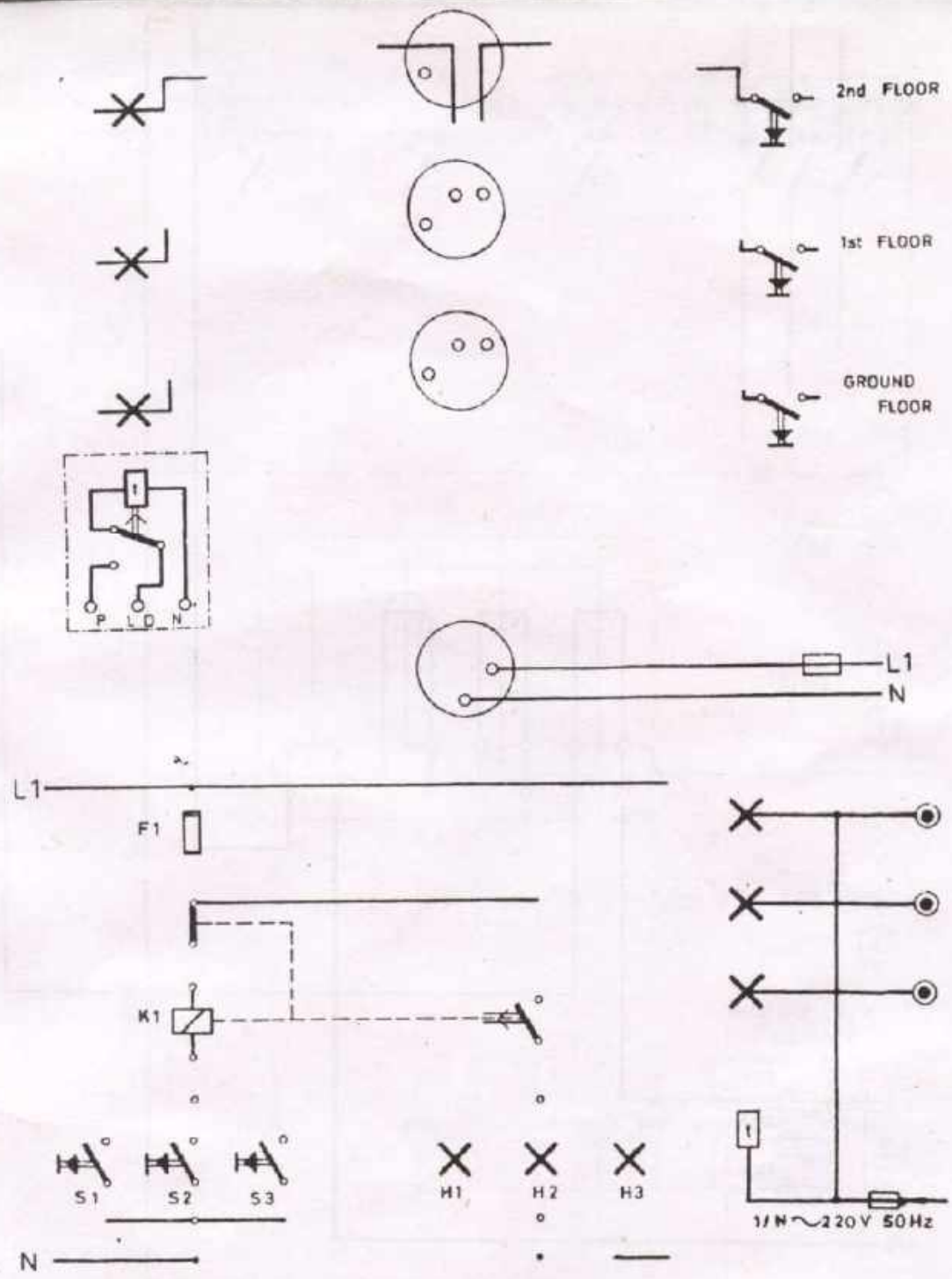
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES
DRAW INSTALLATION-LAYOUT OF ABOVE SHOWN WIRING DIAGRAM
If 8V bell indicator is not available then perform this exercise without Transformer at 220V.

	INDICATOR BELL INSTALLATION	EP 2.3/3.5.2/11 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



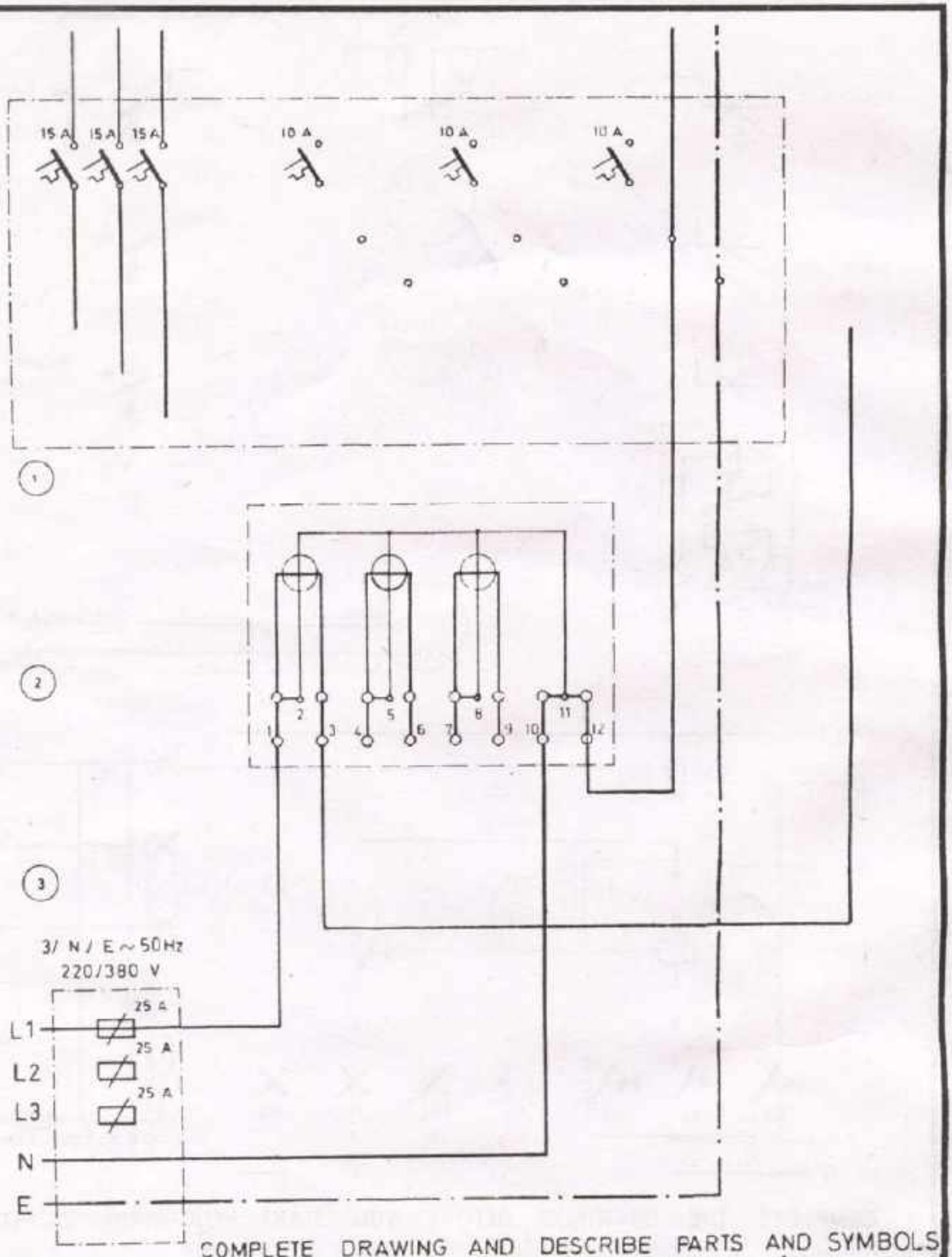
COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING ' EXERCISES
If 8V bell is not available then perform this exercise without Transformer at 220V.

	TREMBLER BELL INSTALLATION	EP.2. 3/3.5.2/8 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



COMPLETE THE DRAWINGS BEFORE YOU START PLUG-WIRING EXERCISES

	TIME SWITCH, STAIRCASE INSTALLATION	EP. 2.3/3.5.2/9 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



COMPLETE DRAWING AND DESCRIBE PARTS AND SYMBOLS

ENERGY METER DISTRIBUTION

EP.2.3/3.5.2/14

Circuits II

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN

GENERAL

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

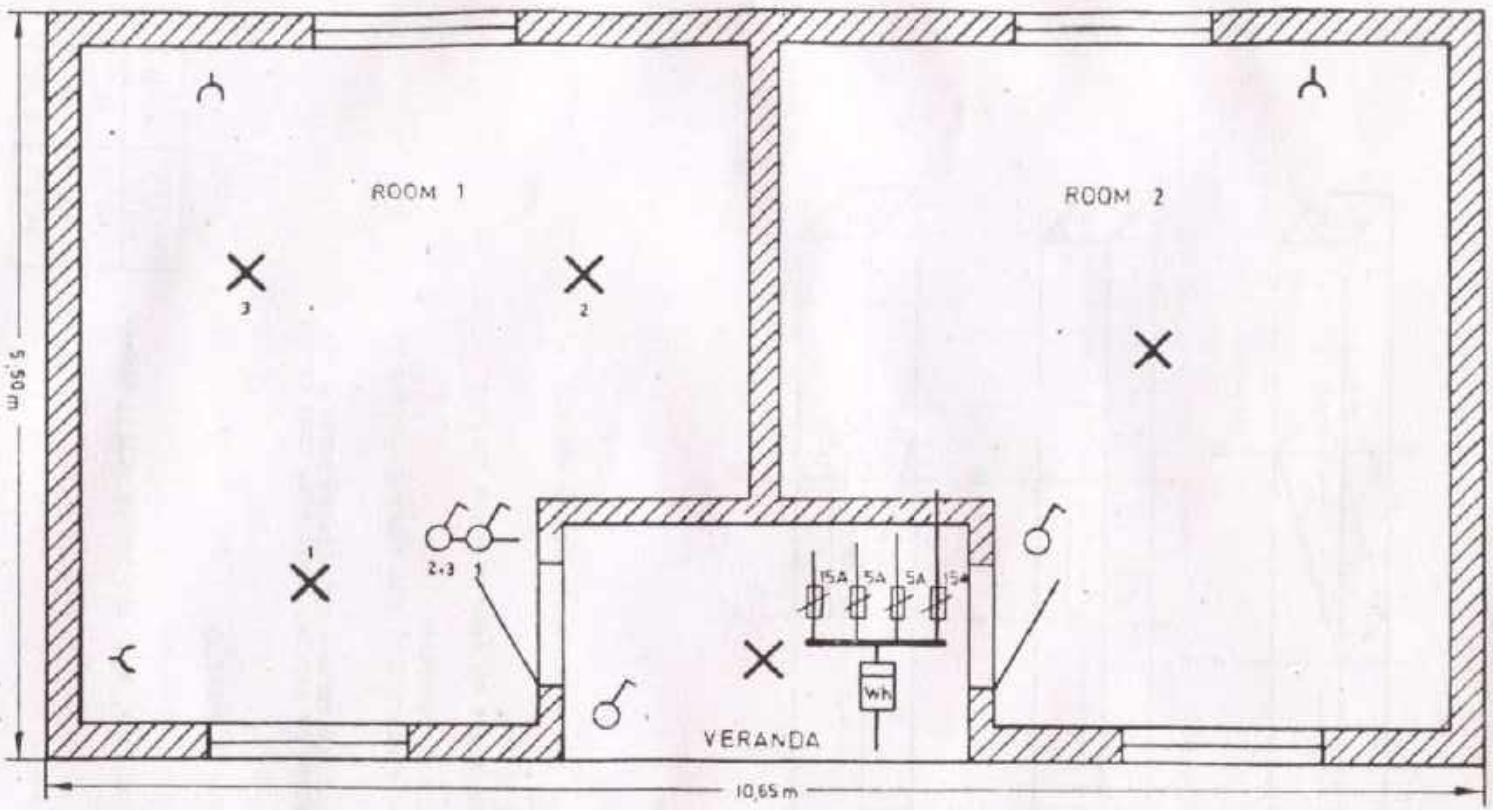
ELECTRICIAN

GENERAL

INSTALLATION LAYOUT FOR BUILDINGS

EP.2.3/3.5.2/16

Circuits II



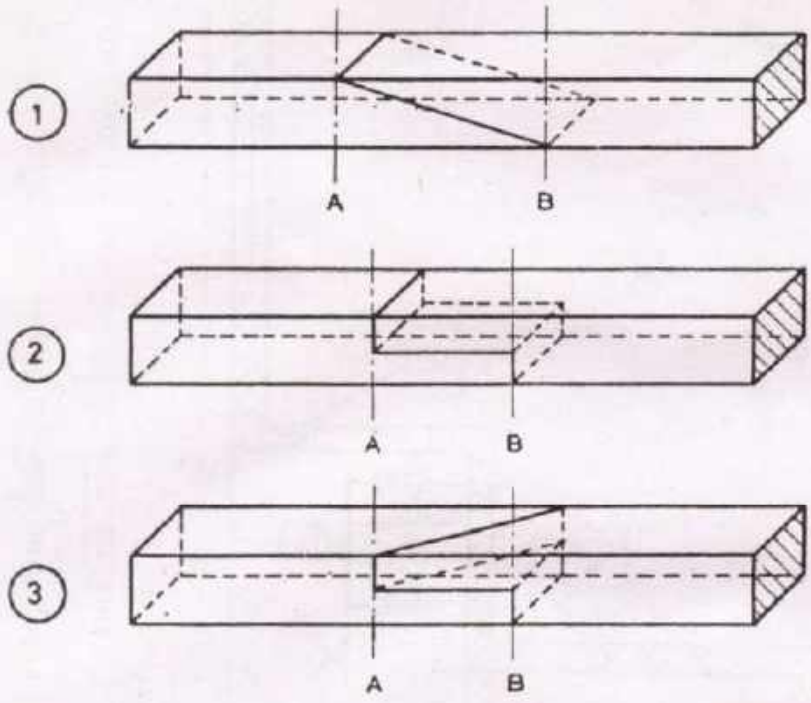
ROOM 1 : 1 CIRCUIT 15A FOR THE TWO POWER SOCKETS.
1 CIRCUIT 5A, LAMP 1 CONTROLLED BY S.P.S. 1, LAMPS 2+3 CONTROLLED BY S.P.S. 2+3 (ONE NO.)

ROOM 2 1 CIRCUIT 15A FOR THE POWER SOCKET.
1 CIRCUIT 5A ROOM AND VERANDA LAMPS, EACH LAMP CONTROLLED BY ONE S.P.S.

COMPLETE THE INSTALLATION LAYOUT FOR THE BUILDING

INDICATE THE NUMBER OF WIRES AND MENTION WHAT SIZE OF CONDUCTOR YOU WOULD USE

INSTALLATION IN CONDUIT, AMBIENT TEMPERATURE = 45° C ≙ 113° F



SEQUENCE OF OPERATION

JOINT 1

1. MARK BOTH PIECES EQUALLY AND THOROUGHLY. LENGTH BETWEEN 'A' AND 'B' ABOUT 2 INCHES.
2. SAW PROPERLY AT MARKED LINES.
3. FILE THE SAWED SURFACES SMOOTH TO MAKE THEM FIT EXACTLY TOGETHER.
4. SCREW (NAIL) THE TWO PIECES TOGETHER.
5. CHECK ALL OVER AND GIVE FINISHING TO THE JOINT ACCORDING TO DRAWING.

JOINT 2

1. MARK BOTH PIECES EQUALLY AND THOROUGHLY. LENGTH BETWEEN 'A' AND 'B' ACCORDING TO WIDTH OF BATTEN. HORIZONTAL LINE IN THE MIDDLE OF BATTEN.

STEP 2, 3, 4 AND 5 AS IN JOINT 1.

JOINT 3

SAME SEQUENCE OF OPERATIONS AS JOINT 2.

TOOLS

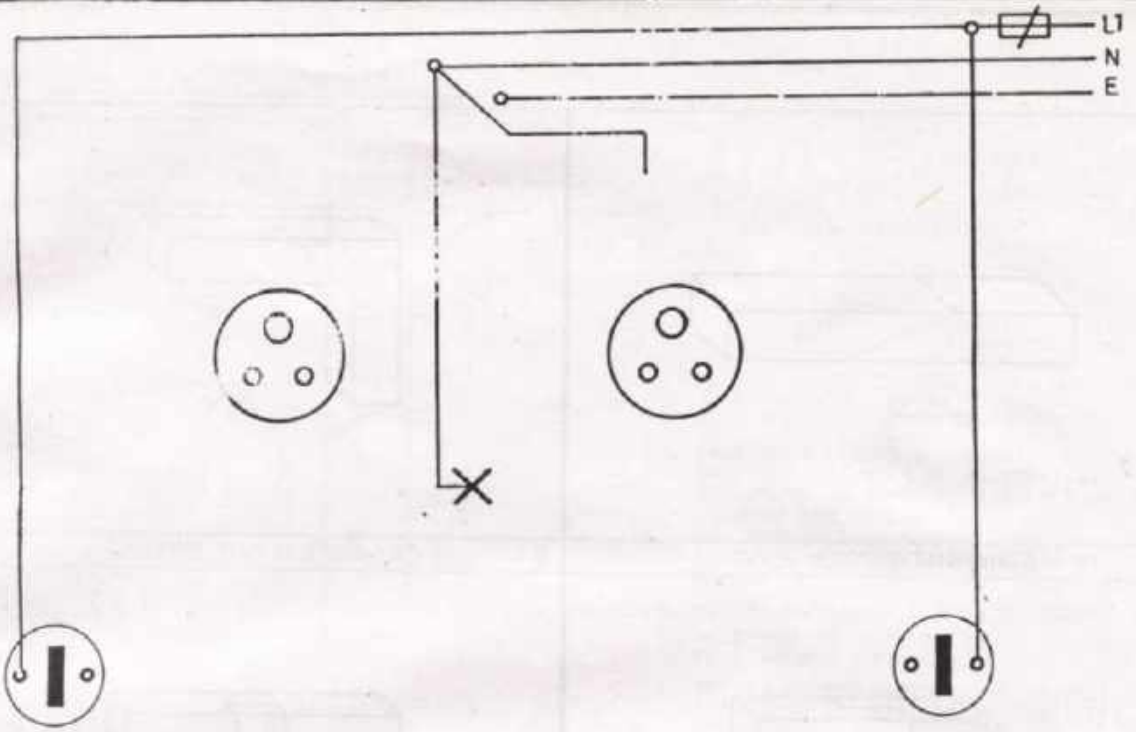
METER RULE, TRY BACK SQUARE, SAW, RASP AND SMOOTH FILES, HAMMER, BENCH HOOK, SCREW DRIVER.

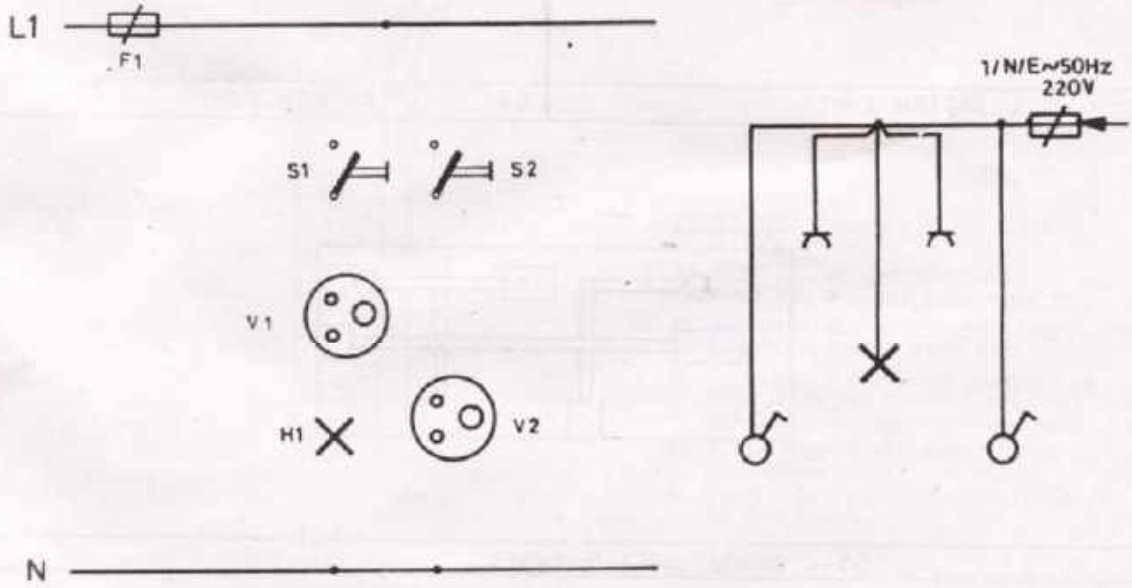
BATTEN-WIDTH	A - B
1/2"	3/4"
3/4"	1"
1"- 2"	1 1/2"

INLINE OR STRAIGHT-BATTEN JOINTS

EP-2-3/3-5-3/1

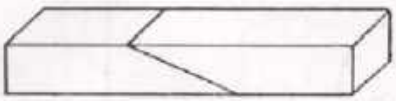
Wood Work



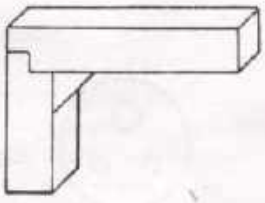


COMPLETE THE DRAWING BEFORE YOU START PLUG-WIRING EXERCISES.

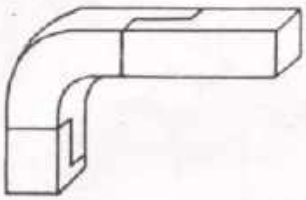
	TEST BOARD	EP.2.3/3.5.2/18 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



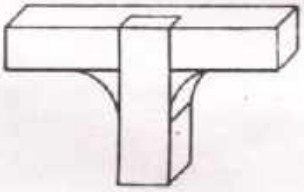
01 STRAIGHT BATTEN JOINT



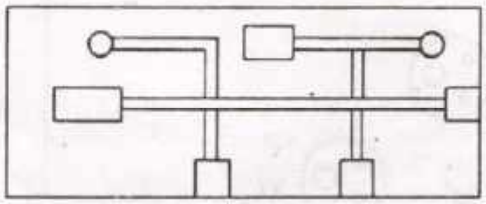
03 CEILING BATTEN JOINT



02 L-BATTEN JOINT



04 T-BATTEN JOINT



05 VARIOUS BATTEN JOINTS

LAYOUT

EP-2.1/3-5.3/
Wood wcrk

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN
GENERAL

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

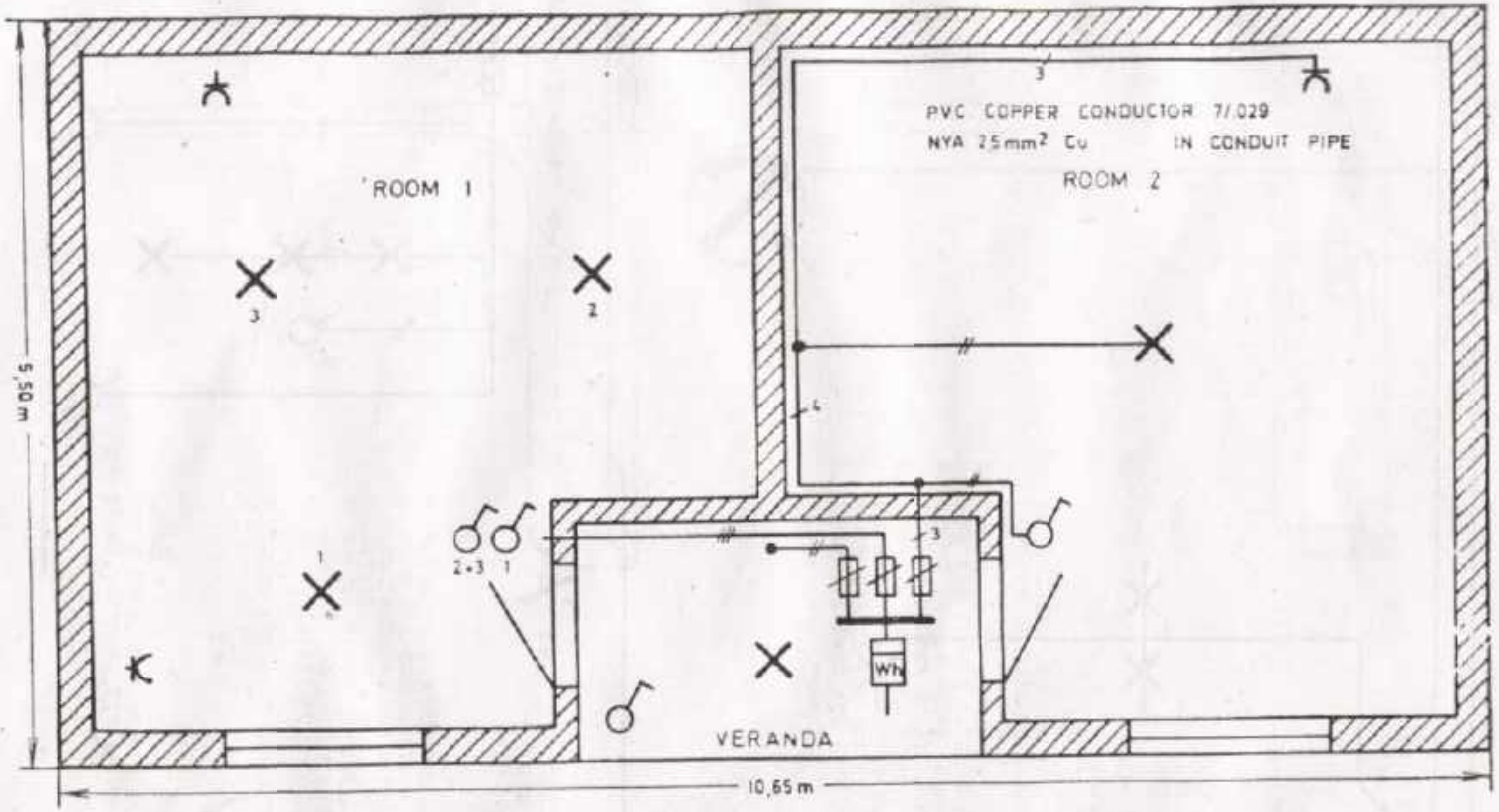
ELECTRICIAN

GENERAL

INSTALLATION-LAYOUT FOR BUILDINGS

EP.2.3/3.52/15

Circuits II



1 CIRCUIT 15 A FOR ROOM 1

LAMP 1 CONTROLLED BY S.P.S. 1
LAMPS 2+3 CONTROLLED BY S.P.S. 2+3

1 CIRCUIT 10 A FOR ROOM 2

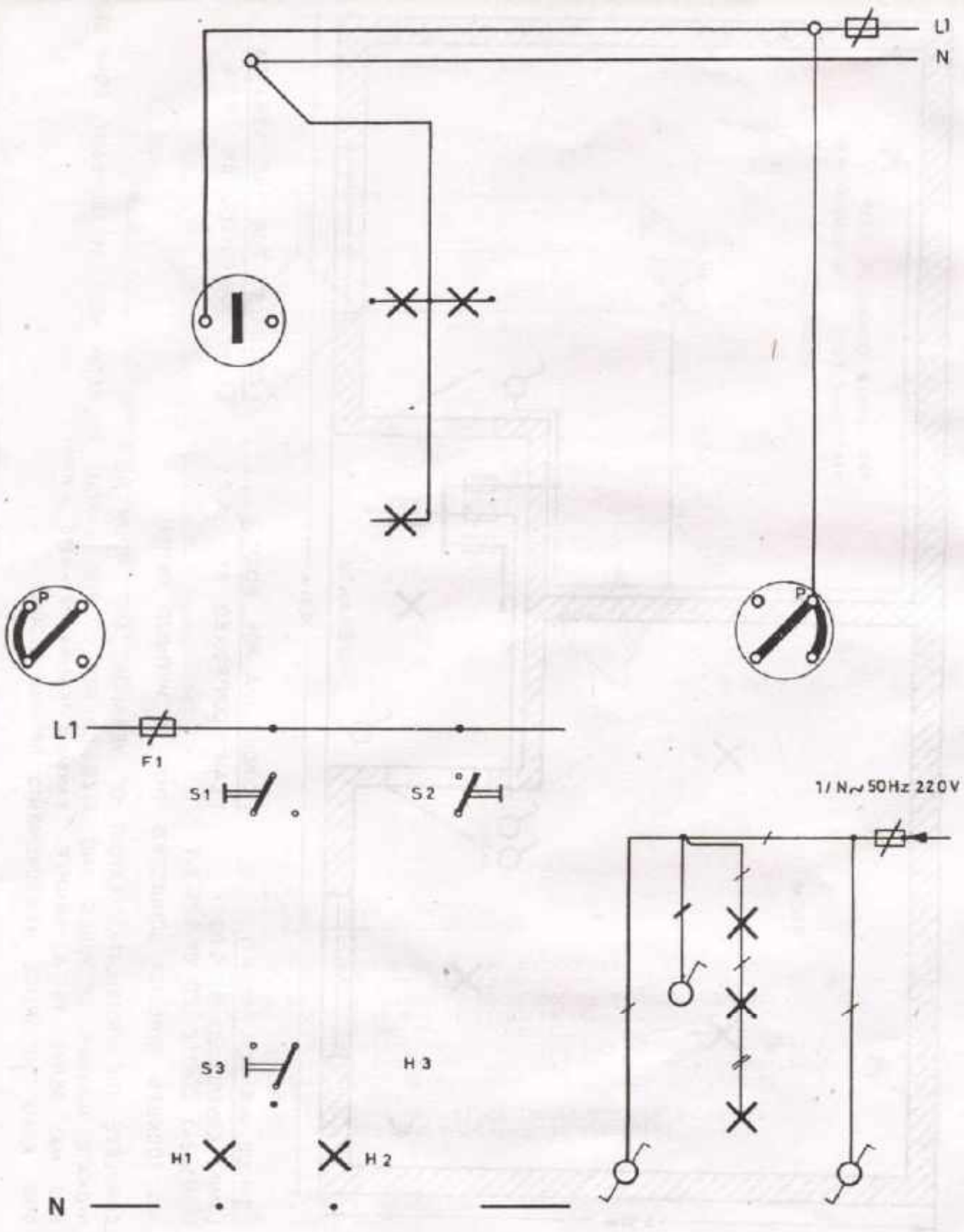
1 LAMP CONTROLLED BY 1 S.P.S.

1 CIRCUIT 5 A FOR THE VERANDA

1 LAMP CONTROLLED BY 1 S.P.S.

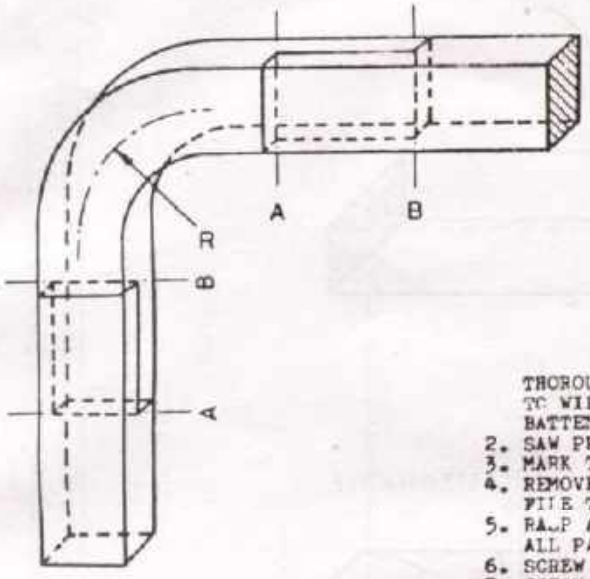
ALL SOCKETS DIRECTLY CONNECTED THAT IS WITHOUT SWITCH

COMPLETE THE INSTALLATION-LAYOUT OF VERANDA AND ROOM NO. 1
INDICATE NUMBER OF WIRES AND SIZE OF WIRES. THE LAYOUT OF ROOM NO. 2 IS ALREADY COMPLETE AND MAY SERVE AS A SAMPLE. (AMBIENT TEMPERATURE = 45°C ≙ 113°F)
GIVE ALSO THE INSIDE MEASUREMENTS OF THE ROOMS.



COMPLETE THE DRAWING BEFORE YOU START PLUG-WIRING EXERCISES

	TWO WAY AND S.P. SWITCH CIRCUIT	EP.2.3/3.5.2/17 Circuits II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



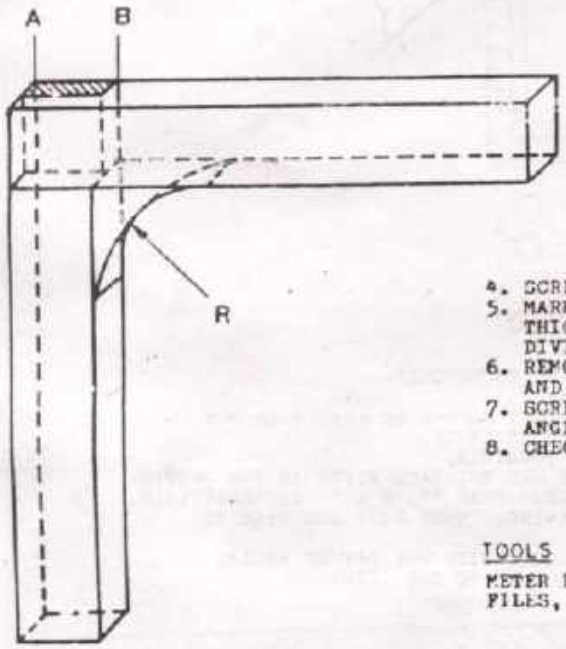
THE "L" JOINT IS A THREE PIECE JOINT IN WHICH TWO PIECES ARE EQUAL.

SEQUENCE OF OPERATION

JOINT 1

1. MARK BOTH EQUAL PIECES THOROUGHLY. LENGTH BETWEEN A AND B IS ACCORDING TO WIDTH OF BATTEN. MIDDLE LINE ALWAYS IN CENTRE OF BATTEN.
2. SAW PROPERLY AT MARKED LINES.
3. MARK THE CORNER PIECE WITH THE HELP OF A DIVIDER.
4. REMOVE EXCESS MATERIAL BY SAWING. THEN RASP AND FILE TO PROPER SHAPE OF BEND.
5. RASP AND FILE THE JOINING SURFACES SMOOTH SO ALL PARTS FIT TOGETHER EXACTLY IN AN 90° ANGLE.
6. SCREW (NAIL) THE THREE PIECES TOGETHER.
7. CHECK ALL OVER AND GIVE FINISHING TO THE JOINT.

R = not less than 2".



JOINT 2

STEP ONE AND TWO AS ABOVE.

3. RASP AND FILE THE SAWED SURFACES SMOOTH TO MAKE THEM FIT TOGETHER EXACTLY IN AN ANGLE OF 90°
4. SCREW (NAIL) THE TWO PIECES TOGETHER.
5. MARK THE CORNER PIECE, WHICH HAS THE SAME THICKNESS AS THE BATTENS, BY THE HELP OF A DIVIDER. R - NOT LESS THAN 1".
6. REMOVE EXCESS MATERIAL BY SAWING. THEN RASP AND FILE TO PROPER SHAPE OF BEND.
7. SCREW (NAIL) THIS CORNER PIECE INSIDE THE BATTEN ANGLE.
8. CHECK ALL OVER AND GIVE FINISHING TO THE JOINT.

TOOLS

METER RULE, TRY BACK SQUARE, SAW, RASP AND SMOOTH FILES, HAMMER, BENCH HOOK, SCREW DRIVER, DIVIDER.

"L" BATTEN JOINTS

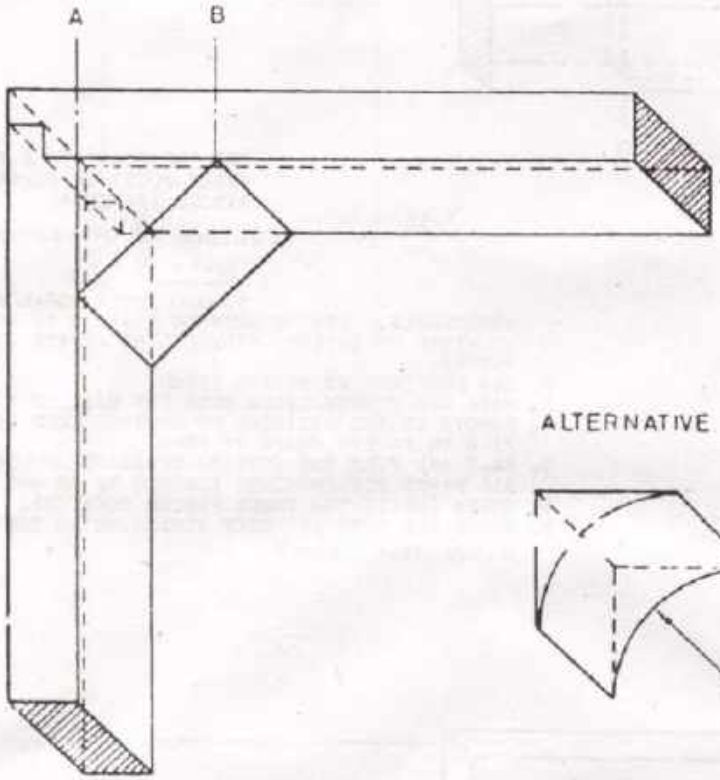
EP.2.3/3.5.3/2

Wood Work

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

INDO GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL



SEQUENCE OF OPERATION

1. MARK THE TWO BATTENS EQUAL AND THOROUGHLY.
2. SAW PROPERLY AT MARKED LINES.
3. RASP AND FILE THE SAWED SURFACES SMOOTH TO MAKE THEM FIT TOGETHER EXACTLY IN THE REQUIRED ANGLE.
4. SCREW (NAIL) THE TWO PIECES TOGETHER.
5. MARK THE CORNER PIECE, WHICH HAS THE SAME WIDTH AS THE BATTEN. LENGTH BETWEEN A AND B NOT LESS THAN 1", R = 1" ALTERNATIVELY.
6. REMOVE EXCESS MATERIAL BY SAWING. THEN RASP AND FILE TO PROPER SHAPE OF BEND.
7. SCREW (NAIL) THIS CORNER PIECE INSIDE THE BATTEN ANGLE.
8. CHECK ALL OVER AND GIVE FINISHING TO THE JOINT.

TOOLS

METER RULE, TRY BACK SQUARE, SAW, RASP AND SMOOTH FILES, HAMMER, BENCH HOOK, SCREW DRIVER.

CEILING OR CORNER BATTEN JOINT

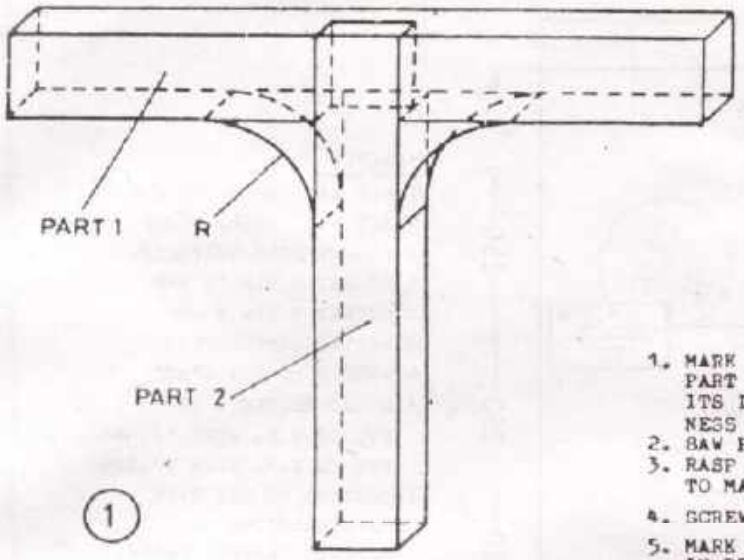
EP.2.3/3.5.3/3

Wood Work

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL

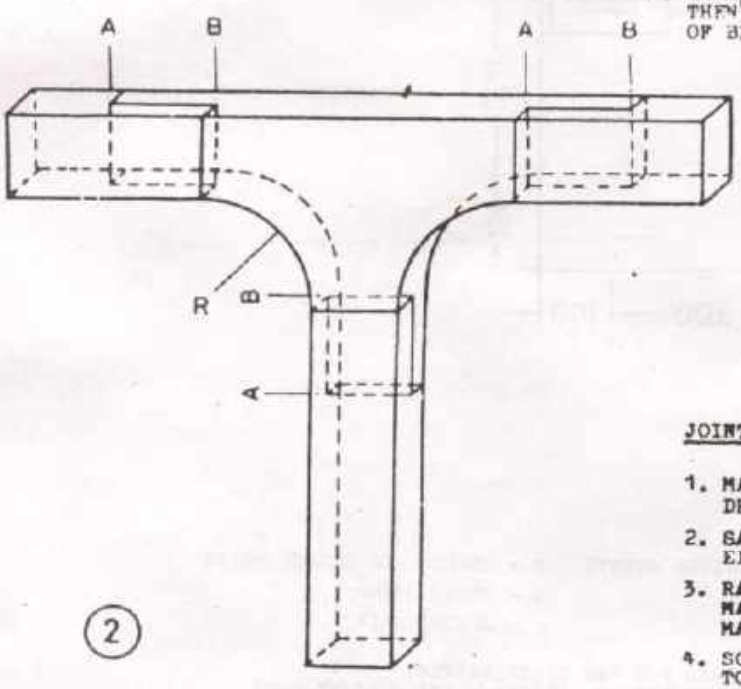


(1)

SEQUENCE OF OPERATION

JOINT 1

1. MARK BOTH PIECES THOROUGHLY. SLOT OF PART 1 IS AS WIDE AS BATTEN PART 2 AND ITS DEPTH IS EQUAL TO HALF THE THICKNESS OF THE BATTEN.
2. SAW PROPERLY AT MARKED LINES.
3. RASP AND FILE THE SAWED SURFACES TO MAKE THEM FIT EXACTLY TOGETHER.
4. SCREW (NAIL) THE PIECES TOGETHER.
5. MARK THE TWO CORNER PIECES AS YOU DID IN PREVIOUS EXERCISES.
6. REMOVE EXCESS MATERIAL BY SAWING. THEN RASP AND FILE TO PROPER SHAPE OF BEND.
7. SCREW (NAIL) THE TWO CORNER PIECES INSIDE THE BATTEN ANGLES.
8. CHECK ALL OVER AND GIVE FINISHING TO THE JOINT.



(2)

JOINT 2

1. MARK ALL PIECES ACCORDING TO THE DRAWING. R = NOT LESS THAN 1".
2. SAW PROPERLY AT MARKED LINES, REMOVE EXCESS MATERIAL FROM BEND.
3. RASP AND FILE SAWED SURFACES TO MAKE THEM FIT EXACTLY TOGETHER AND MAKE PROPER SHAPE OF THE BEND.
4. SCREW (NAIL) ALL FOUR PIECES TOGETHER.
5. CHECK ALL OVER AND GIVE FINISHING TO THE JOINT.

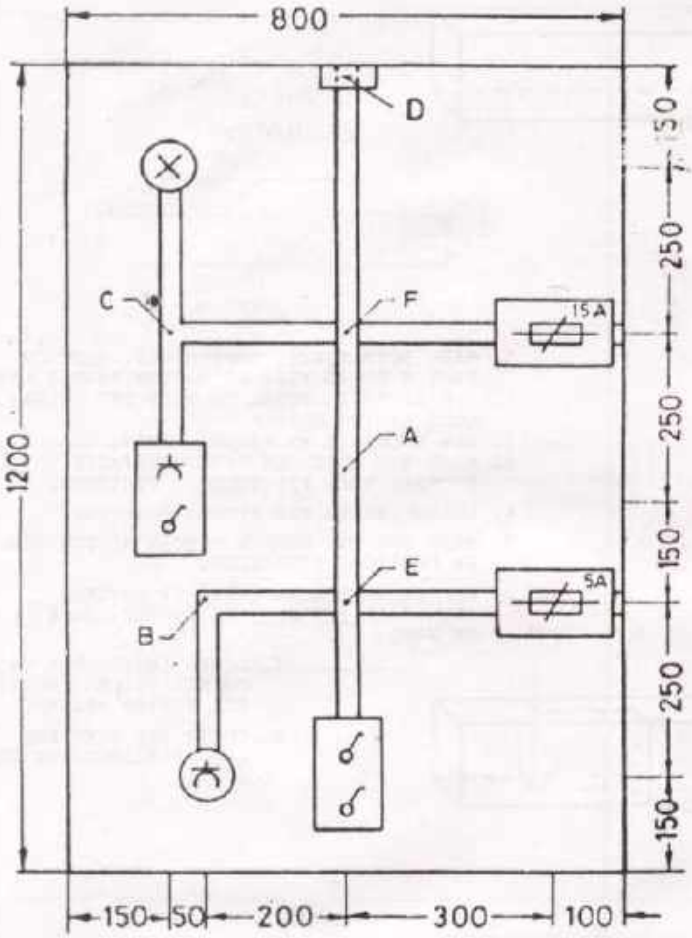
TOOLS

METER RULE, TRY BACK SQUARE, SAW, RASP AND SMOOTH FILES, HAMMER, BENCH HOOK, SCREW DRIVER.

"T" BATTEN JOINTS

EP.2.3/3.5.3/4

Wood Work



MATERIAL

1 KIT KAT (FUSE) 15 AMP.
1 KIT KAT (FUSE) 5 AMP.
3 SINGLE POLE SWITCHES.
1 SOCKET 3 PIN 15 AMP.
1 SOCKET 3 PIN 5 AMP.
2 BATTEN LAMPHOLDERS
4 WOODEN BOARDS 4"x7"
3 ROUND BLOCKS
PVC OR V.R. WIRE 1/.044
PVC OR V.R. WIRE 7/.029
ACCORDING TO THE TYPE
OF INSTALLATION
SCREWS, CLAMPS, NAILS,
BATTEN MATERIAL.

BATTEN WIRING.

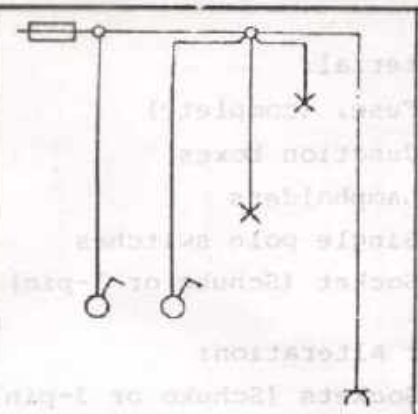
A - INLINE JOINT (STRAIGHT JOINT)
B - "L" JOINT
C - "T" JOINT
D - CEILING OR CORNER JOINT
E - CROSS JOINT
F - BRIDGE JOINT

ESTIMATE MATERIAL REQUIRED FOR THE INSTALLATION.
DRAW COMPLETE INSTALLATION LAYOUT, WIRING - AND CURRENT PATH DIAGRAMS OF ABOVE INSTALLATION OVERLEAF.
15 AMP. CIRCUIT: CONTROL-LAMP IN PARALLEL TO THE SOCKET, CONTROLLED BY A SINGLE POLE SWITCH.
5 AMP. CIRCUIT: ONE LAMP AND ONE SOCKET EACH ONE CONTROLLED BY A SINGLE POLE SWITCH.

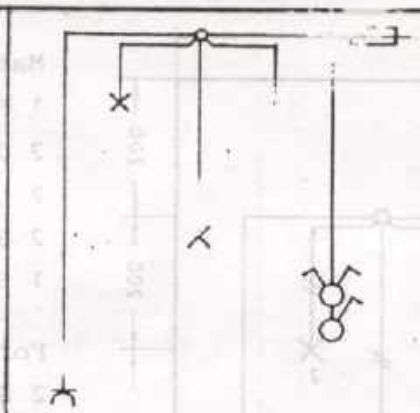
CHECK AND CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

JOINTS

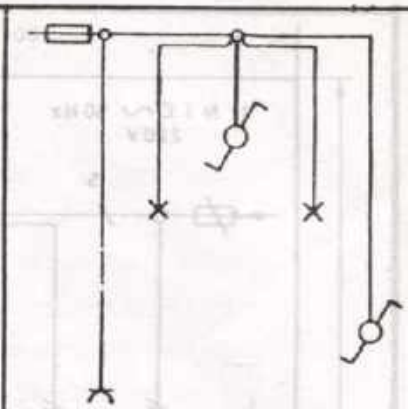
EP 2.3/3.5.3/5
Wood Work



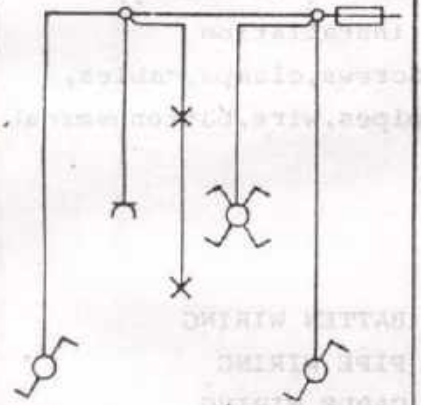
1 KITCHEN INSTALLATION



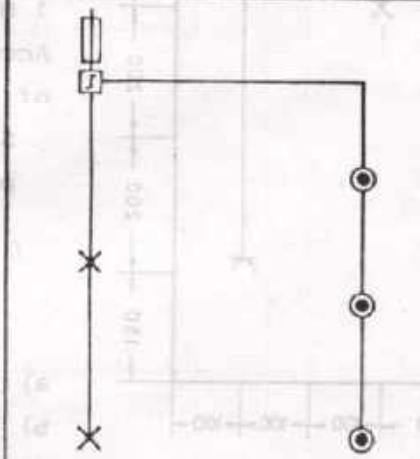
2 DRAWING ROOM INST.



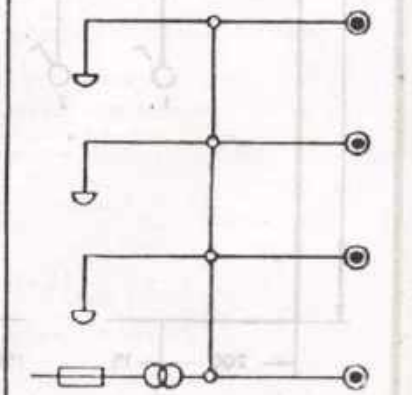
3 SLEEPING ROOM INST.



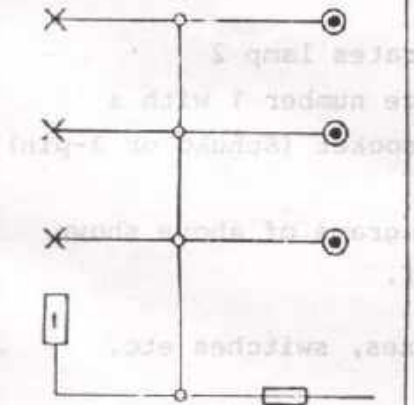
4 HALL INSTALLATION



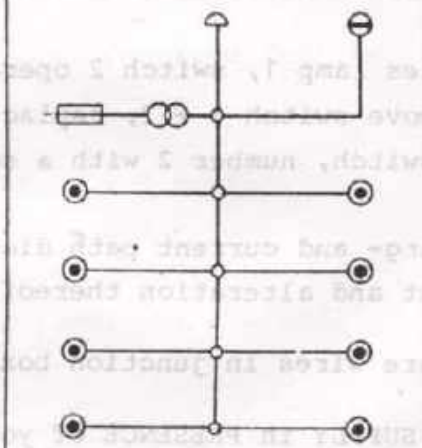
5 IMPULSE SWITCH INST.



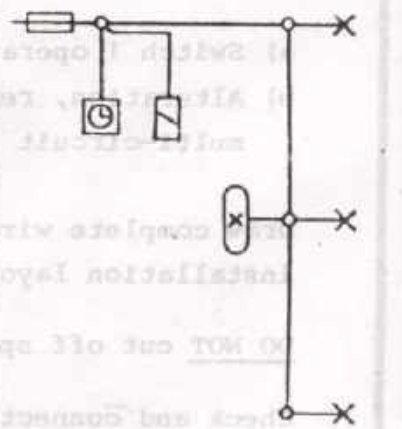
6 TREMBLER BELL INST.



7 TIME SWITCH INST



8 INDICATOR BELL INST



9 TIMING SWITCH INST.

LAYOUT

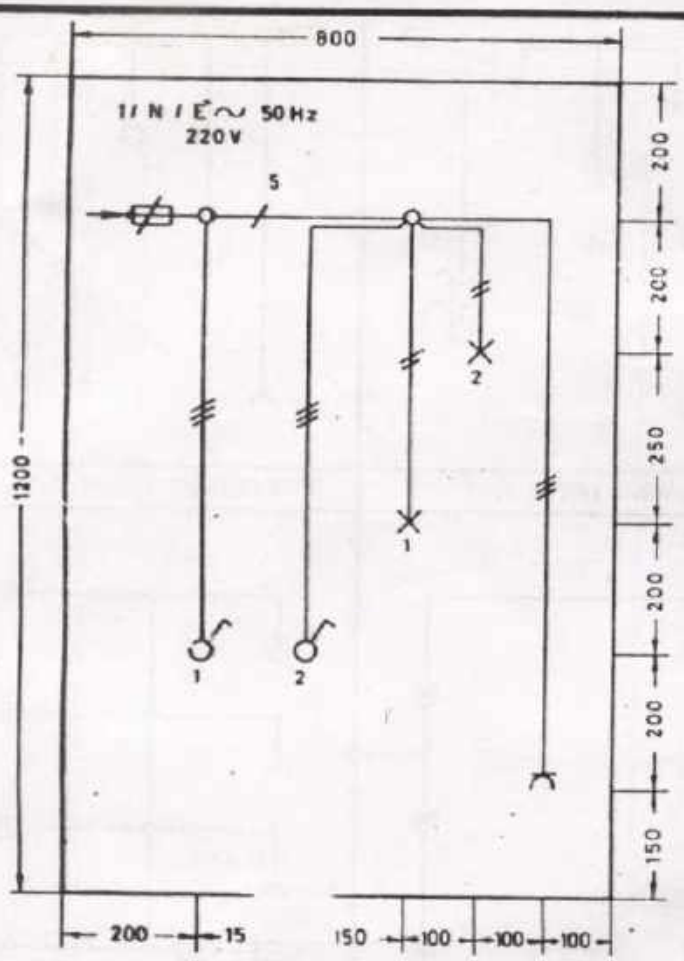
EP 2.1/3.5.4/

Installation II

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL



Material:

1 Fuse, (complete)
2 Junction boxes
2 Lampholders
2 Single pole switches
1 Socket (Schuko or 3-pin)

For Alteration:

2 Sockets (Schuko or 3-pin)
Use instead of
2 Single pole switches
1 Multicircuit switch
According to the type
of installation
Screws, clamps, cables,
pipes, wire, batten material.

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

Estimat t · 'erial required for the installation

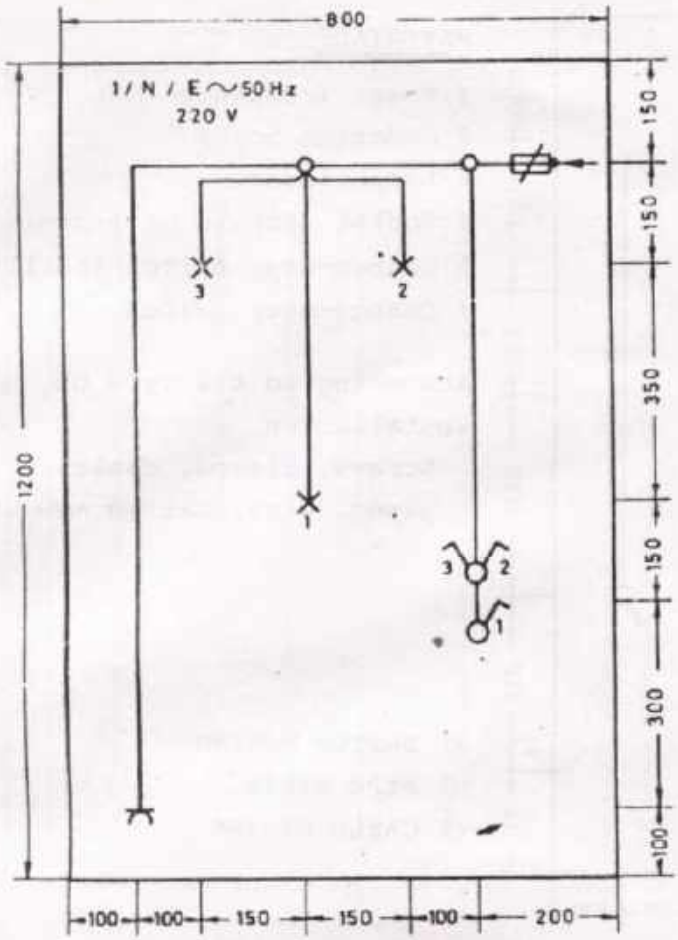
a) Switch 1 operates lamp 1, switch 2 operates lamp 2
b) Alteration, remove switch 1 + 2, replace number 1 with a multi-circuit switch, number 2 with a socket (Schuko or 3-pin)

Draw complete wiring- and current path diagrams of above shown installation layout and alteration thereof.

DO NOT cut off spare wires in junction boxes, switches etc.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

	KITCHEN	EP 2.3/3.5.4/1 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Fuse, (complete)
2 Junction boxes
3 Lampholders
1 Socket (Schuko or 3-pin)
1 Single pole switch
1 Multicircuit switch
According to the type of installation
Screws, clamps, cable, pipes, wire, batten material

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

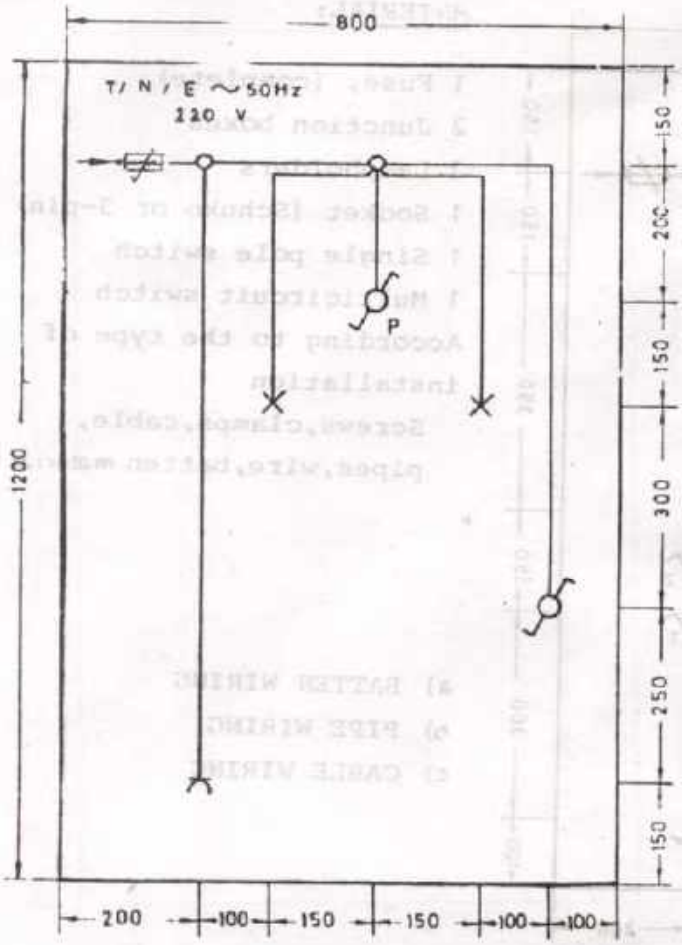
Indicate number of wires in above given installation layout.

Estimate the material required for the installation.

Draw complete wiring- and current path diagrams of above shown installation layout.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

	DRAWING/LIVING ROOM	EP 2.3/3.5.4/2 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAININC PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Fuse, (complete)
2 Junction boxes
2 Lampholders
1 Socket (Schuko or 3-pin)
1 Change-over switch (pull)
1 Change-over switch

According to the type of installation
Screws, clamps, cable, pipes, wire, batten material

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

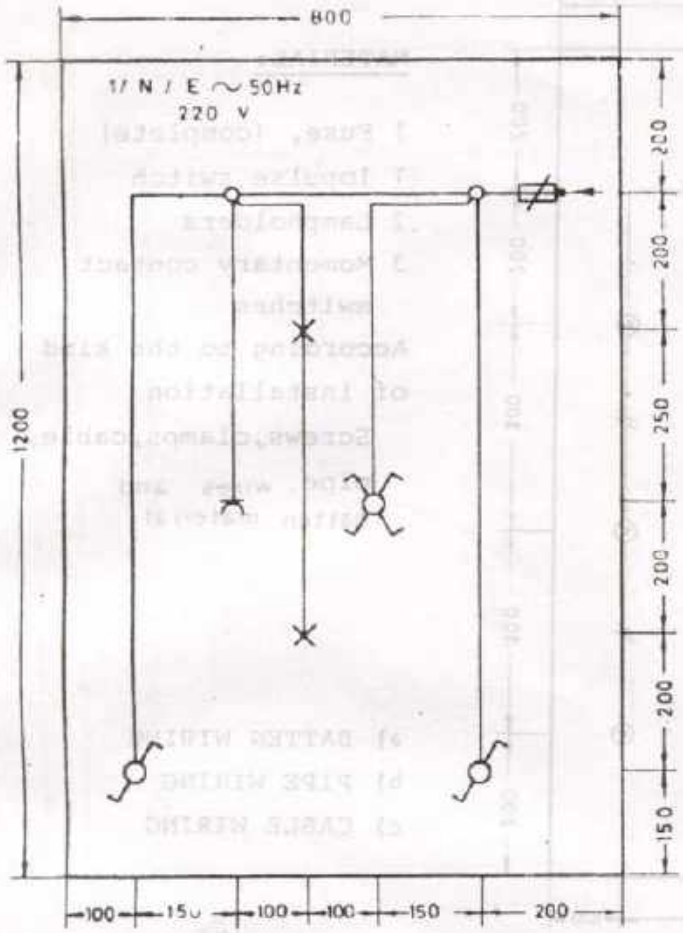
Indicate number of wires in above given installation layout.

Estimate the material required for the installation.

Draw complete wiring- and current path diagrams of above shown installation layout.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

	SLEEPING ROOM	EP 2.3/3.5.4/3 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Fuse, (complete)
2 Junction boxes
2 Lampholders
2 Change-over switches
1 Intermediate switch
1 Socket (Schuko or 3-pin)
According to the type of installation
Screws, clamps, cables, pipes, wire, batten material.

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

Indicate number of wires (conductors) in above given installation layout.

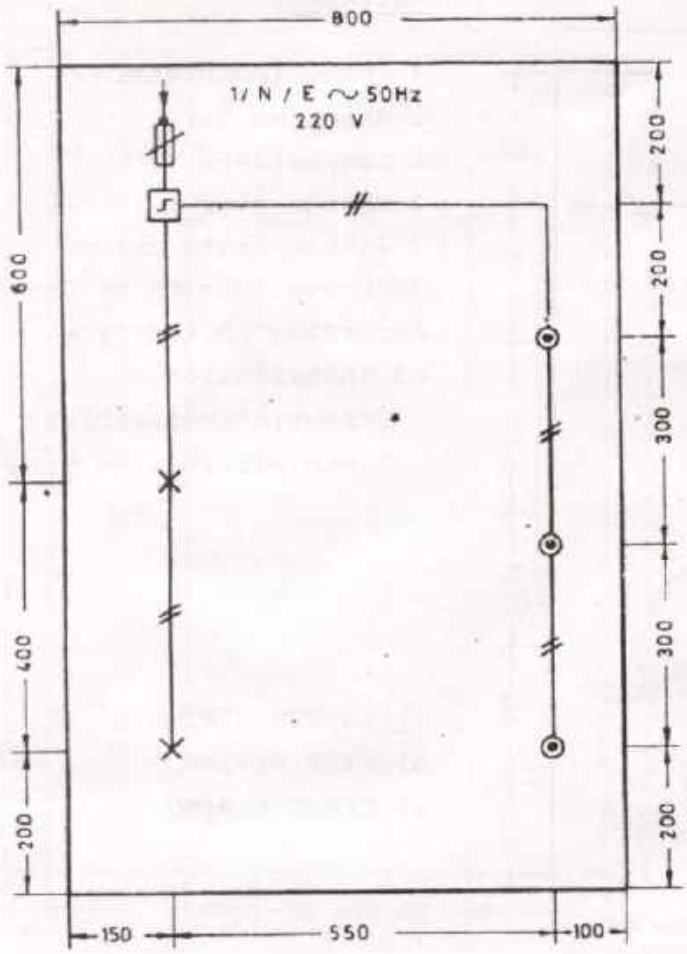
Estimate the material required for the installation.

Draw complete wiring- and current path diagrams of above shown installation layout.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

If intermediate switch is not available then perform practical exercise of Drg.No. EP/23/3.5.4/10

	HALL	EP 23/3.5.4/4
		Installation II



MATERIAL:

1 Fuse, (complete)
1 Impulse switch
2 Lampholders
3 Momentary contact switches
According to the kind of installation
Screws, clamps, cable, pipe, wires and batten material.

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

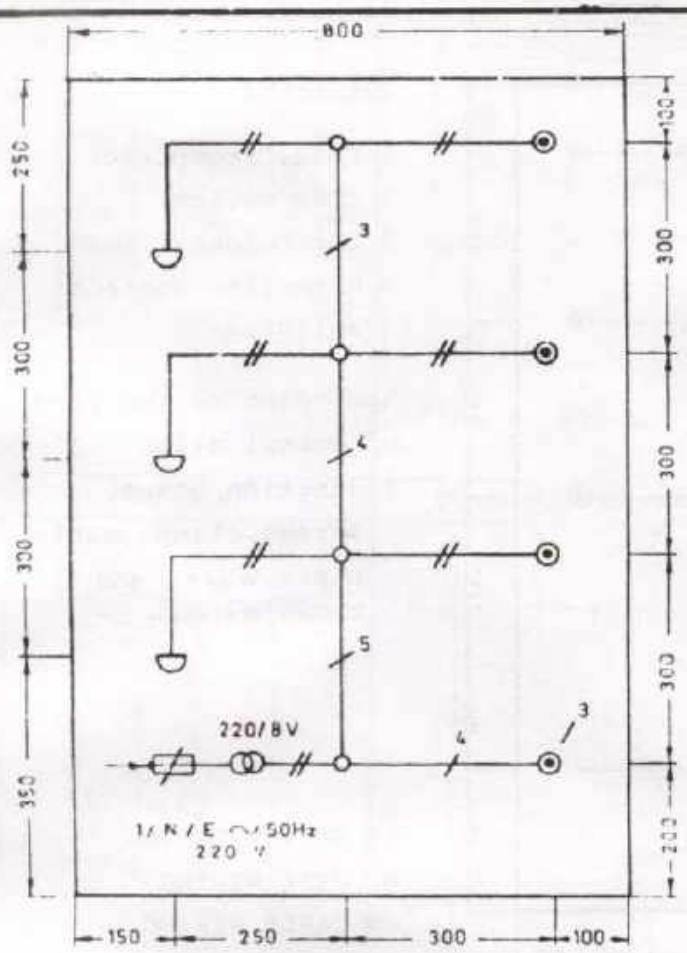
Estimate the material required for the installation to be made.

Draw complete wiring and current path diagrams of above shown installation layout.

Check and connect in PRESENCE of your INSTRUCTOR.

If impulse switch is not available then perform practical exercise of Drg.No. EP/2.3/3.5.4/11

	IMPULSE SWITCH	EP 2.3/3.5.4/5 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Puse, (complete)
1 Transformer 220/8 V
3 Trembler bells
3 Momentary contact switches, single
3 Momentary contact switches with name plate
According to the kind of installation
4 Junction boxes, screws, clamps, cable, pipes, wires and batten material.

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

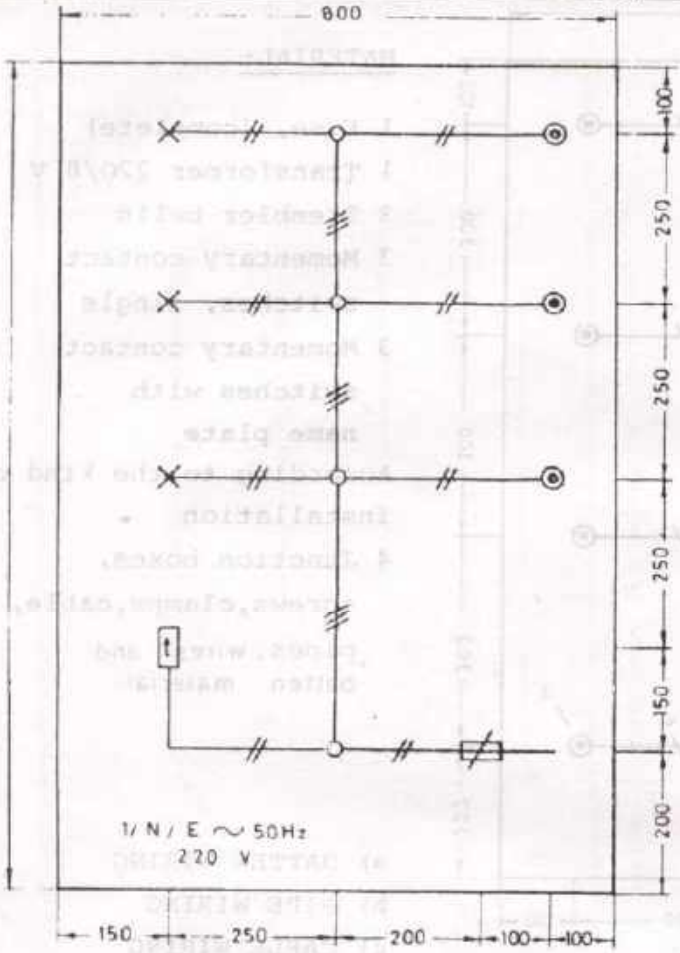
Estimate the material required for the installation to be made.

Draw complete wiring- and current path diagrams of above shown installation layout.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

If 8V bell is not available then perform this exercise without Transformer at 220V

	TREMBLER BELL	EP 2.3/3.5.4/6 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Fuse, (complete)
1 Time switch
3 Lampholders
3 Momentary contact switches

According to the kind of installation
4 Junction boxes, screws, clamps, cable, pipes, wires and batten material.

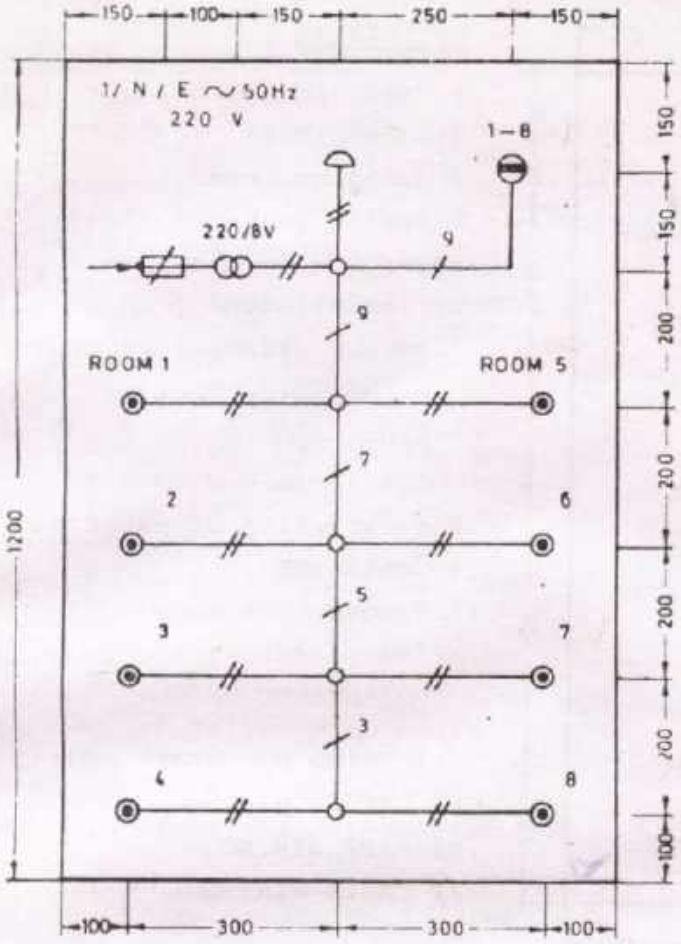
a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

Estimate the material required for the installation to be made.

Draw complete wiring- and current path diagrams of above shown installation layout.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

	TIME SWITCH	EP 2.3/35.4/7 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Fuse, (complete)
1 Transformer 220/8 V
1 Number-Indicator 8 Nos.
1 Trembler bell
8 Momentary contact switches
According to the kind of installation
5 Junction boxes, screws, clamps, cable, pipes, wires and batten material.

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

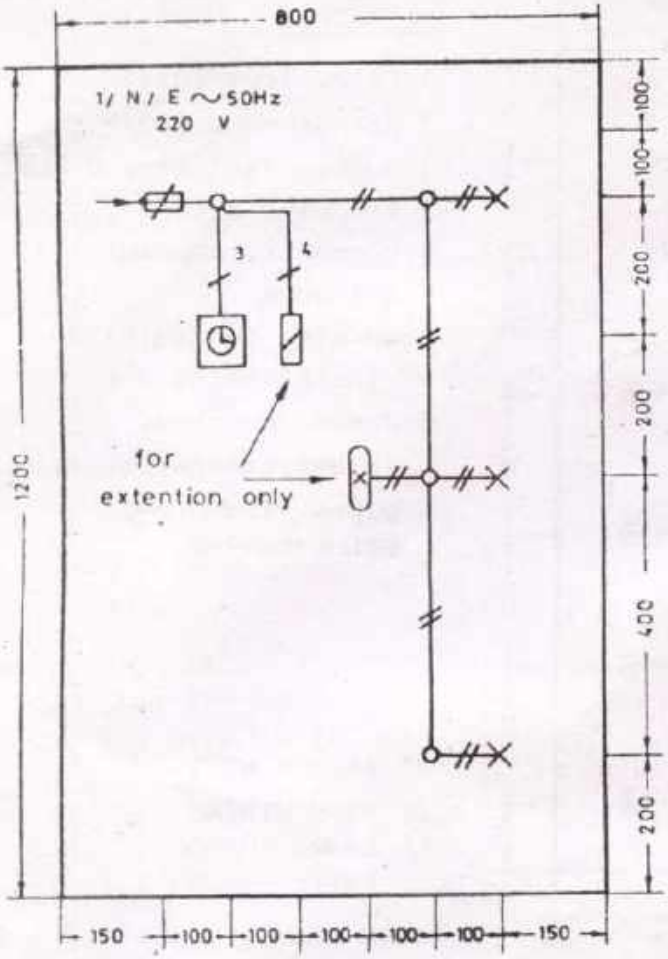
Estimate the material required for the installation to be made.

Draw complete wiring-and current path diagrams of above shown installation layout.

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

If 8V bell indicator is not available then perform this exercise without Transformer at 220V.

	INDICATOR BELL	EP 2.3/3.5.4/8 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 Fuse, (complete)
3 Lampholders
4 Junction boxes
1 Timing switch
According to the kind of installation
screws, clamps, cable, pipes, wires and batten material.

For extension of exercise
1 Contactor
1 Fluorescent Lamp, (complete)

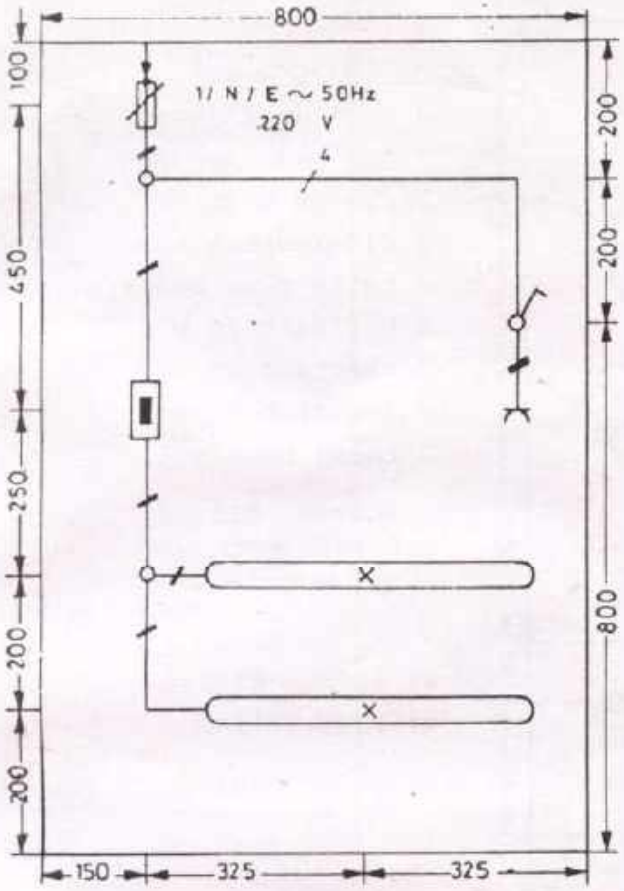
a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

Estimate the material required for the installation to be made.

Draw complete wiring- and current path diagrams of above shown installation layout.
a) without extension
b) with extension

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR.

	TIMING SWITCH	EP 2.3/3.5.4/9 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 fuse (with base) complete
1 single pole switch
2 fluorescent tubes 20 W
2 pairs tube holders
1 ballast 40 W
2 starters 20 W
2 junction boxes
1 3-pin socket
2 round blocks

According to the type of installation

screws, clamps, cable, pipes, wires and batten material.

a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

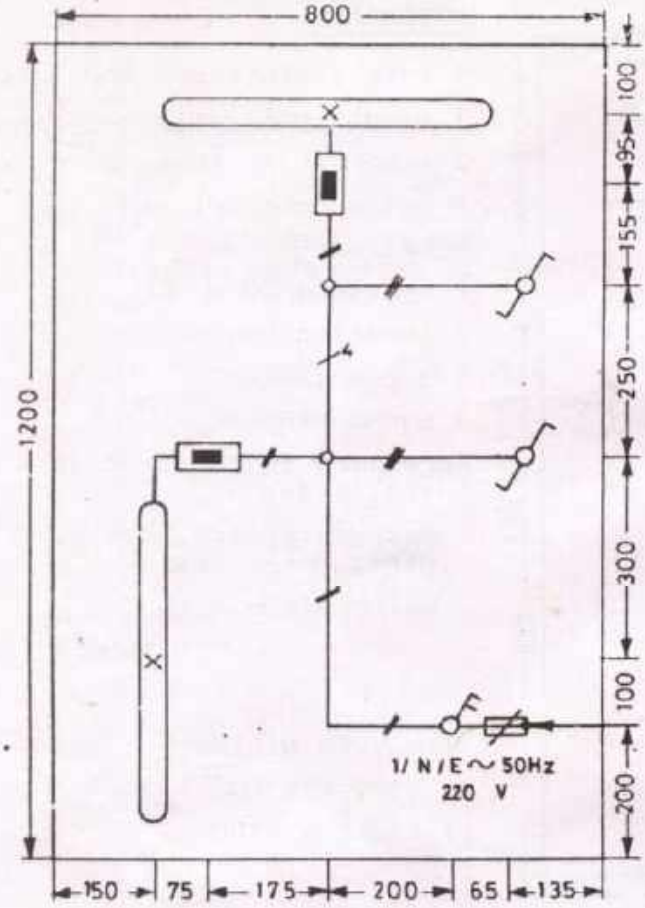
Estimate the material required for the installation to be made

a)
b)
c)
d)

Draw complete WIRING- and CURRENT PATH DIAGRAM of above shown INSTALLATION-LAYOUT.

CHECK AND CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

	FLUORESCENT LAMPS WITH ONE BALLAST	EP 2.3/3.5.4/10 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



MATERIAL:

1 [illegible]se (with base) complete
1 two pole switch
2 change over switches
2 fluorescent tubes 20 W
2 pairs tube holders
2 ballasts 20 W
2 starters 20 W
2 junction boxes
3 round blocks

screws, clamps, pipes, wires and batten material.

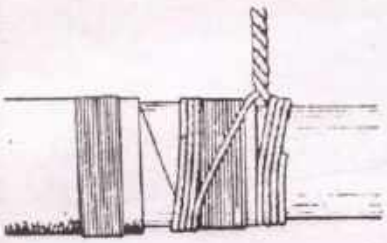
a) BATTEN WIRING
b) PIPE WIRING
c) CABLE WIRING

Estimate the material required for the installation to be made

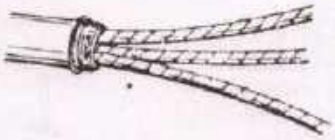
a)
b)
c)
d)

CHECK AND CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

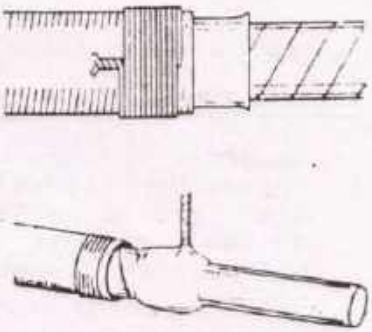
	FLUORESCENT LAMPS WITH TWO BALLAST	EP 2.3/3.5.4/11 Installation II
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING P3K GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



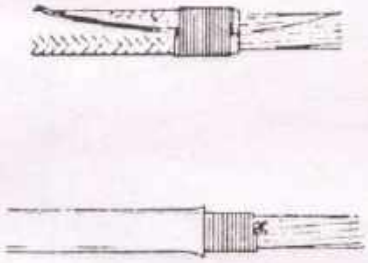
1 STRIPPING



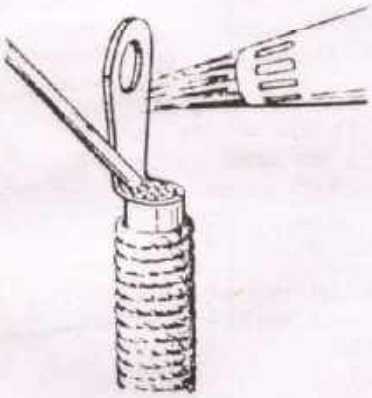
2 STRIPPING



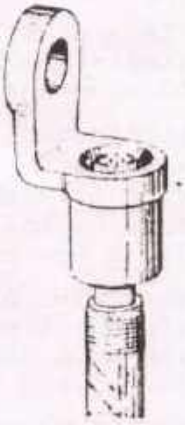
3 INSTRUCTION SHEET



4 INSTRUCTION SHEET



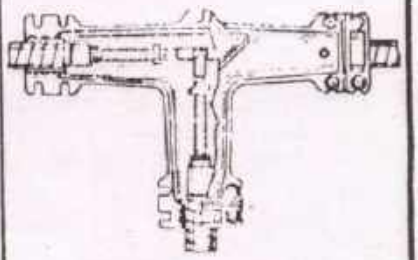
5 SOLDERING



6/7 WELDING

8 TERMINAL BOX

9 CABLE BOX



10 CABLE DISTR. PLUG

LAYOUT

EP 2.1/3.5.5/
Cable jointing

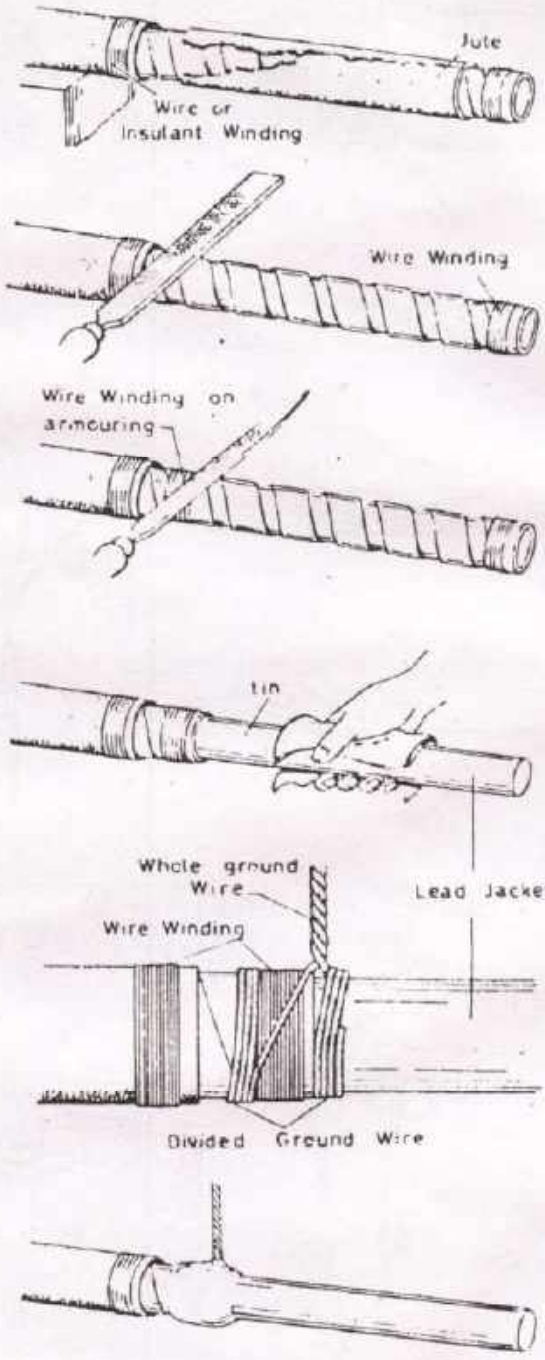
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

P&K GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN
GENERAL

SEQUENCE OF OPERATION

1. In order to ease working and ensure greater reliability, place end of cable on some suitable support (e.g. trestle), and mark the length to be off-set.
2. Secure jute with wire or insulant winding.
   See instr. sheet No. EP/2.3/3.5.5/3
3. Incise and peel jute sheathing.
4. File steel-tape armouring bare for 20 to 30 mm and tin.
5. Place wire winding on tinned steel-tape armouring (some 10 windings).
6. Incise armouring in front of winding by filing all around with triangular file and remove by knicking.
   Note: Saw must not be used.
7. Heat with blow-lamp and peel-off the impregnated and well-adhesive paper sheath.
   (e.g. with petroleum)
8. Scrape bare and tin lead jacket for some 20 to 30 mm next to wire winding.
9. Loop one half of ground wire in 2 windings around armouring and lead jacket.
10. Join the three windings by bead soldering.
    See instr. sheet No. EP/2.3/3.5.5/3



STRIPPING OF ARMOURED CABLES

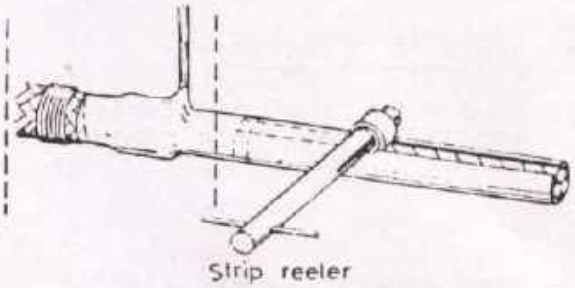
EP 2.3/3.5.5/1
Cable jointing

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING
PAK-GERMAN TECHNICAL TRAINING PROGRAMME

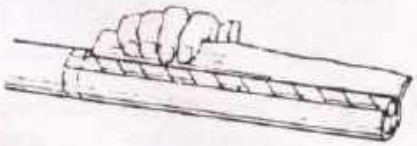
ELECTRICIAN
GENERAL

SEQUENCE OF OPERATION

11. Notch the lead sheath all around to the required length, then notch again all around according to the set-off length of the joint wire sheath (belt).
The lead sheath section between the two notches serves as protection of the remaining belt and is removed later. (see Step 18)

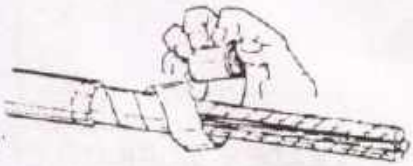

Strip reeler

12. Crack two closely parallel longitudinal cracks and reel off intermediate strip with flat-nosed pliers or strip reeler.



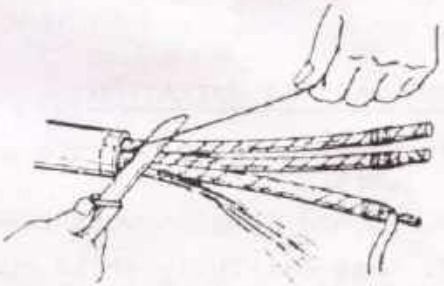
13. Turn up lead sheath and tear off at notch (do not cut).

14. Reel off and tear off joint wire sheathing (belt).



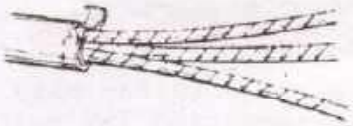
15. Cut off filler with knife from inside to outside.
Do not cut against wires.

16. Lace wires with (impregnated) twine according to connecting length.
See instr. sheet No.2.3/3.5.5/4

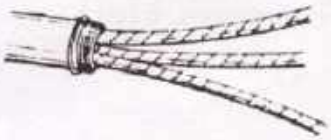


17. Strip wires to windings, whereby the outer layers should be notched and the inner layers torn.

18. Remove remaining lead sheath (belt) and expand end of lead sheathing to funnel.



19. Lace exposed joint wire sheathing (belt) by winding with (impregnated) binder twine.
See instr. sheet No.2.3/3.5.5/4

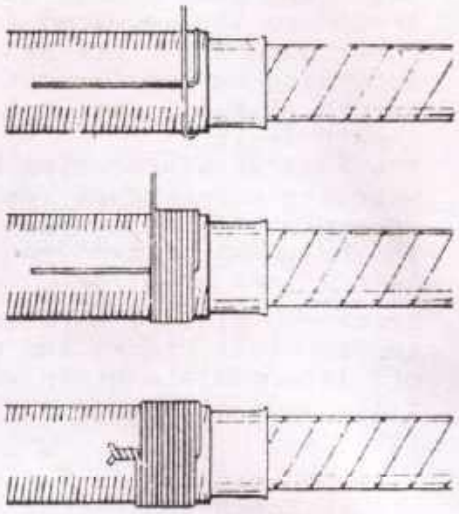


	STRIPPING OF ARMOURED CABLES	EP 2.3/3.5.5/2 Cable jointing
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL

WIRE WINDINGS

SEQUENCE OF OPERATION

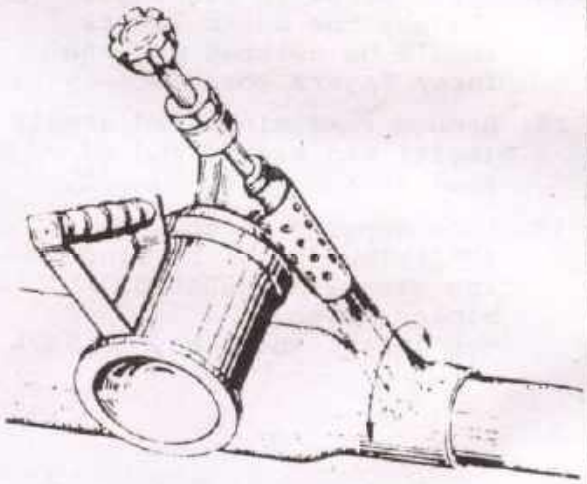
1. Bend wire right angularly and loop around the cable.
2. Wind several layers tightly and securely over loop.
3. Twist and cut wire ends.



TINNING OF LEADEN WORK-PIECES

SEQUENCE OF OPERATION

1. Clean and scrape work-pieces bare.
2. Spread flux on work-piece.
3. Heat carefully while moving flame back and forth (simultaneously).
4. Melt solder (rod tin).
5. Heat the applied solder only to a pasty condition (it must not flow) and spread with flux-soaked cloth.



Note
The back and forth movement of the flame during the heating of the work-piece is necessary for preventing localized over-heating (melting of the lead).

TWINE WINDING WITH THREADED END

SEQUENCE OF OPERATION

1. Loop end of twine and start winding just before end of insulation.

2. Loop twine in several closely adjacent firm windings and thread end through loop.

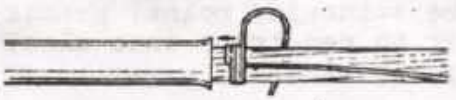
3. Cut ends of twine.

TWINE WINDING WITH KNOTTED END

SEQUENCE OF OPERATION

1. Crease end of twine and wind some three layers around crease.

2. Push winding under knurled cable jacket, tighten slightly and continue winding.



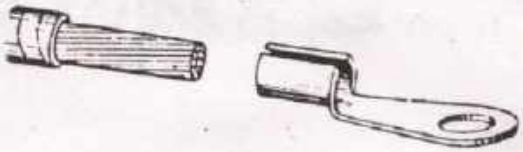
3. Knot and cut ends.

Note:
Windings are made of tape, twine or wire, depending on the purpose and composition of the line to be laced.
They must be smooth and uniform, firm and unshiftable.

SEQUENCE OF OPERATION

1. Strip line to required length (= length of sleeve + 10 mm).
   Clean conductor if necessary.

2. Push stripped end into the sleeve.

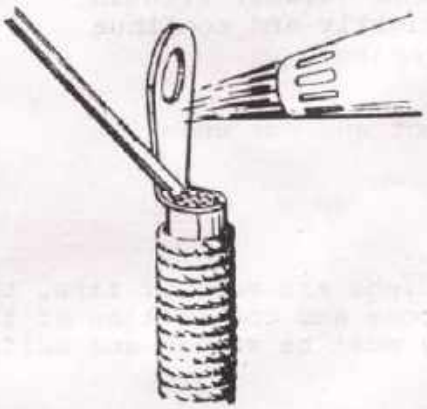


3. Protect insulation from soldering heat, e.g. by lacing with asbestos yarn.

4. Put cable and cable-lug in vertical position.

5. Coat soldering point with paste flux.

6. Solder, heat cable-lug above the soldering point, permit solder to penetrate into sleeve by knocking.



7. Insulate and secure and protect by lacing, if this should be required.

Note:
The solder must fill the sleeve of the cable-lug completely, but must not penetrate any further.

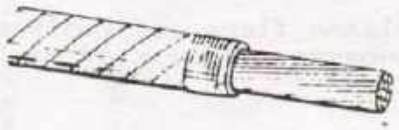
Only solders containing a minimum of 40% tin should be used.

	MOUNTING LARGE CABLE-LUGS BY SOLDERING	EP 2.3/3.5.5/5 Cable jointing
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL

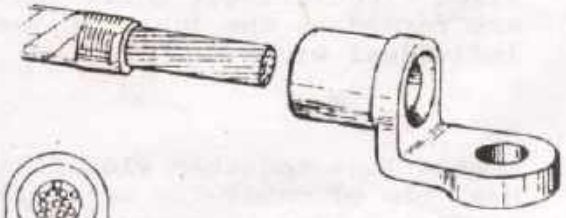
The Preliminaries for welding cable-lugs on aluminium conductors require particularly meticulous execution, so as to ensure that the actual welding be rapid and reliable.

Working Steps

1. Set-off and strip cables to required length and form out the conductors.

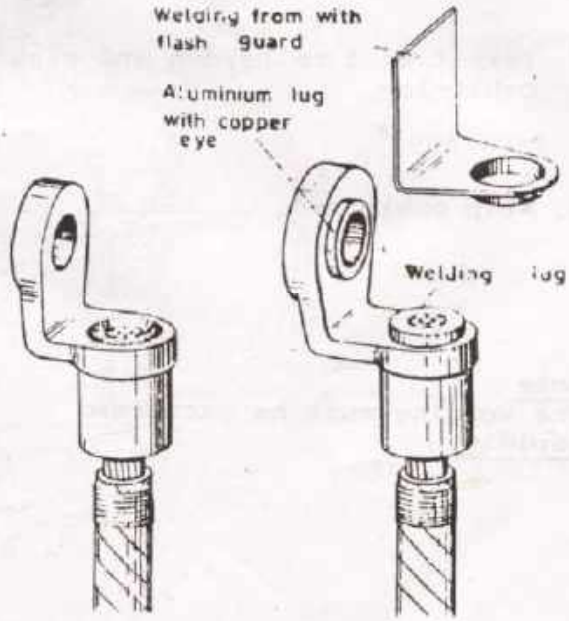


2. Smooth cut conductor ends by cutting followed by subsequent cleaning (use benzine on cable cores). Form round segmental conductor beforehand.



3. Attach cable-lugs. Fill hole of cable-lug with pointed wires from waste conductor ends completely.

4. Place conductor and cable-lug in vertical position, and attach welding form with flash guard if this is required.



5. Coat points to be welded with suitable flux. The flux must not be hygroscopic after cooling.

6. Coat filler with flux and prepare.

Note
The fillers used should preferably be waste ends of the cable core to be welded.

	WELDING CABLE-LUGS ON ALUMINIUM CONDUCTORS	EP 2.3/3.5.5/6 Cable jointing
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL

SEQUENCE OF OPERATION

1. Set welding flame pointedly and at low-oxygen (excess of gas).

2. Heat conductor end with pointed flame circulatingly until lugs are formed on the faces of the individual wires.

3. Spread lugs together with filler. Heat rim of cable-lug until its surface bulges.

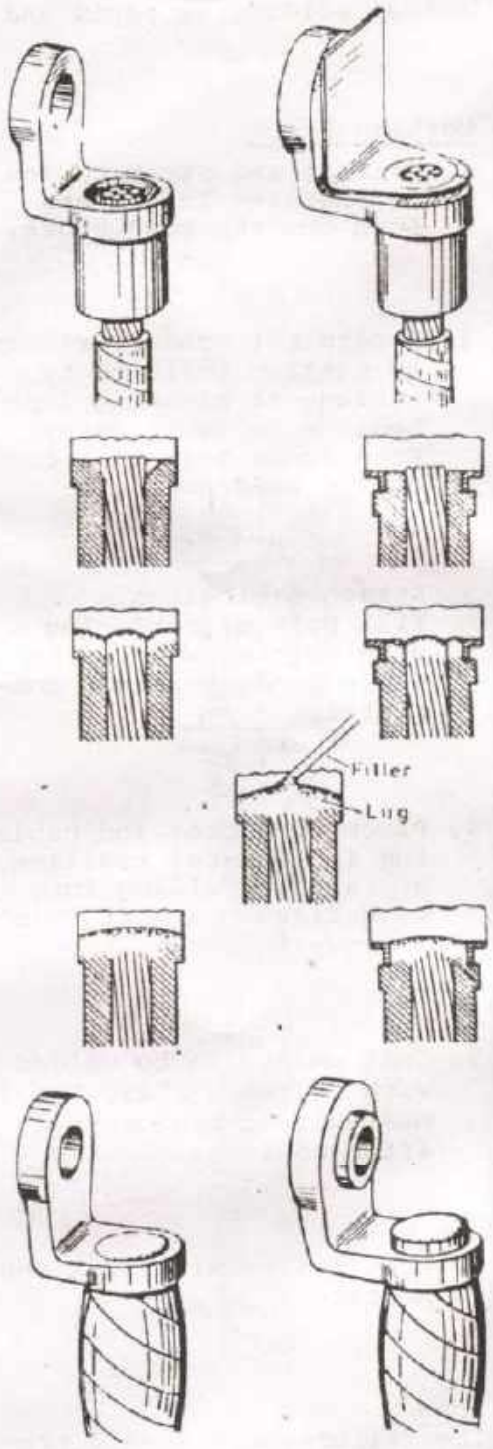
4. Spread the conductor and lug melts together. Bufld up filler until a lug is formed.

   In building up the lug feed filler to the melt and continue to feed while stirring.

   Take off filler before removing flame.

5. Permit melt to harden and clean cable-lug.

6. Wrap cable end.



Note
The welding must be performed rapidly.

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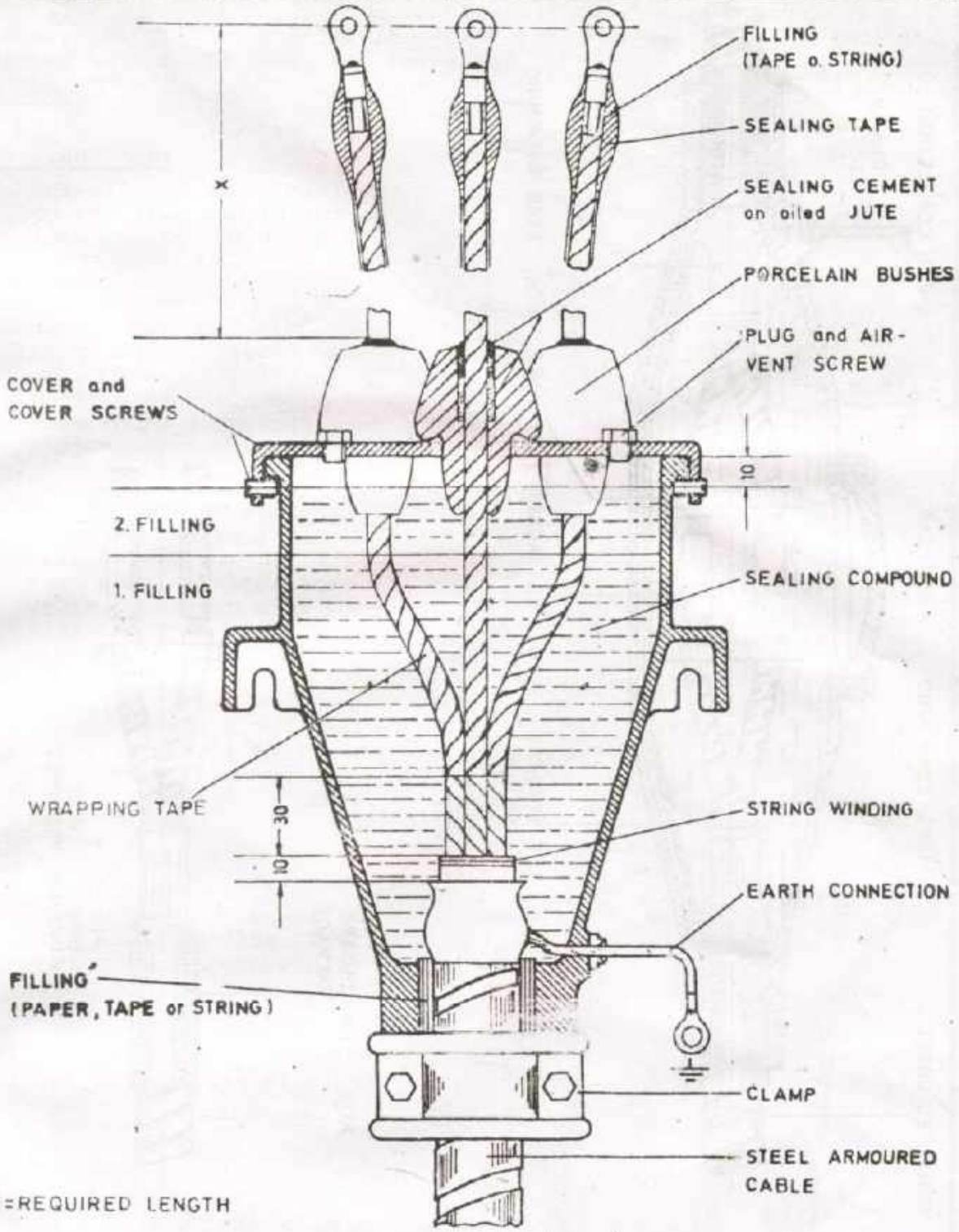
	WELDING CABLE-LUGS ON ALUMINIUM CONDUCTORS	EP 2.3/3.5.5/7 Cable jointing
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		ELECTRICIAN GENERAL



TERMINAL BOX

EP 2.3/3.5.5/8

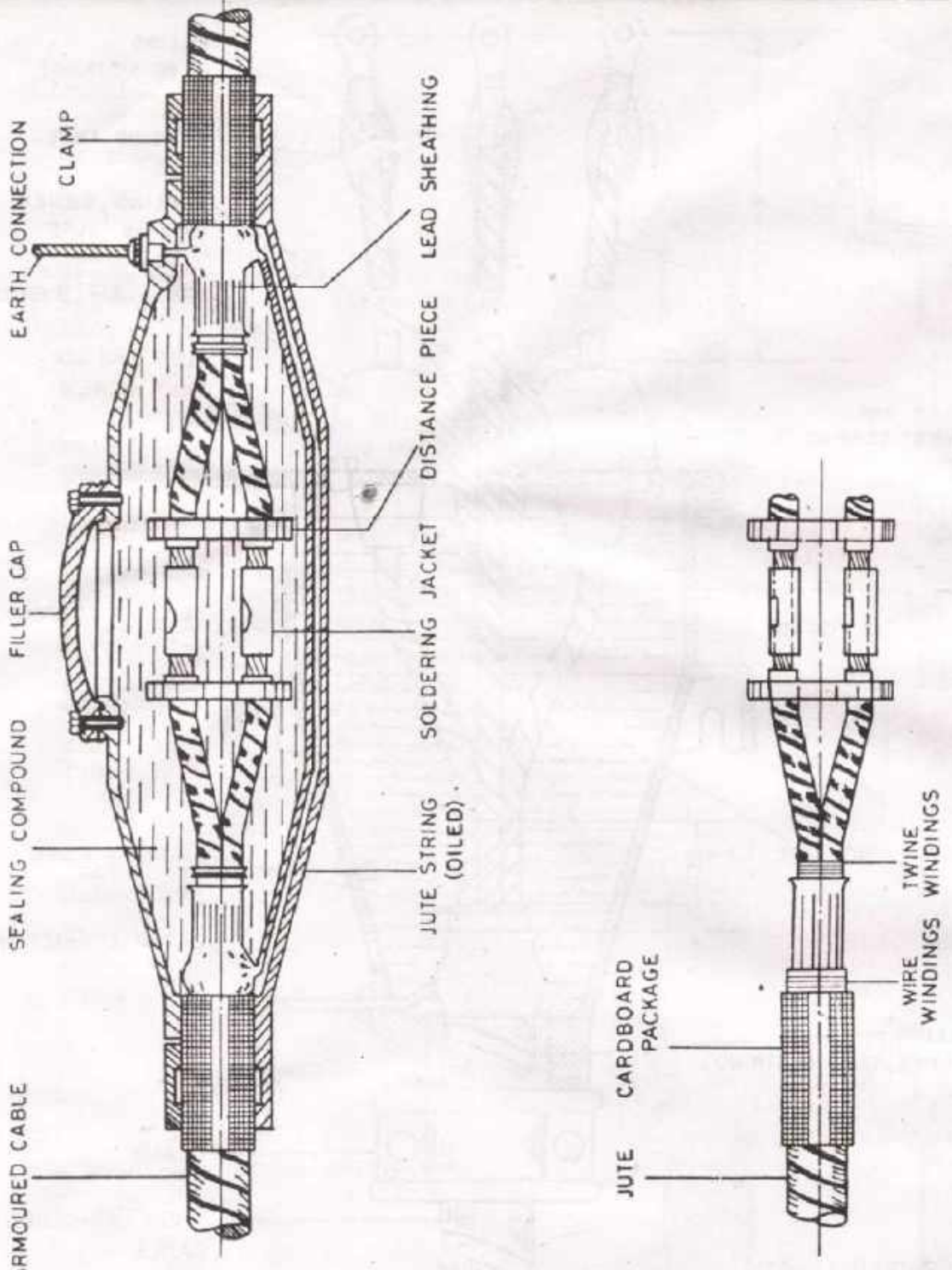
Cable jointing

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN

GENERAL



CABLE-CONNECTING BOX

EP 2.3/3.5.5/9

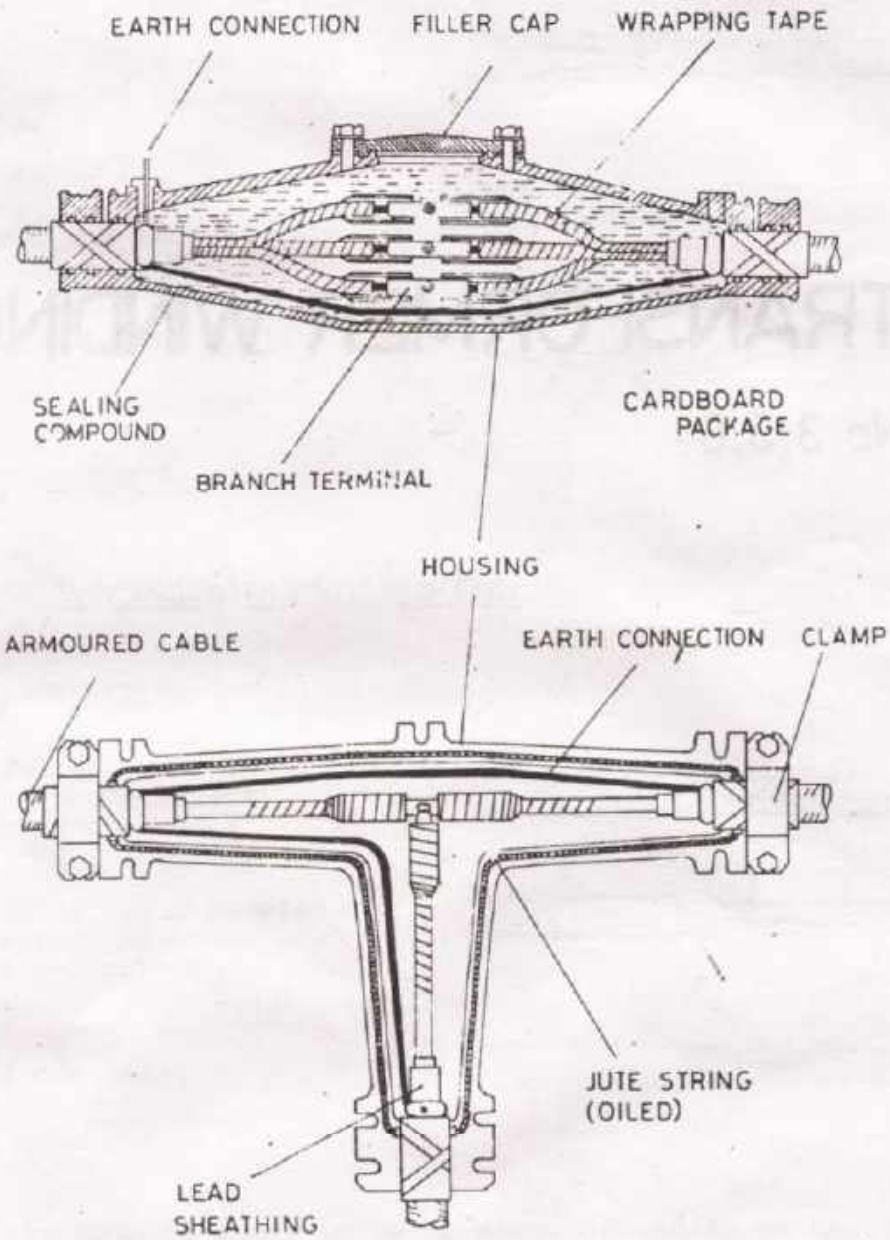
Cable jointing

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN

GENERAL



CABLE DISTRIBUTION PLUG

EP 2.3/3.5.5/10

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL

TRANSFORMER WINDING

No. 3.5.6

REPAIR OF A TRANSFORMER WINDING

CHECKING OF A TRANSFORMER WINDING

DISMANTLING OF TRANSFORMER

REPAIR OF THE WINDING

ASSEMBLING

TESTING

CALCULATION

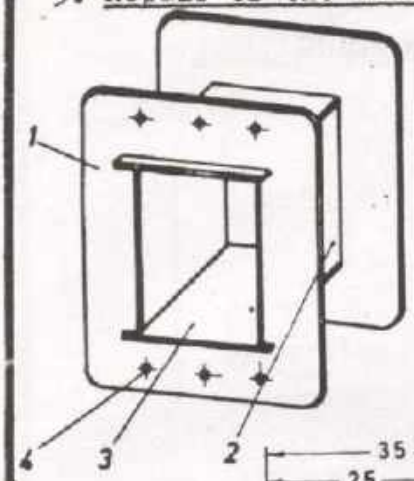
REPAIR OF A TRANSFORMER WINDING

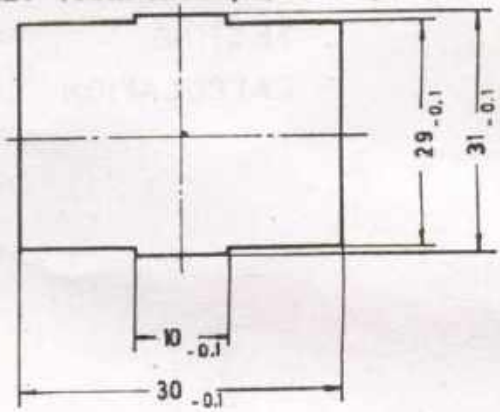
1. Checking of a Transformer Winding
While checking the transformer winding with an ohmmeter, we find the defective winding which has to be rewound.

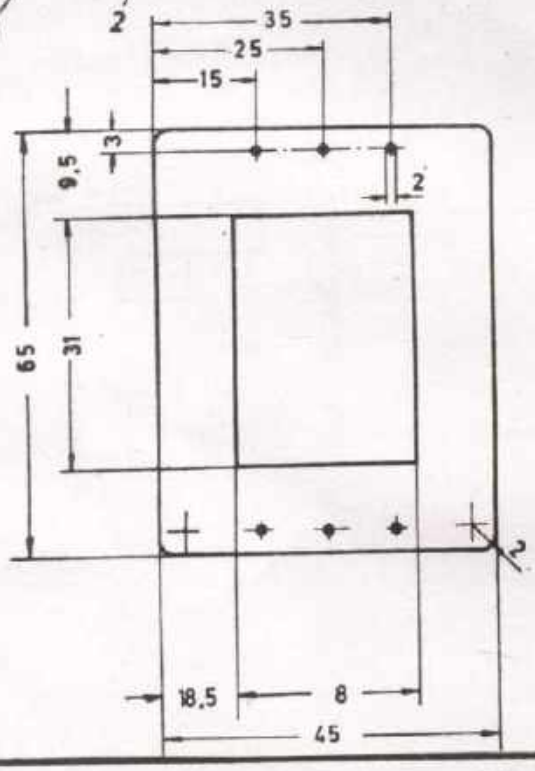
2. Dismantling of the Transformer
a) Dismantle the outer frame.
b) Remove the first three iron laminations, one by one with the help of a proper tool. Then remove the remaining laminations by hand.
c) Solder off the terminals of the coil which must be removed and note how to connect it again.
d) Remove the outer card paper layer again if possible.
e) Remove the winding of the coil carefully counting its number of turns. Record the sequence of coils, its cross-sectional area and its paper layers. Dismantle as many coils until you remove the defective winding.

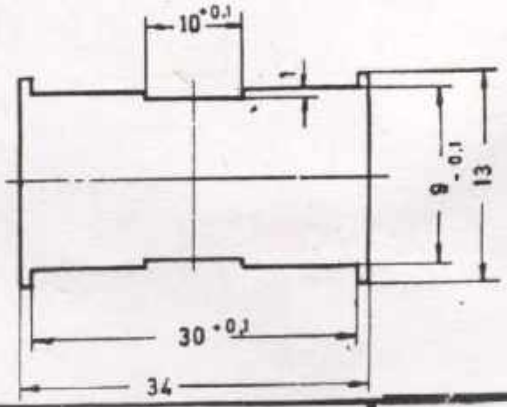
3. Repair of the Winding

a) Mostly only the coil is defective and not the bobbin. In case to make a new bobbin, adjust the size of the new bobbin acc. to the size of the transformer to be repaired.
1. Flange 2 units
2. Strap 2 units
3. Strap 2 units
4. Holes for soldering lugs
Material: varnished paper 1.5 mm.



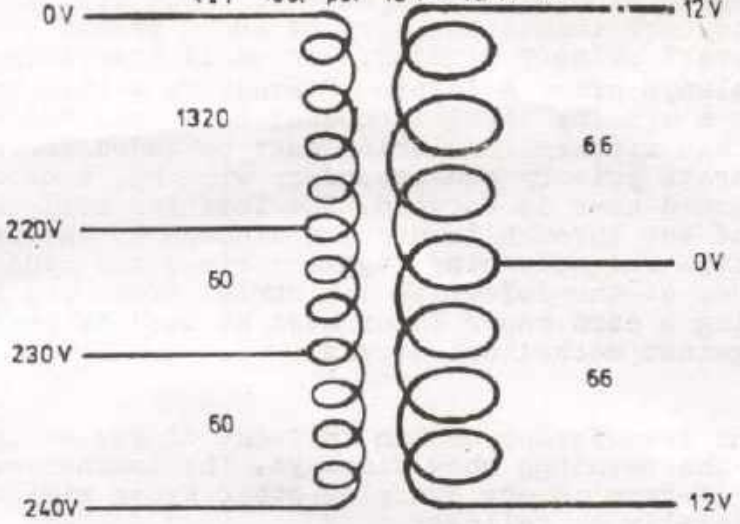






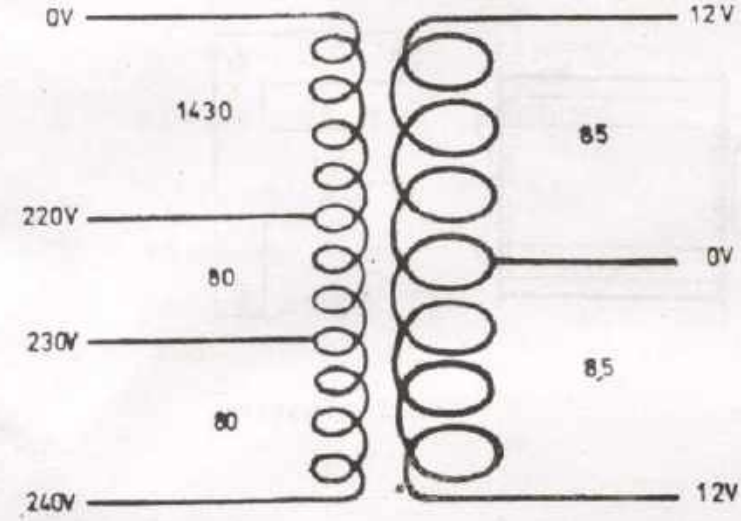
b) For rewinding a transformer three examples are given. The manufacture is Hamid Corporation, Faiz Bagh, Lahore

(I) Out put 12V+ 12V/ 3A



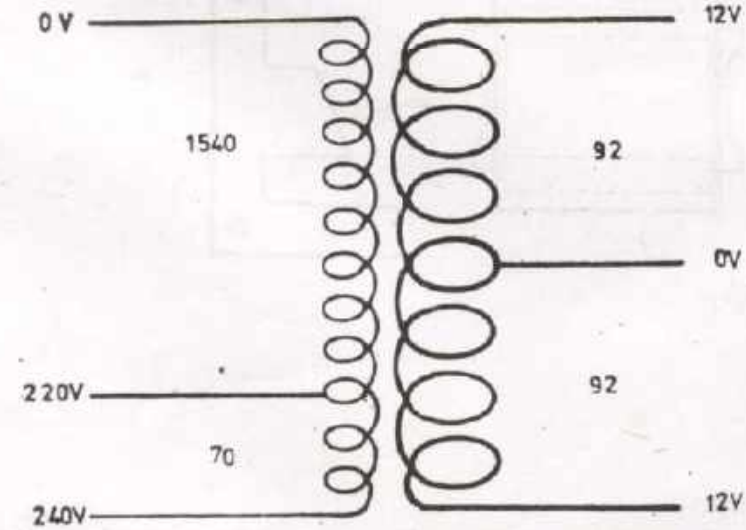
SWG prim 33/0.05 mm²
SWG sec 20/0.65 mm²

(II) Out put 12V+12V/ 2A



SWG prim 34/0.043 mm²
SWG sec 22/0.4 mm²

(III) Out put 12V+12V / 1A



SWG prim 37/0.0235mm²
SWG sec 25/0.2 mm²

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

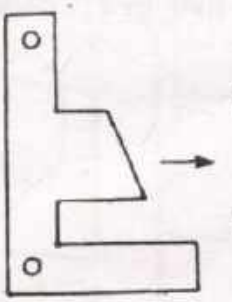
No. EP 2.3/3.5.6/2
Transformer Winding

c) Before starting to wind a card paper layer (cut acc. to bobbin size) as core insulation must be wound around the bobbin. Then start primary winding. For small transformers (up to 10 A) always after 4 layers of windings a thin butter paper layer as a winding insulation must be added. For big transformers this winding insulation must be added for every layer. To separate primary and secondary winding, a card paper layer should come in between. The lead for coil tapping must be brought out through insulation sleeves to the soldering lug strip. The soldering lugs are rings and pins pressed together at the soldering lug strip. After the last layer of winding a card paper layer must be used to protect the winding against mechanical stress.

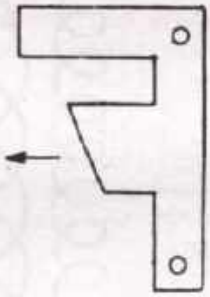
4. Assembling

a) Put the rewound transformer bobbin in front of you at the table so that the openings show sideways. The lamination of the iron core (F-type in our example, other types similar) is done horizontally as follows:

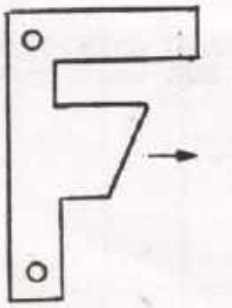
1st lamination



2nd lamination



3rd lamination



4th lamination