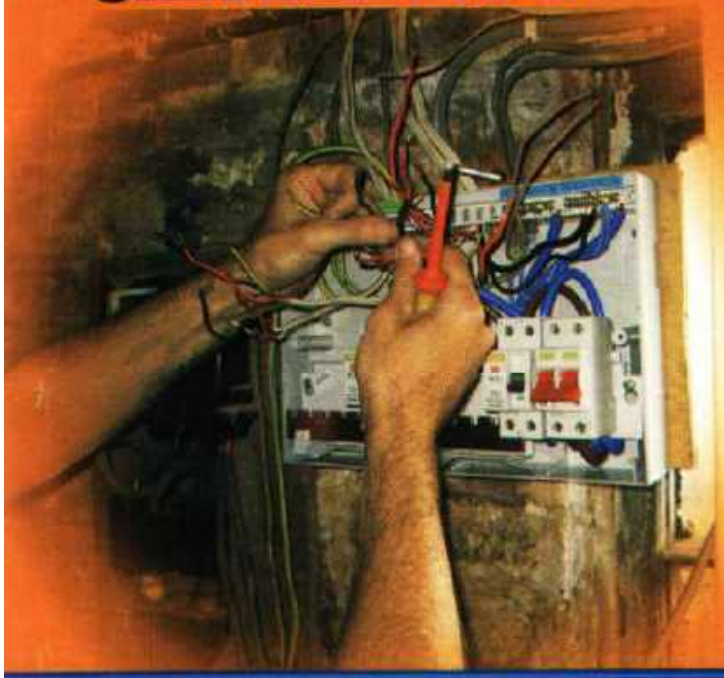
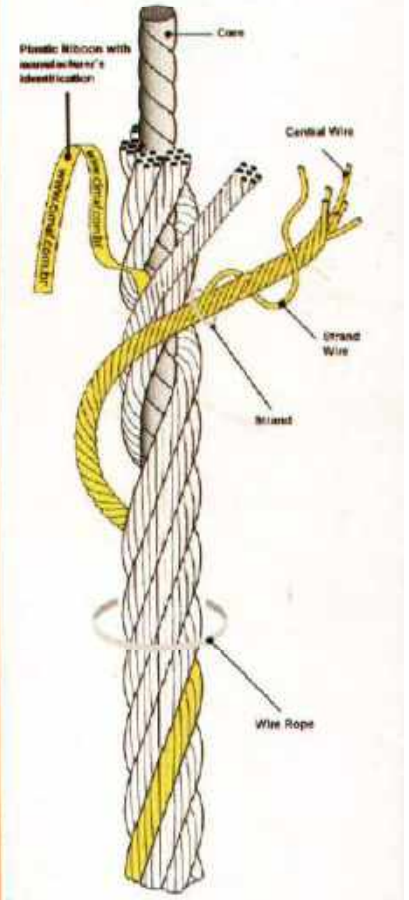
# TRADE TRAINING-III

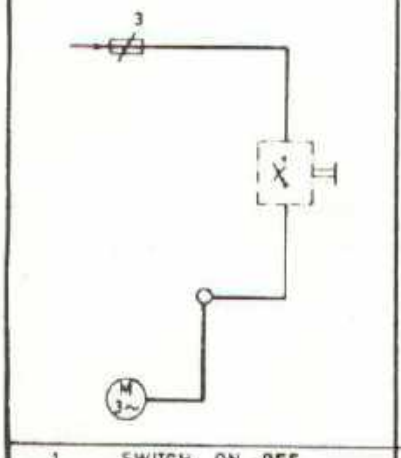
## TTC PROGRAMME

# ELECTRICIAN GENERAL

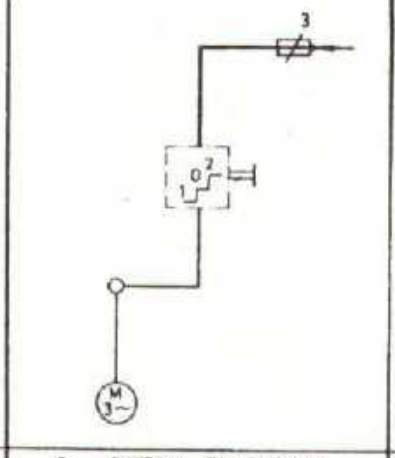




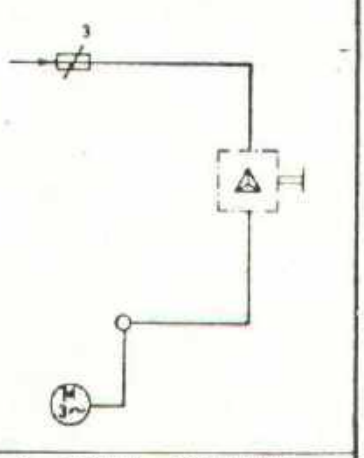

TEVTA
GOVERNMENT OF THE PUNJAB
TECHNICAL EDUCATION & VOCATIONAL TRAINING AUTHORITY
TRADE TESTING BOARD
DEVELOPMENT CELL LAHORE
T.T.P. Series No.34A
Price Rs.60.00



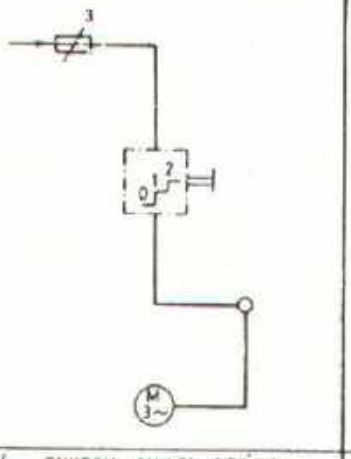
1 SWITCH, ON-OFF



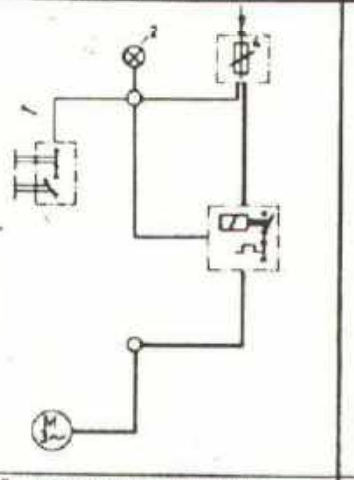
2 SWITCH, REVERSING



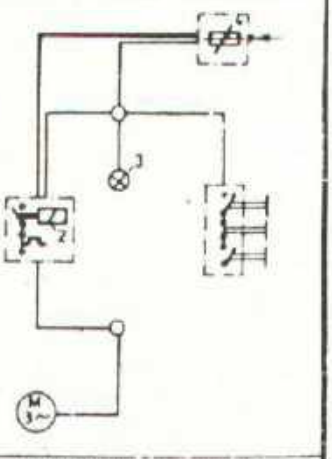
3 SWITCH, STAR-DELTA



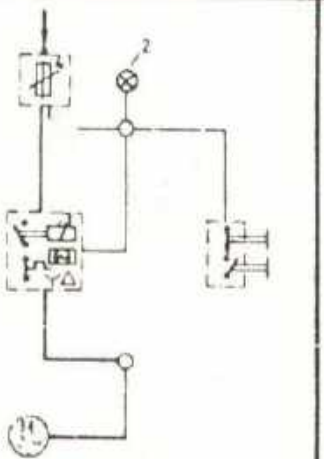
4 SWITCH, MULTI SPEED



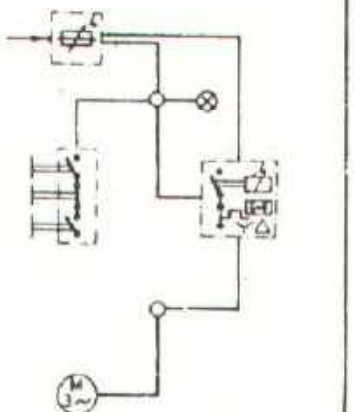
5 CONTACTOR, ON-OFF



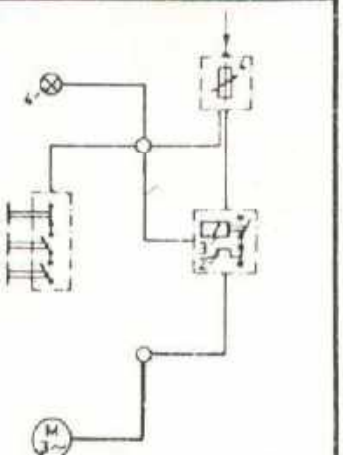
6 CONTACTOR, REVERSING



7 CONTACTOR, STAR-DELTA



8 CONTACTOR, YΔ-REVERSING



9 CONTACTOR, MULTI SPEED

LAYOUT

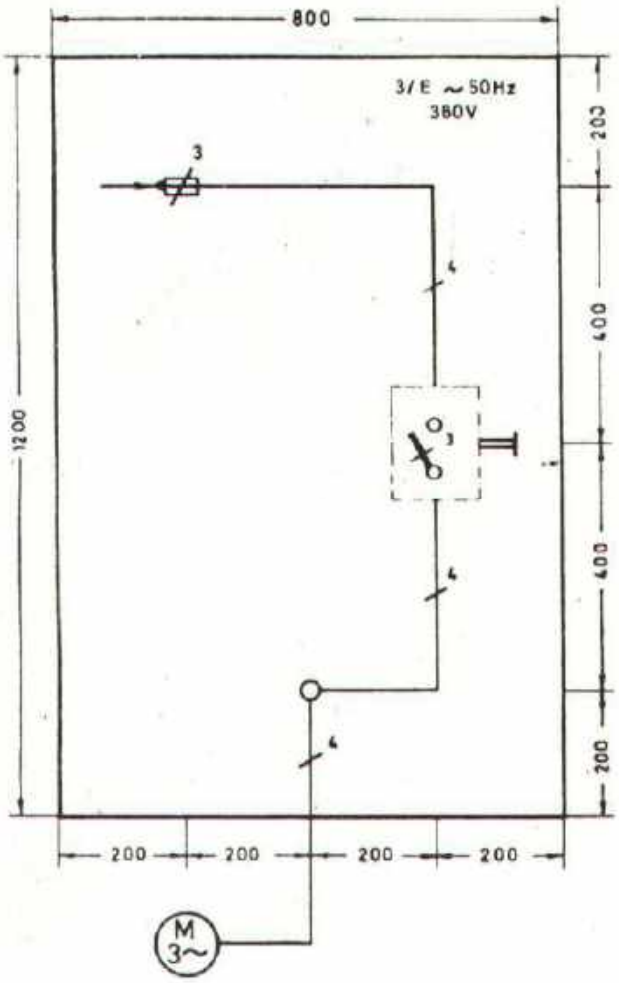
EP 2.1/4.5.1/

installation III

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL




MATERIAL:

1 Motor 3~ 380 V

3 Fuses (complete)

1 Drum Switch 3~
ON - OFF

1 Appliance Connection Box

Cable

Pipe

Wire

Clamps

Screws

Connectors

The motor 3~ 380 V is to be connected via fuses and switch.

Take fuses suitable for your motor.

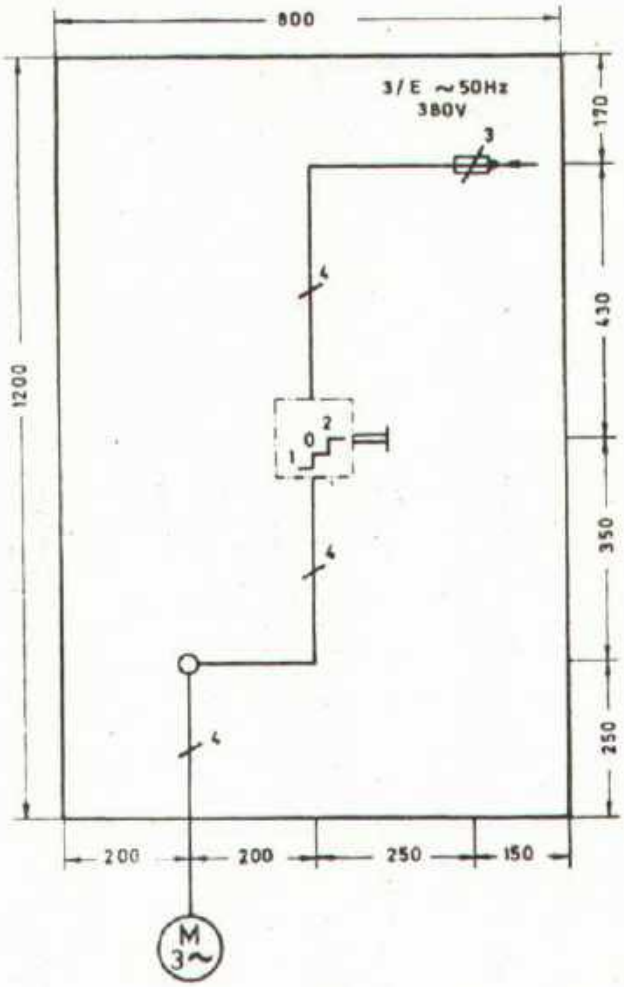
All components are to be installed according to the given drawing and measurements.

Give estimate for the material.

(A suitable motor protection switch should be provided additionally, if available.)

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | | |
|---|---|---|
| Exercise sheet No. 4.5.2/7 may be used in addition | MOTOR CONNECTION, ON-OFF | EP 2.3/4 5.1/1<br>Installation III |




MATERIAL:

1 Motor 3~ 380 V

3 Fuses (complete)

1 Drum Switch 3~ Reversing

1 Appliance Connection Box

Cable

Pipe

Wire

Clamps

Screws

Connectors

The Motor 3~ 380 V is to be connected via fuses and reversing switch.

Take fuses suitable for your motor.

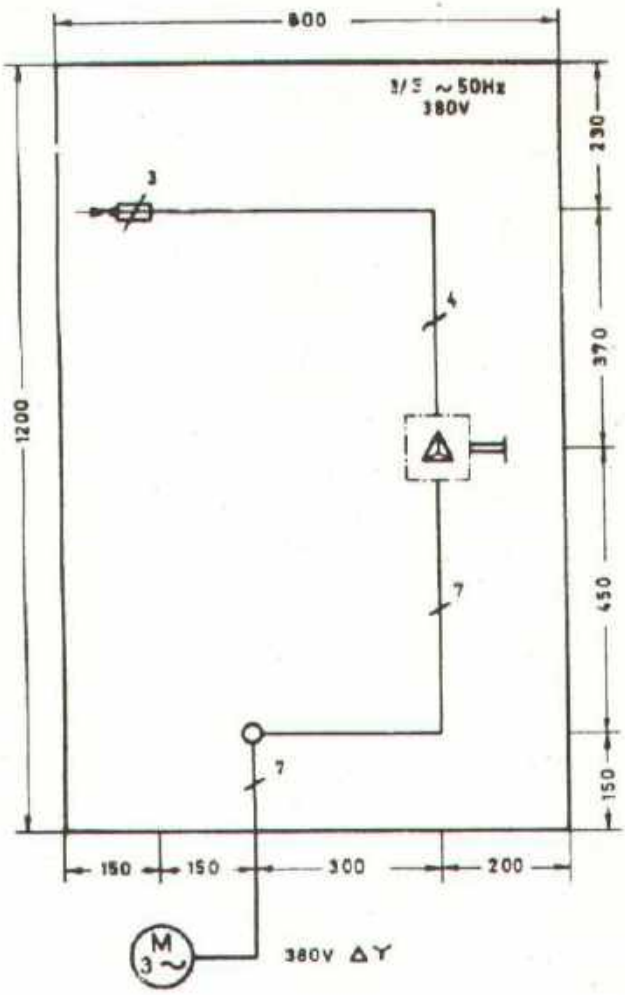
All components are to be installed according to the given drawing and measurements.

Give estimate for the material.

(A suitable motor protection switch should be provided additionally, if available.)

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | | |
|---|---|---|
| Exercise sheet No. 4.5.2/8 may be used in addition | MOTOR CONNECTION, REVERSING | EP 2.3/4.5.1/2<br>Installation III |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |




MATERIAL:

1 Motor 3 ~ 660 / 380 V

3 Fuses (complete)

1 Drum Switch 3 ~
Star - Delta

1 Appliance Connection
Box

Cable

Pipe

Wire

Clamps

Screws

Connectors

The three-phase motor 660 / 380 V is to be connected via fuses and star - delta switch.

Take fuses suitable for your motor.

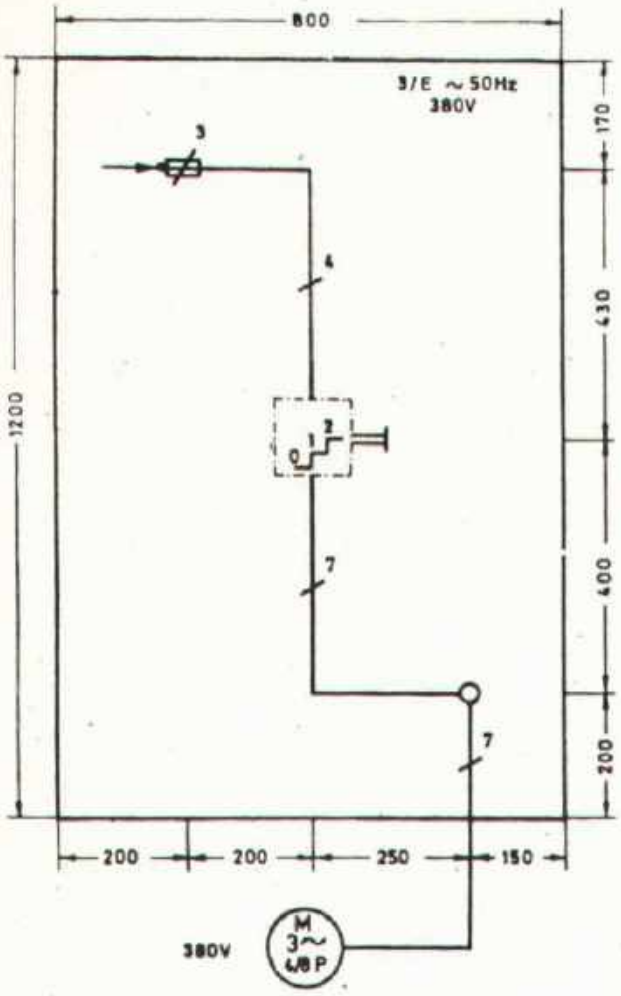
All components are to be installed according to the given drawing and measurements.

Give estimate for the material.

(A suitable motor protection switch should be provided additionally, if available.)

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | | |
|---|---|---|
| Exercise sheet No. 4.5.2/9 may be used in addition | MOTOR CONNECTION, STAR-DELTA | EP 2.3/4.5.1/3<br>Installation III |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |




MATERIAL:

1 Motor 3~ 380 V
(Double Speed 4/8 P)

3 Fuses (complete)

1 Drum Switch 3~
Double Speed
(suitable for your motor)

1 Appliance Connection Box

Cable

Wire

Clamps

Screws

Connectors

Pipe

The three-phase double speed motor 380 V is to be connected via fuses and double speed switch.

Take fuses suitable for your motor.

All components are to be installed according to the given drawing and measurements.

Give estimate for material.

(A suitable motor protection switch should be provided additionally, if available.)

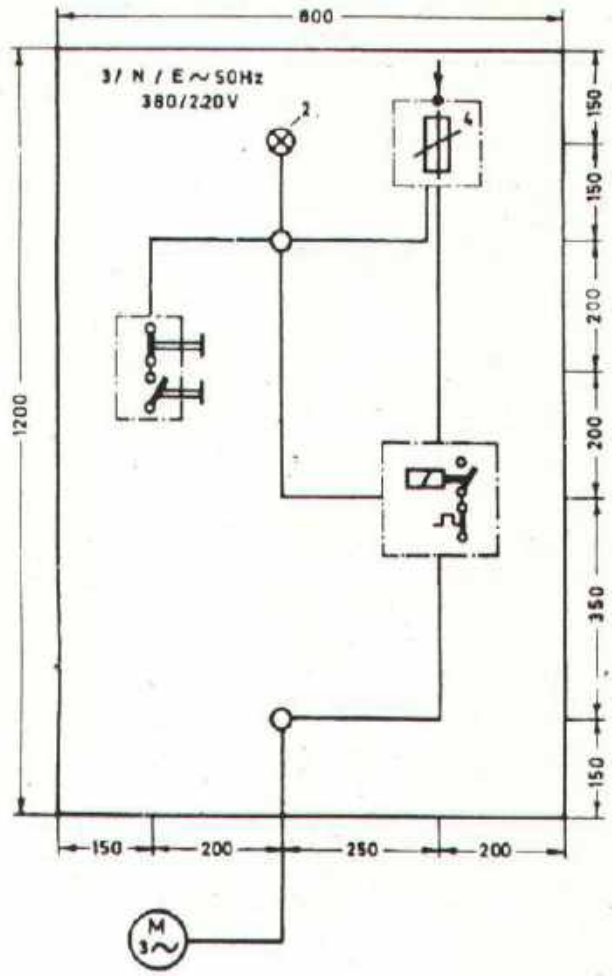
CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | | |
|---|---|---|
| Exercise sheet No. 4.5.2/11 may be used in addition | MOTOR CONNECTION, DOUBLE SPEED | EP 2.3/4.5.1/4<br>Installation III |

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL




MATERIAL:

1 Motor 3~ 380 V Δ

4 Fuses (complete)
(3 for main or power circuit, 1 for control circuit)

1 Junction Box

1 Appliance Connection Box

1 Automatic Contactor

1 Therm. Motor Protection Switch
(Overload Relay)

1 Double Push Button Switch
(momentary contact)

2 Control Lamps
(complete)

Cable

Wire

Pipe

Clamps

Screws

Connectors

Indicate number of wires in the installation layout

The motor 3~ 380 V is to be connected via fuses, automatic contactor and therm. motor protection switch.

The control circuit consisting of fuse, double push button (momentary contact), control lamps, automatic contactor coil as well as auxiliary contacts and therm. motor protection switch has to be installed as a separate circuit to the power (main) circuit.

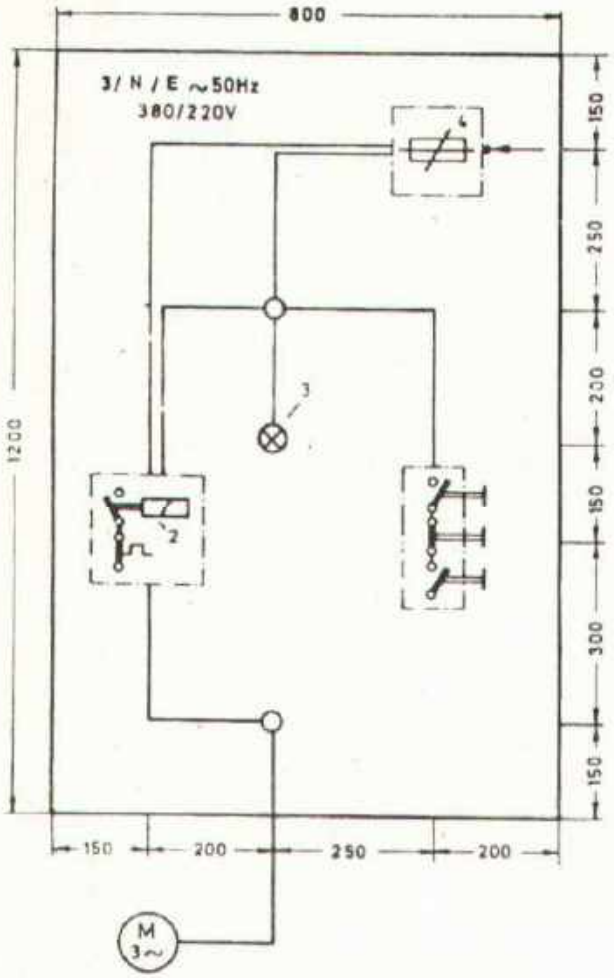
All components are to be installed according to the given drawing and measurements.

Take fuses suitable for your motor.

Adjust also therm. motor protection switch.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| Exercise sheet No. 4.5.3/8,9+10 may be used in addition | MOTOR CONNECTION, CONTACTOR ON–OFF | EP 2.3/4.5.1/5 |
|---|---|---|
| | | Installation III |




MATERIAL:

1 Motor 3~ 380 V
4 Fuses (complete)
1 Junction Box
1 Appliance Connection Box
3 Control Lamps (compl.)
1 Triple Push Button Switch (momentary contact)
2 Automatic Contactors
1 Therm. Motor Protection Switch (Overload Relay)

Cable
Pipe
Wire
Clamps
Screws
Connectors

Indicate number of wires in the installation layout.

The three-phase motor 380 V is to be connected via fuses, automatic contactor and therm. motor protection switch.

The control circuit consisting of fuse, triple push button switch, control lamps, automatic contactor coils as well as auxiliary contacts and therm. motor protection switch has to be installed as a separate circuit to the power (main) circuit.

All components are to be installed according to the given drawing and measurements.

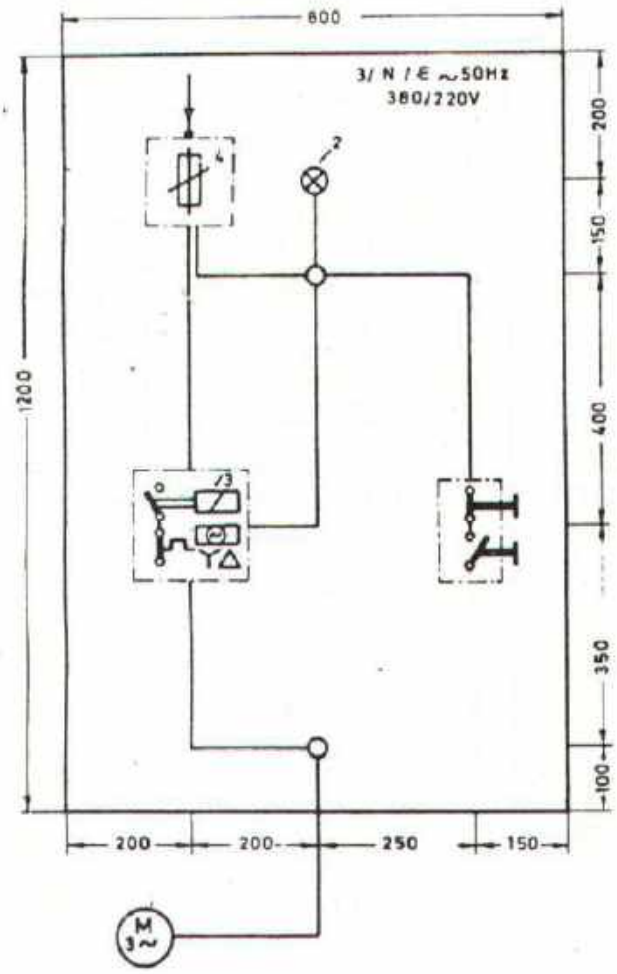
Take fuses suitable for your motor.

Adjust also therm. protection switch.

Give estimate for material.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | | |
|---|---|---|
| Exercise sheet No. 4.5.3/11,12+13 may be used in addition | MOTOR CONNECTION, CONTACTOR REVERSING | EP 2.3/4.5.1/6 Installation III |




MATERIAL:

1 Motor 3~ 660/380 V
4 Fuses (complete)
1 Junction Box
1 Appliance Connection Box
2 Control Lamps (compl.)
1 Double Push Button Switch (mo[illegible]en [illegible]ntact)
3 Automatic Contactors
1 Therm. Motor Protection Switch (Overload Relay)
1 Timing Relay (Timer)

Cable
Pipe
Wire
Clamps
Screws
Connectors

Indicate number of wires in the installation layout.

The three-phase motor 660/380 V is to be connected via fuses, automatic contactors and therm. motor protection switch.

The control circuit consisting of fuse, double push button switch, control lamps, timer, automatic contactor coils as well as auxiliary contacts and therm. motor protection switch has to be installed as a separate circuit to the power (main) circuit.

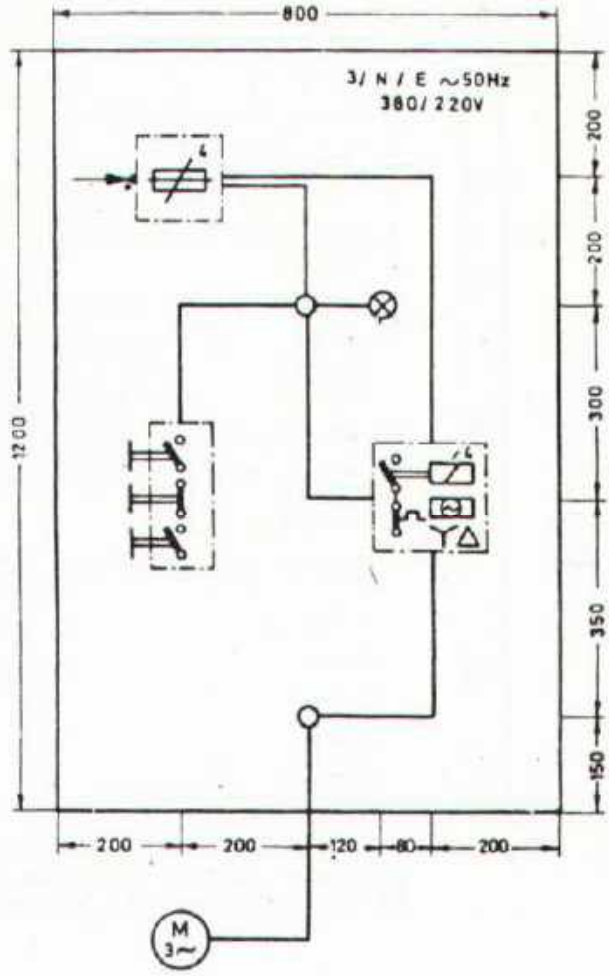
All components are to be installed according to the given drawing and measurements.

Take fuses suitable for your motor.

Adjust also therm. motor protection switch.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | | |
|---|---|---|
| Exercise sheet No. 4.5.3/14,15+16 may be used in addition | MOTOR CONNECTION CONTACTOR STAR DELTA | EP 2.3/4.5.1/7 Installation III |




MATERIAL:

1 Motor 3~ 660/380 V
4 Fuses (complete)
1 Junction Box
1 Appliance Connection Box
1 Control Lamp (complete)
1 Triple Push Button Switch (momentary contact)
4 Automatic Contactors
1 Therm. Motor Protection
1 Timing Relay (Timer)

Cable
Pipe
Wire
Clamps
Screws
Connectors

Indicate number of wires in the installation layout.

The three-phase motor 660/380 V is to be connected via fuses, automatic contactors and motor protection switch.

The control circuit consisting of fuse, triple push button switch, control lamp, timer, automatic contactor coils as well as auxiliary contacts and therm. motor protection switch has to be installed as a separate circuit to the power (main) circuit.

All components are to be installed according to the given drawing and measurements.

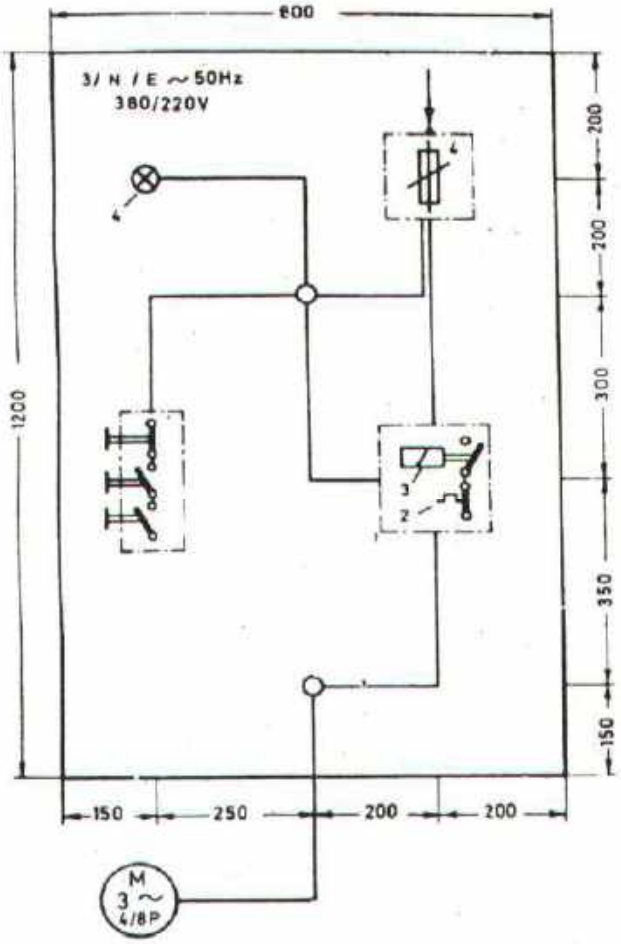
Take fuses suitable for your motor.

Adjust also therm. motor protection switch.

Give estimate for material.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| Exercise sheet No. 4.5.3/17 ff. 19 may be used in addition | MOTOR CONNECTION, CONTACTOR STAR-DELTA REV. | EP 2.3/4.5.1/8 |
|---|---|---|
| | | Installation III |




MATERIAL:

1 Motor 3~ 380 V 4/8 P
4 Fuses (complete)
1 Junction Box
1 Appliance Connection Box
4 Control Lamps (complete)
1 Triple Push Button Switch (momentary contact)
3 Automatic Contactors
2 Therm. Motor Protection Switches (Overload Relay)

Cable
Pipe
Wire
Clamps
Screws
Connectors

Indicate number of wires in the installation layout.

The three-phase double speed motor 380 V is to be connected via fuses, automatic contactors and therm. motor protection switches.

The control circuit consisting of fuse, triple push button switch, control lamps, automatic contactor coils as well as auxiliary contacts and therm. motor protection switches has to be installed as a separate circuit to the power (main) circuit.

All components to be installed according to the given drawing and measurements.

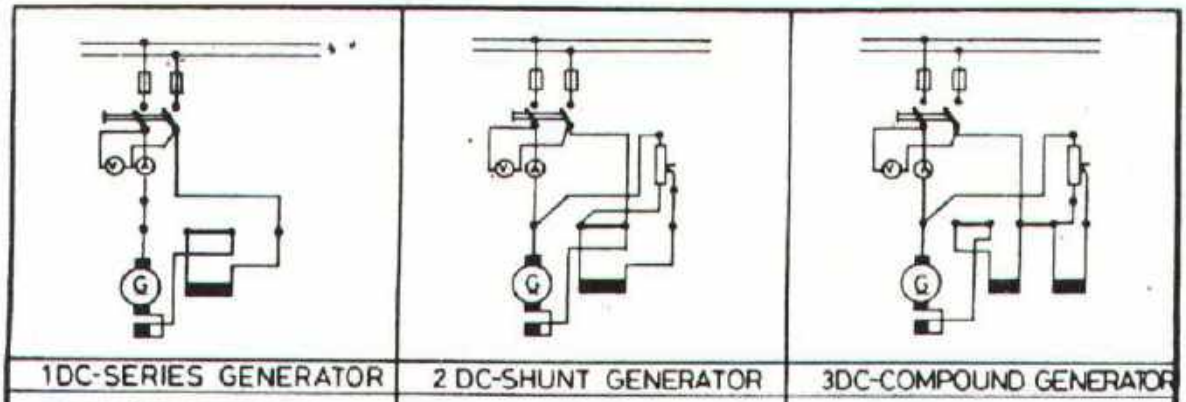
Take fuses suitable for your motor.

Adjust also therm. motor protection switch.

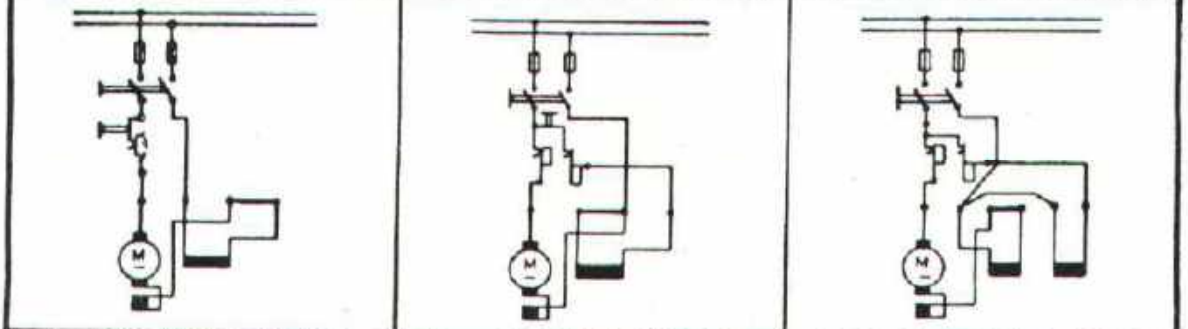
Give estimate for material.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

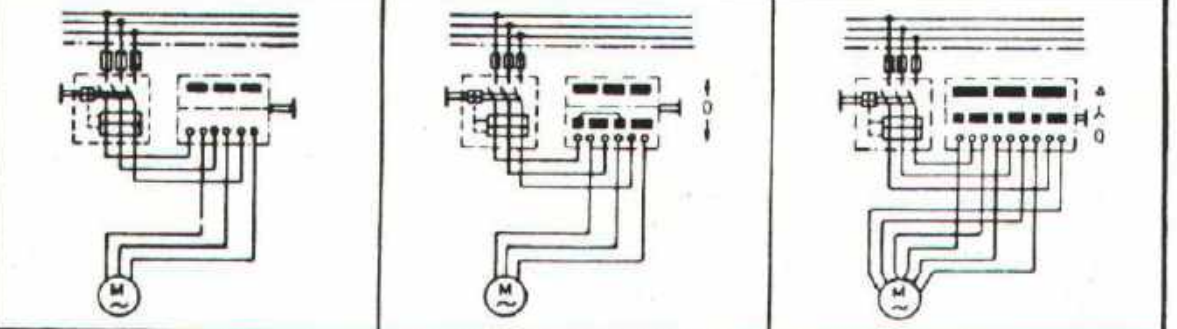
| | | |
|---|---|---|
| Exercise sheet No. 4.5.3/20, 21+22 may be used in addition | MOTOR CONNECTION, CONTACTOR MULTI-SPEED | EP 2 3/4.5.1/9<br>Installation III |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |



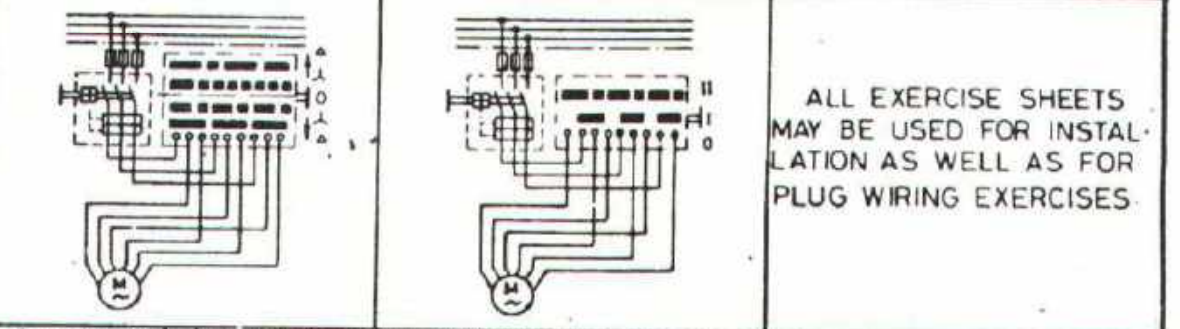
1 DC-SERIES GENERATOR | 2 DC-SHUNT GENERATOR | 3 DC-COMPOUND GENERATOR



4 DC-SERIES MOTOR | 5 DC-SHUNT MOTOR | 6 DC-COMPOUND MOTOR



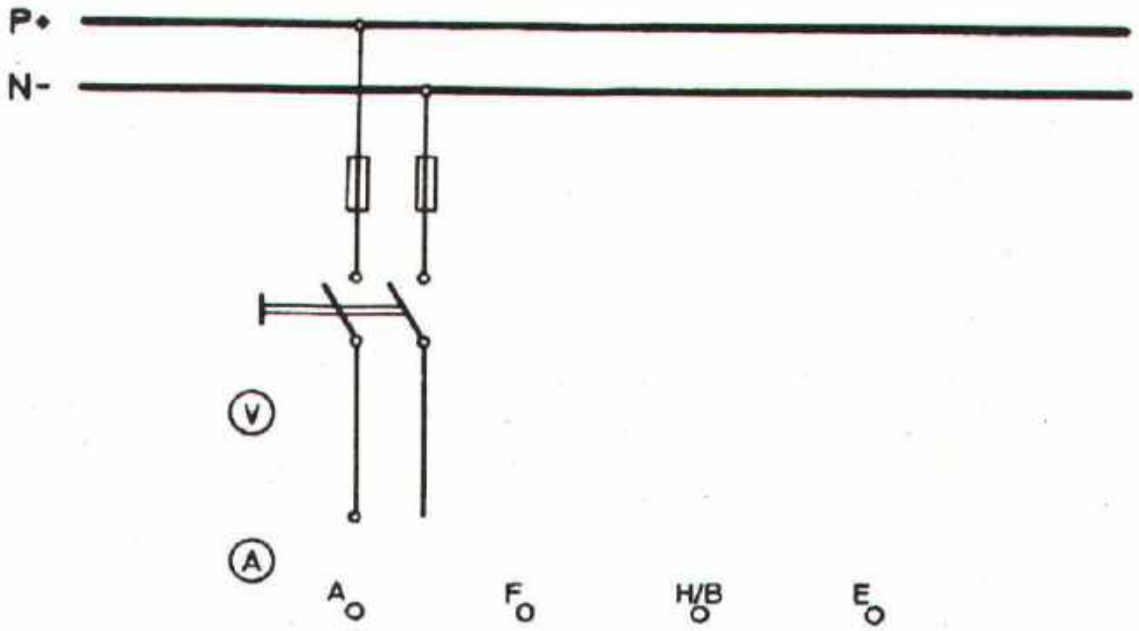
7 SWITCH, ON-OFF | 8 SWITCH, REVERSING | 9 SWITCH Y Δ

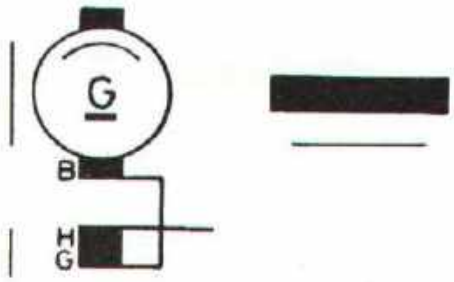


10 SWITCH, Y Δ REVERSING | 11 SWITCH, MULTI SPEED

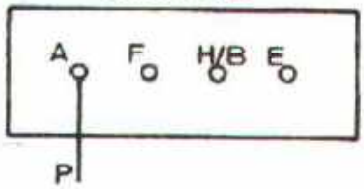
ALL EXERCISE SHEETS MAY BE USED FOR INSTALLATION AS WELL AS FOR PLUG WIRING EXERCISES.

| | | |
|---|---|---|
| | LAYOUT | EP 2.1/4.5 2/ Motors & Switches |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |

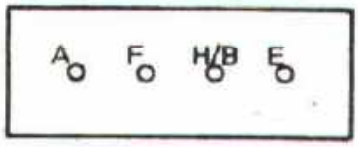



CLOCKWISE

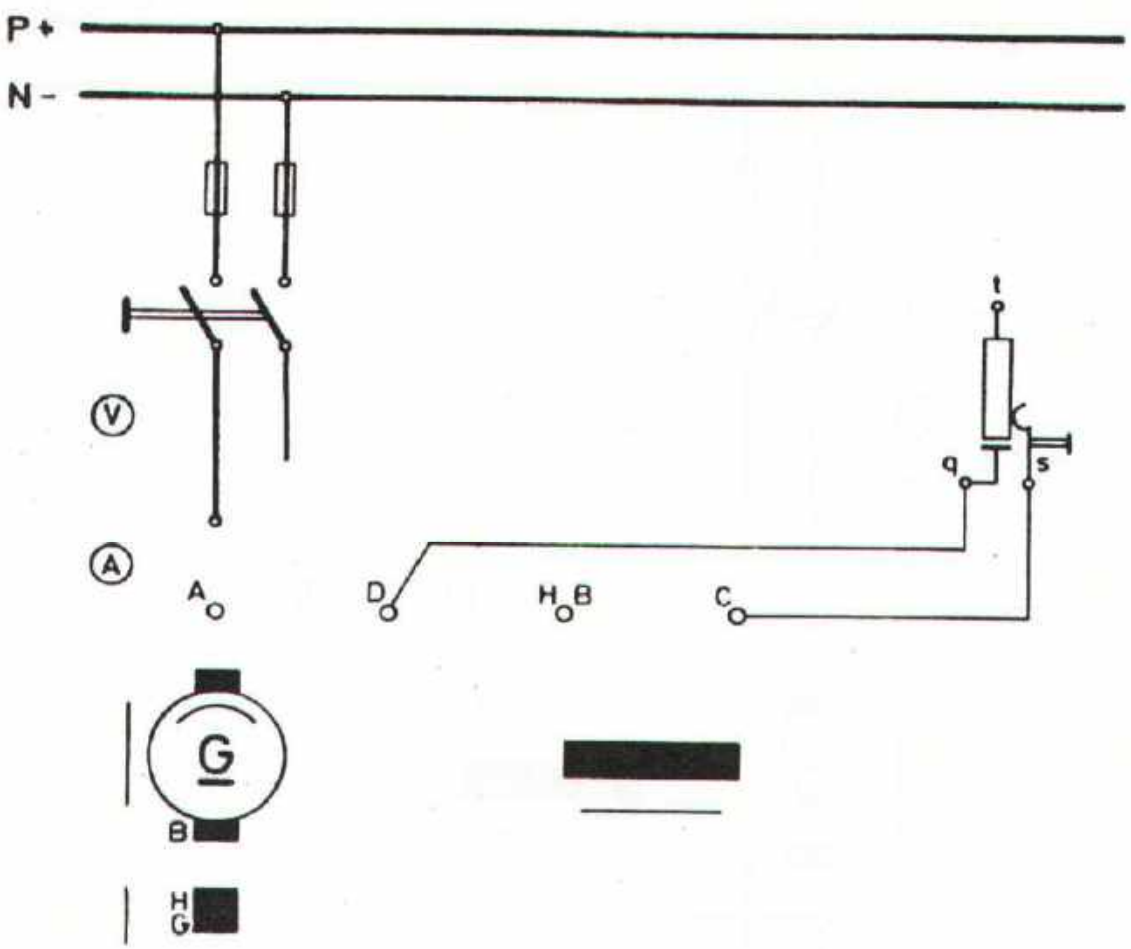



ANTI-CLOCKWISE

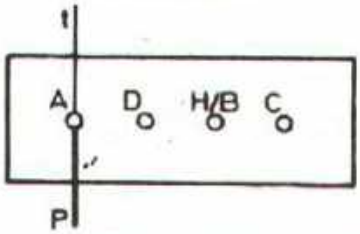



a.) COMPLETE DRAWING, MARK FLOW OF CURRENT AND DIRECTION OF GENERATOR ROTATION.
b.) DRAW CONNECTIONS AND LINKS FOR CLOCKWISE AND ANTI-CLOCKWISE DRIVE.
c.) WHAT RULES CAN YOU APPLY TO DETERMINE THE FLOW (DIRECTION) OF CURRENT ?
d.) WHAT MEASURES CAN BE TAKEN TO INCREASE OR DECREASE THE VOLTAGE OUTPUT ?
EXPERIMENTS REGARDING WORKING PRINCIPLES AND CHARACTERISTICS ARE TO BE MADE-LAB

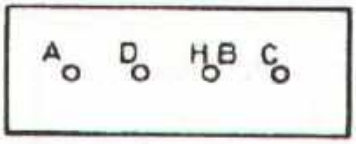
| | SERIES WOUND D.C GENERATOR | EP 2.3/4.5 2/1<br>Motor & Switches |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |




CLOCKWISE




ANTI-CLOCKWISE



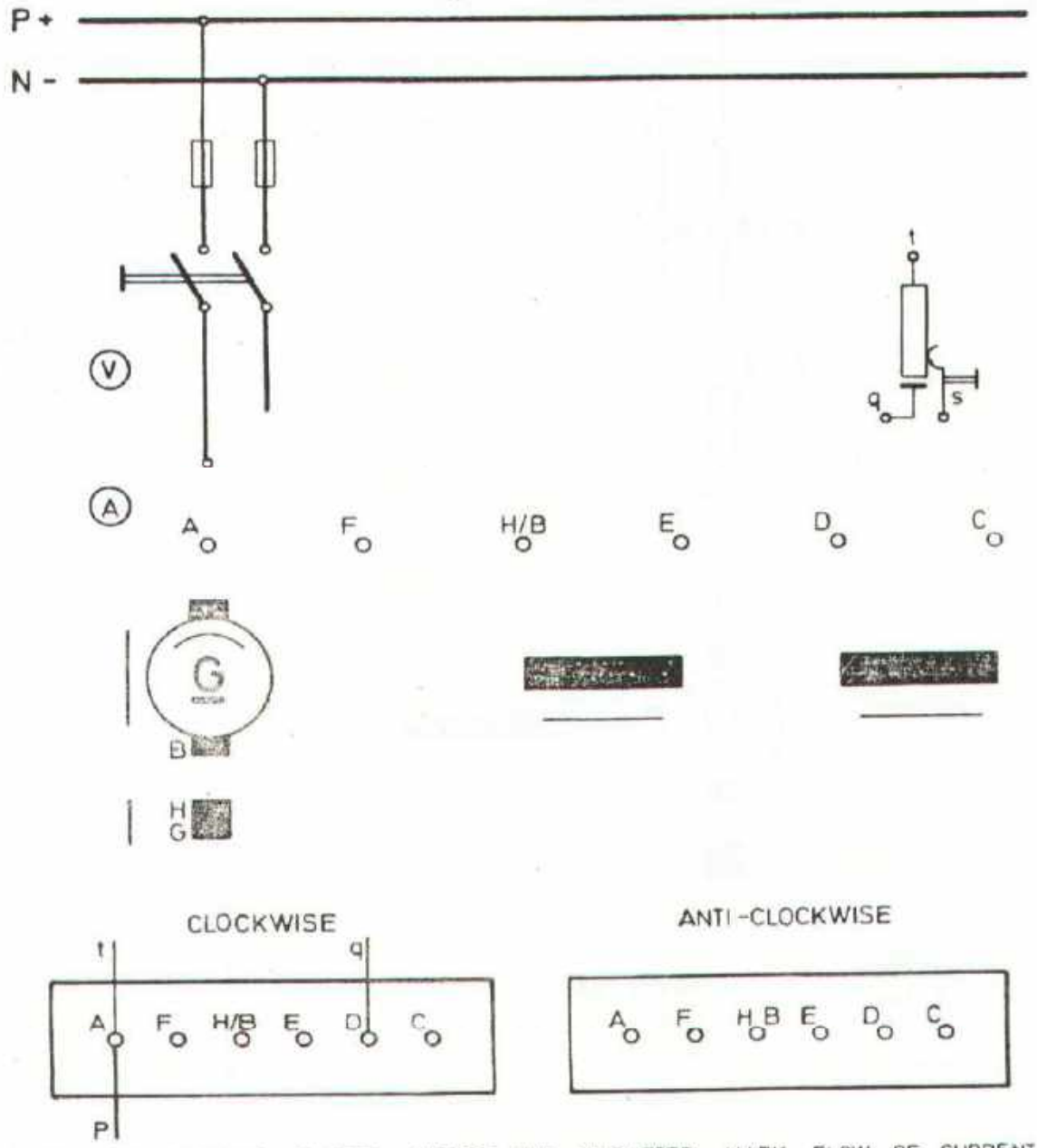

a.) COMPLETE DRAWING, CONNECT AMPERE AND VOLTMETER, MARK FLOW OF CURRENT AND DIRECTION OF GENERATOR ROTATION.

b.) DRAW CONNECTIONS AND LINKS FOR CLOCKWISE AND ANTI-CLOCKWISE DRIVE

c.) WHAT MEASURES CAN BE TAKEN TO INCREASE OR DECREASE THE VOLTAGE OUTPUT?

EXPERIMENTS REGARDING WORKING PRINCIPLES AND CHARACTERISTICS ARE TO BE MADE-LAB.

| | SHUNT WOUND D.C. GENERATOR | EP 2.3/4.5.2/2 |
|---|---|---|
| | | Motors&Switches |



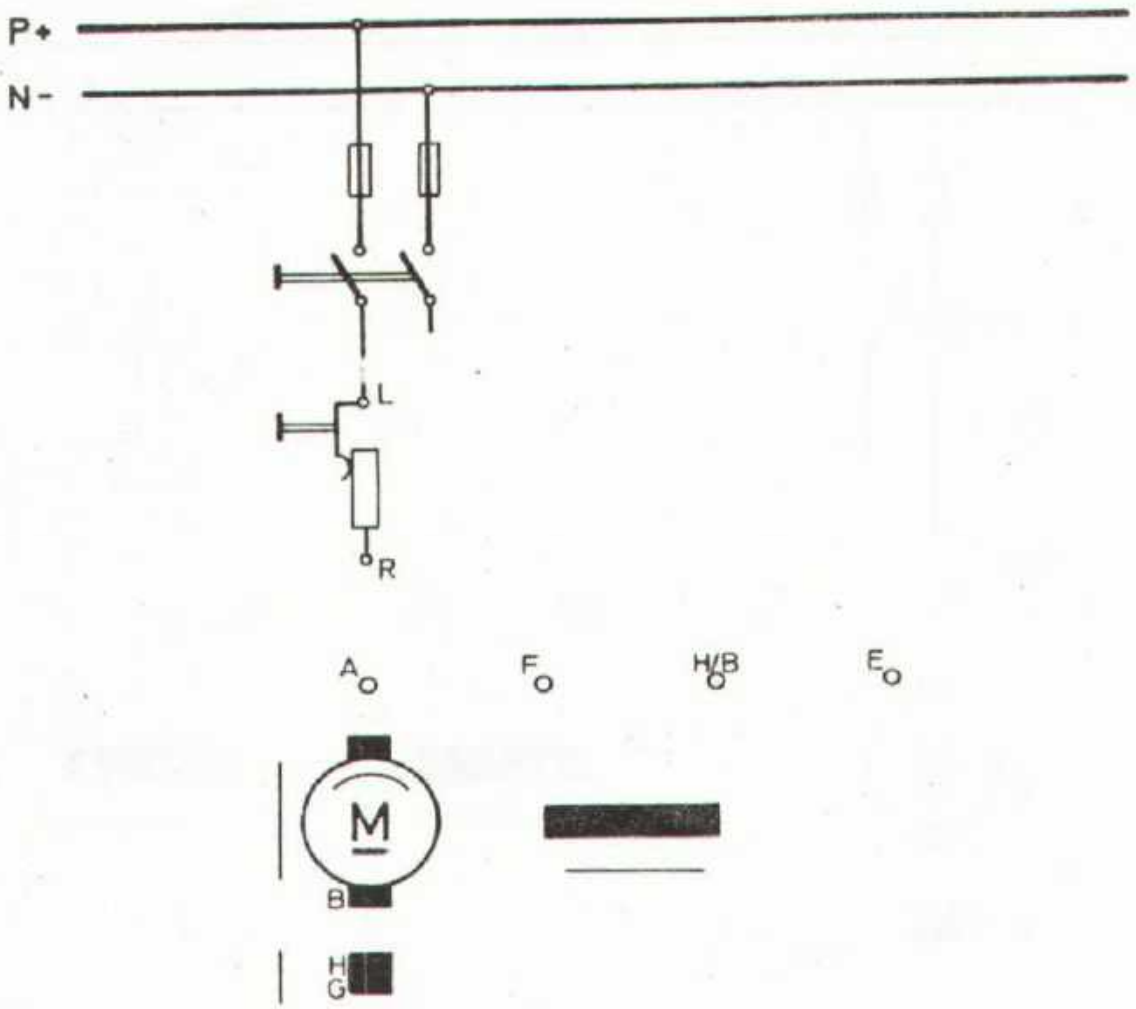

a.) COMPLETE DRAWING, CONNECT AMPERE- AND VOLTMETER, MARK FLOW OF CURRENT AND DIRECTION OF GENERATOR ROTATION.

b.) DRAW CONNECTIONS AND LINKS FOR CLOCKWISE AND ANTI-CLOCKWISE DRIVE.

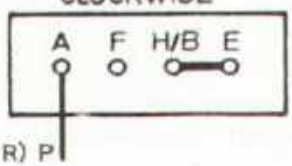
c.) WHAT MEASURES CAN BE TAKEN TO INCREASE OR DECREASE THE VOLTAGE OUT PUT ?

EXPERIMENTS REGARDING WORKING PRINCIPLES AND CHARACTERISTICS ARE TO BE MADE-LAB.

| | COMPOUND WOUND D.C. GENERATOR | EP 2.3/4.5.2/3<br>Motors&Switches |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |

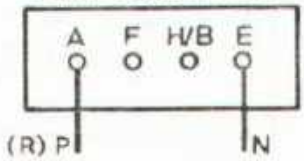



CLOCKWISE




DRAW CONNECTIONS AND LINKS FOR CLOCKWISE AND ANTI-CLOCKWISE DRIVE.

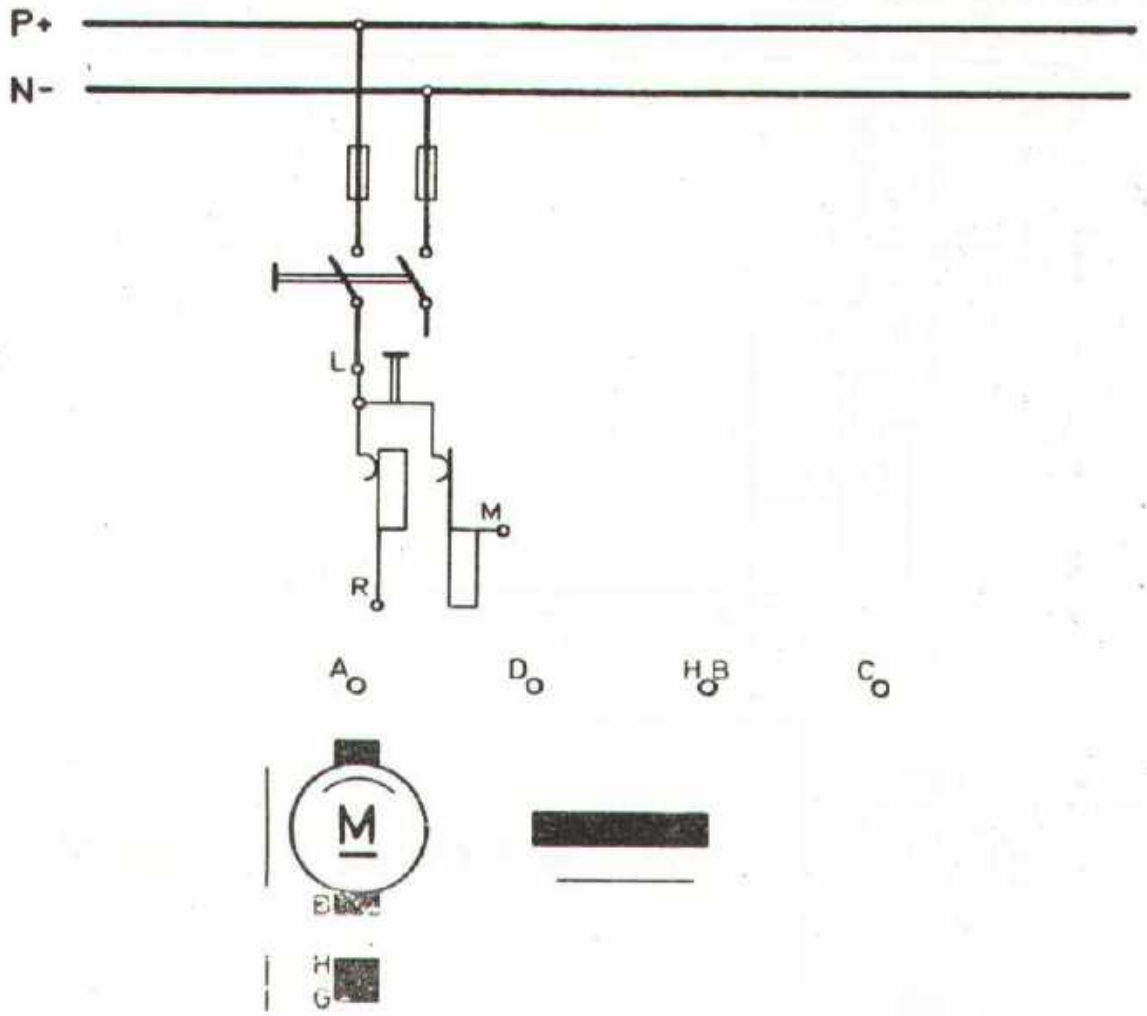
ANTI-CLOCKWISE



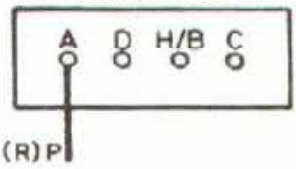

a.) COMPLETE DRAWING, MARK FLOW OF CURRENT AND DIRECTION OF MOTOR ROTATION
b.) WHAT RULES CAN YOU APPLY TO DETERMINE THE FLOW (DIRECTION) OF CURRENT ?
c.) WHAT MEASURES CAN BE TAKEN TO INCREASE OR DECREASE THE SPEED / POWER ?
d.) GET YOUR DRAWING CHECKED, TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
EXPERIMENTS REGARDING WORKING PRINCIPLES AND CHARACTERISTICS ARE TO BE MADE-LAB

# SERIES WOUND D.C. MOTOR

EP 2.3/4.5.2/4
Motors & Switches

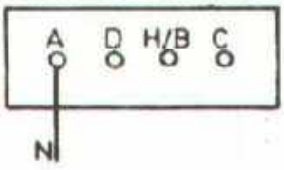



CLOCKWISE



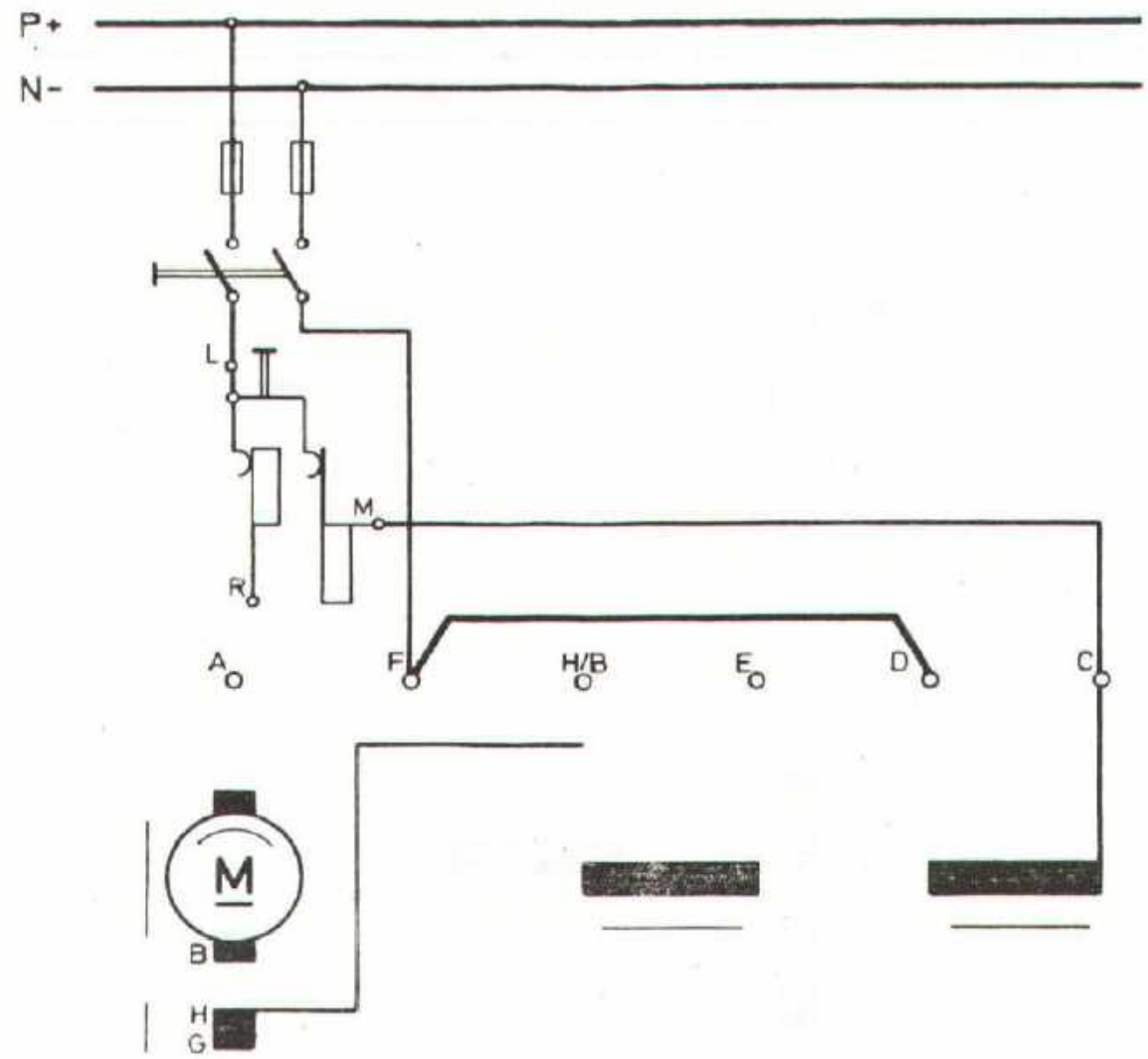

DRAW CONNECTIONS AND LINKS FOR CLOCKWISE AND ANTI-CLOCKWISE DRIVE

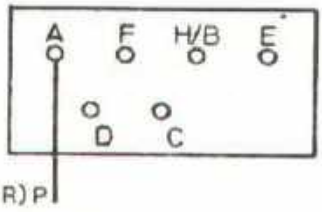
ANTI-CLOCKWISE



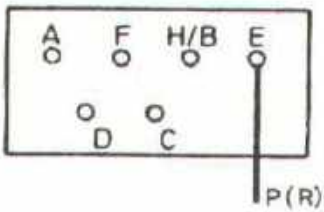

a.) COMPLETE DRAWING, MARK FLOW OF CURRENT AND DIRECTION OF MOTOR ROTATION.
b.) WHAT RULES CAN YOU APPLY TO DETERMINE THE DIRECTION OF MOTOR ROTATION ?
c.) WHAT MEASURES CAN BE TAKEN TO INCREASE OR DECREASE THE SPEED / POWER ?
d.) GET YOUR DRAWING CHECKED, TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB. EXPERIMENTS REGARDING WORKING PRINCIPLES AND CHARACTERISTICS ARE TO BE MADE-LAB

| | SHUNT WOUND D.C. MOTOR | EP 2.3/4.5.2/5<br>Motors & Switches |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME<br>19 | | ELECTRICIAN<br>GENERAL |



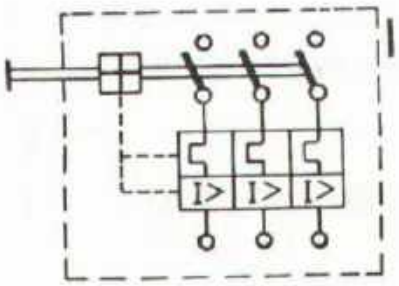



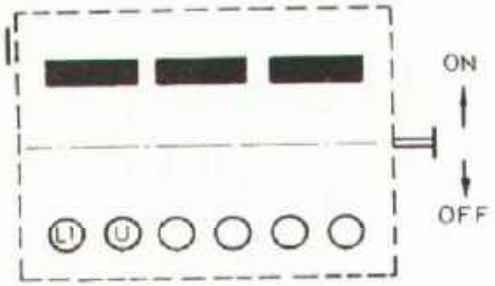

DRAW CONNECTIONS AND LINKS FOR CLOCKWISE AND ANTI-CLOCKWISE DRIVE.

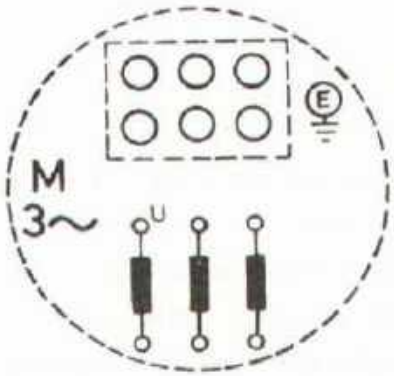



a.) COMPLETE DRAWING, MARK FLOW OF CURRENT AND DIRECTION OF MOTOR ROTATION.
b.) WHAT RULES CAN YOU APPLY TO DETERMINE THE DIRECTION OF MOTOR ROTATION ?
c.) WHAT MEASURES CAN BE TAKEN TO INCREASE OR DECREASE THE SPEED / POWER ?
d.) GET YOUR DRAWING CHECKED, TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
EXPERIMENTS REGARDING WORKING PRINCIPLES AND CHARACTERISTICS ARE TO BE MADE - LAB.

| | COMPOUND WOUND D.C. MOTOR | EP 2.3/4.5.2/6 |
|---|---|---|
| | | Motors & Switches |


Complete the wiring diagram and inner connections between motor-terminal and motorwindings.
Indicate all missing letters.
Draw installation layout overleaf.

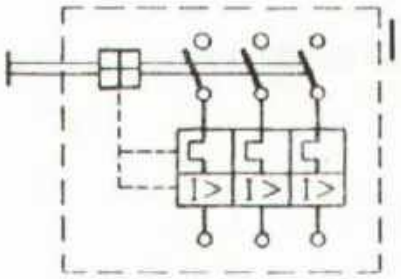
Supply 3 x 380 V, Motor 380V △ 3~

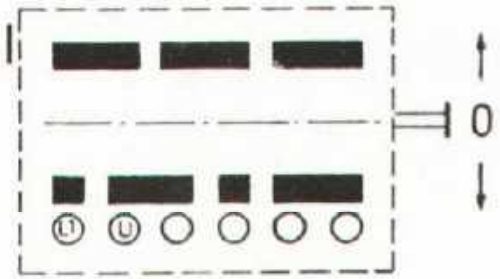
Have your drawing checked before starting practical work

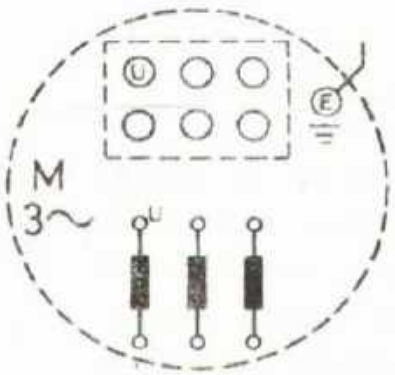
Check and connect SUPPLY in PRESENCE of your INSTRUCTOR

| | ON-OFF DRUM SWITCH | EP 2.3/4.5.2/7<br>Motors&Switches |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |

L1
L2
L3
E




Complete the wiring diagram and inner connections between motor-terminal and motorwindings.
Indicate all missing letters.
Draw installation layout overleaf.

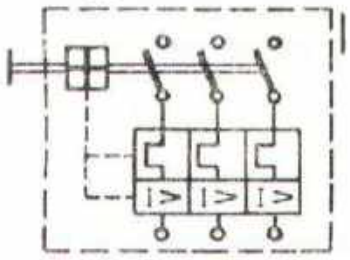
Supply 3 x 380 V, Motor 380V △ 3~

Have your drawing checked before starting practical work

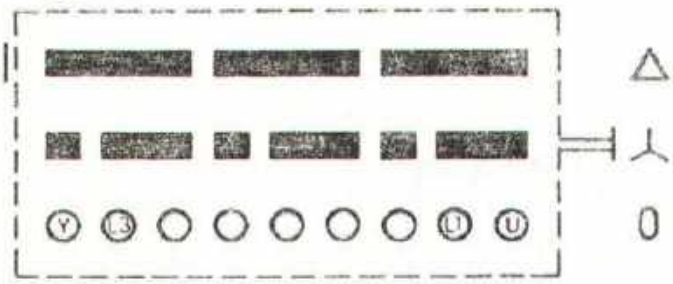
Check and connect SUPPLY in PRESENCE of your INSTRUCTOR

| | REVERSING DRUM SWITCH | EP 2.3/4.5.2/8 |
|---|---|---|
| | | Motors&Switches |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING | | ELECTRICIAN |
| PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | GENERAL |

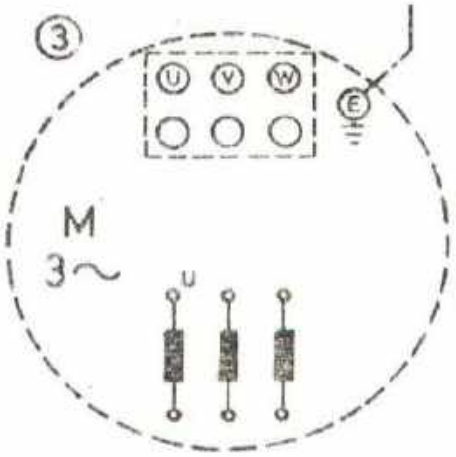

①




②




③




Complete the wiring diagram and inner connections between motorterminal and motorwindings

Indicate all missing letters

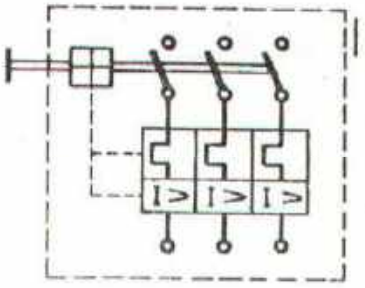
Draw installation layout overleaf.

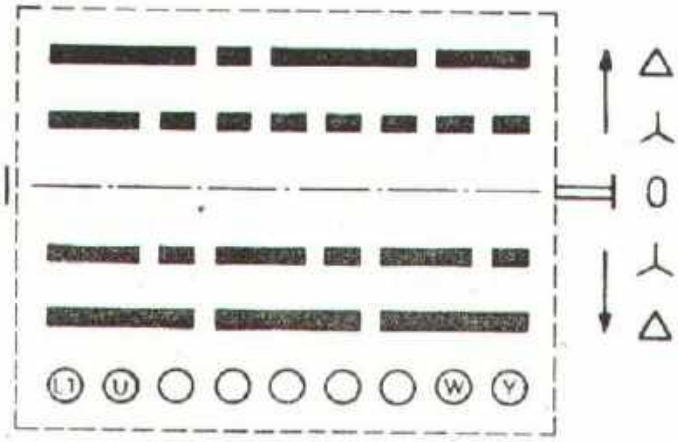
Have your drawing checked before starting practical work.

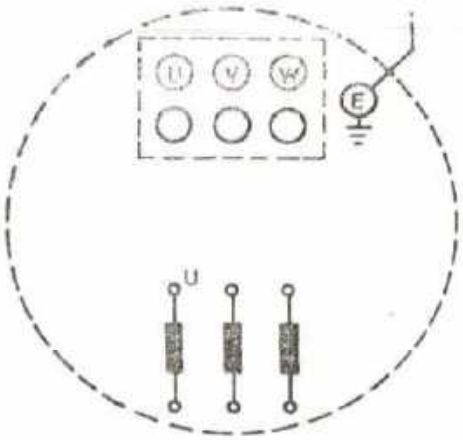
Name devices indicated with ① .....
② .....
③ .....

Check and connect SUPPLY in PRESENCE of your INSTRUCTOR

| | | |
|---|---|---|
| | STAR-DELTA DRUM SWITCH | EP 2.3/4.5.2/9<br>Motors&Switches |



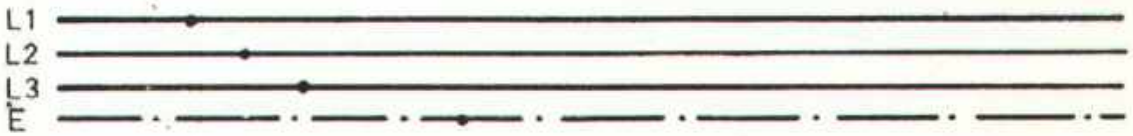



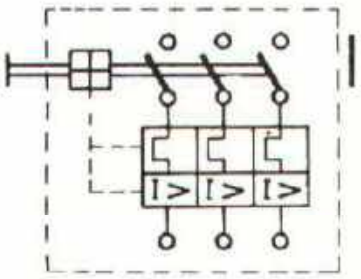

Complete the wiring diagram and inner connections between motorterminal and motorwindings.
Indicate all missing letters.
Draw installation layout overleaf.

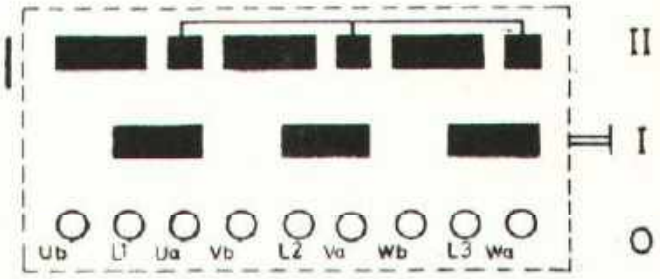
Have your drawing checked before starting practical work.

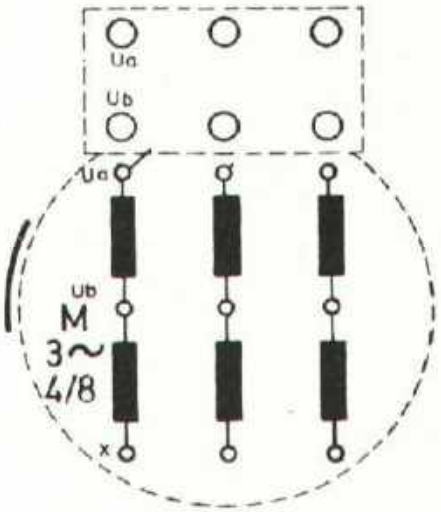
Check and connect SUPPLY in PRESENCE of your INSTRUCTOR

| | STAR-DELTA REVERSING DRUM SWITCH | EP 2.3/4.5.2/10 Motors&Switches |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN GENERAL |



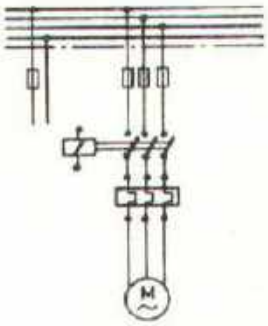




Complete the wiring diagram and inner connections between motor terminal and motor windings.
Indicate all missing letters.
Draw installation layout overleaf.

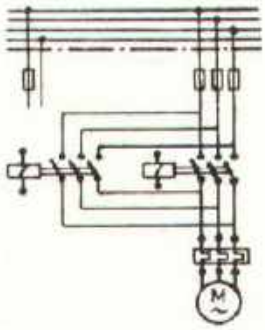
Have your drawing checked before starting practical work.

**Check** and connect SUPPLY in PRESENCE of your INSTRUCTOR

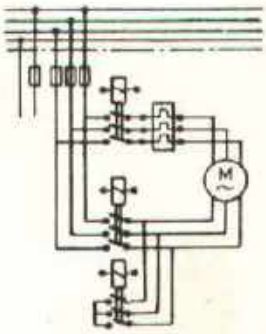
| | MULTI SPEED DRUM SWITCH | EP2.3/4.5.2/11<br>Motors&Switches |
|---|---|---|



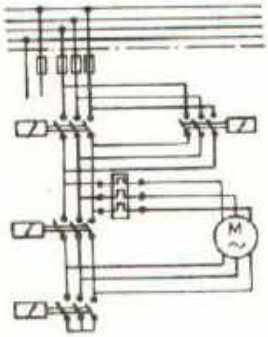
8 – 9 – 10 CONT ON OFF



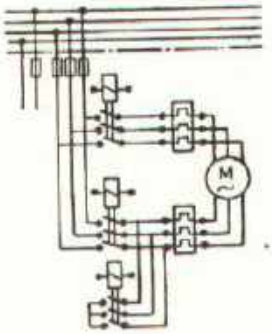
11 – 12 – 13 CONTACTOR REV -



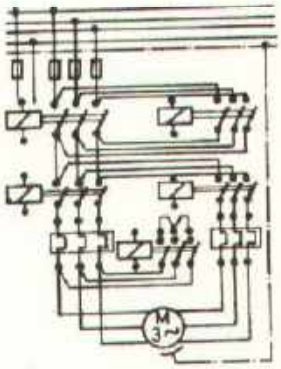
14 – 15 – 16 CONTACTOR 人 △



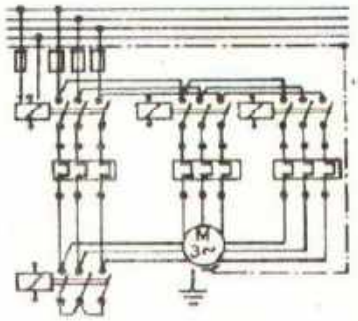
17 – 18 – 19 CONT 人 △ REV -



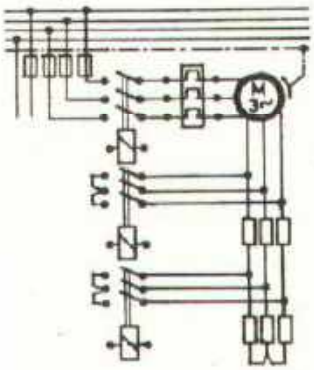
20 – 21 – 22 CONT-MULTI SPEED



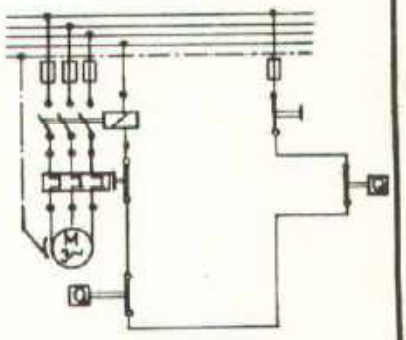
23 – 24 – CONT-MULTI SPEED REV



25 – 26 CONT-THREE SPEED



27 – 28 – 29 CONT-ROTOR STARTER



30 CONT-PUMP CONTROL

| | | |
|---|---|---|
| | LAYOUT | EP 2.1/4.5.3/ Contactors |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |

CONTACTORS

As a prime mover the 3 phase motor dominates the field. Apart from individual fractional H.P. motors which have manually operated starters, most motors are controlled by means of a contactor. These are operated by various control devices, either manually or automatically, from signals actuated by time, movement, pressure, quantity or temperature. Control sequencing necessary between several drives can easily be carried out with contactors, interlocking being arranged via their auxiliary contacts.

The load rating stated in kW is the basic parameter required to allow a correct selection of contactors. This figure by itself, however, is not always sufficient. The type of load, its operating cycle, switching frequency and total life required, all influence the overall load on the contactor. All this has to be considered when installing a contactor.

AUXILIARY CONTACTS

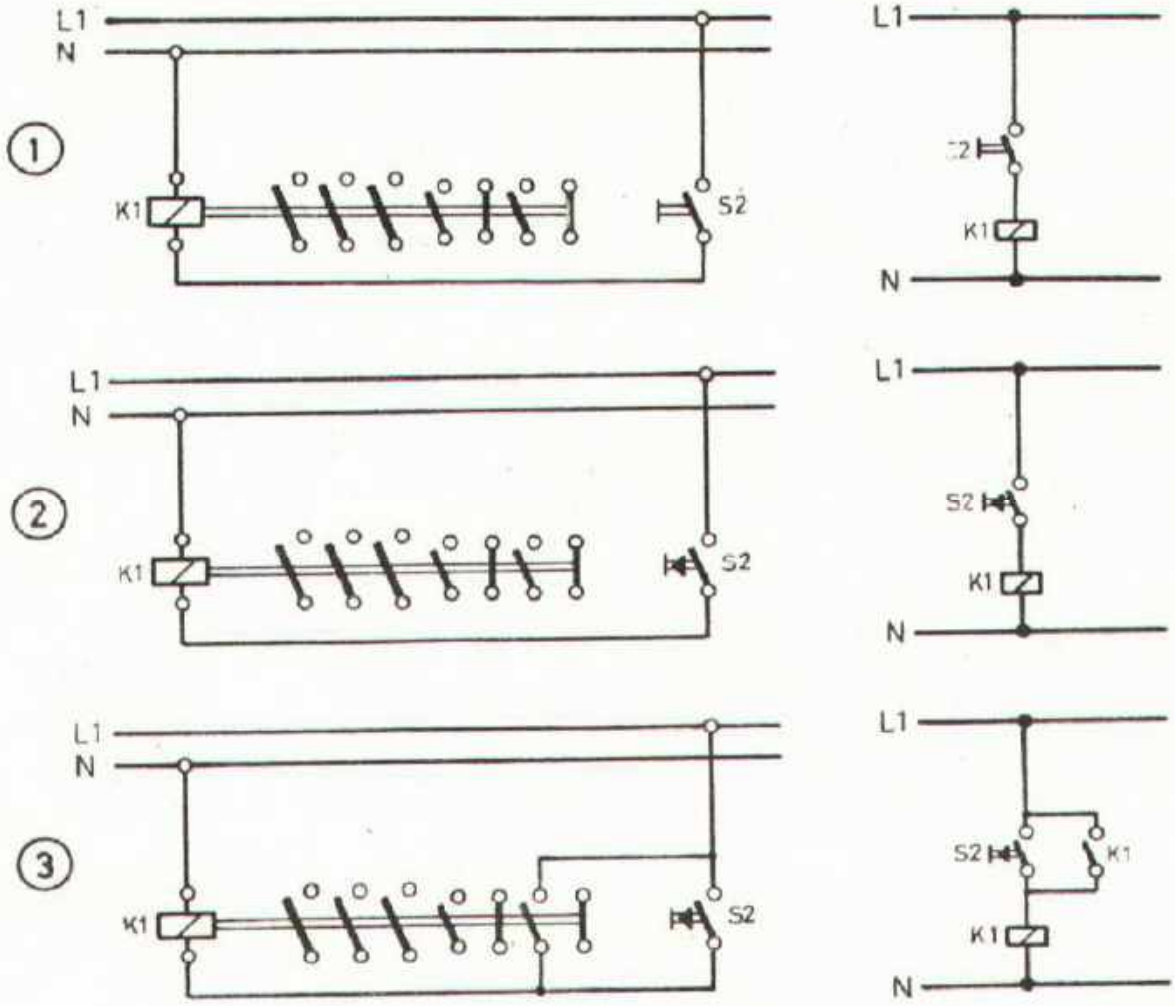
These contacts are used in contactor coil circuits and together with control devices (such as push-buttons, limit switches, timers and the like) form the control circuit of control systems for motors, solenoids, clutches etc. The contacts of control circuits are therefore not subjected to any great load. Bearing in mind the large number of relays in large control systems, the dimensions have to be kept small.

A selection of most common circuits in different representations such as mains wiring circuits, current path - and wiring diagrams of control circuits for contactors will be given later in this course.

Drawing exercises CIRCUITS III are to be completed in parallel with this course and to be used together with its diagrams to carry out the practical exercises.

Besides the circuits actually shown here, there are many possible variations, combinations and extensions of contactor circuits under different conditions, such as circuits which comprise additional limit switches, pressure and level switches, temperature dependent switches, special motors such as brake motors. (Motors with an incorporated brake to stop them immediately when the circuit is interrupted.)

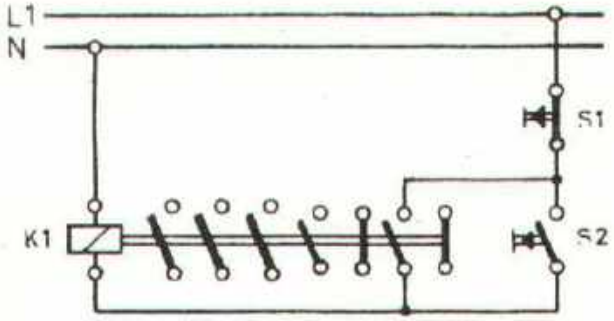
All these circuits will be understood more easily when you have studied and worked through this course.




① In the first step the control circuit is switched with a single pole switch.

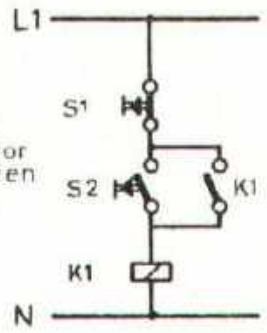
② We now operate the control circuit with a momentary contact switch (push button). The contactor only gives a connection as long as you press the button.

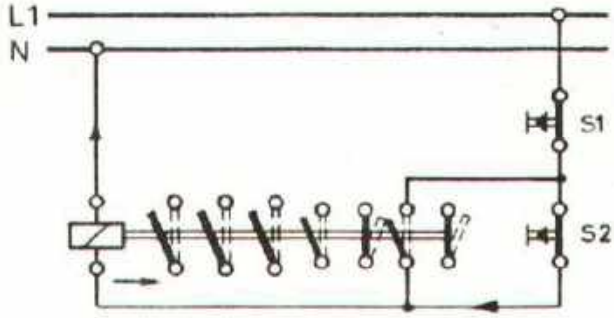
③ A "closer" is connected within the circuit in parallel to the push button. If the push button is now pressed, the circuit is closed, first with the push button and then with the "closer" of the contactor itself. By releasing the push button the circuit remains closed due to the "closer". To open the circuit we need another switch in series to the afore mentioned ones; it is called an "opener".




OFF

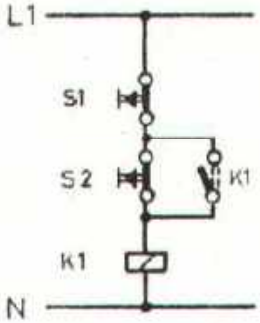
Circuit disconnected closer of contactor and S2 are both open

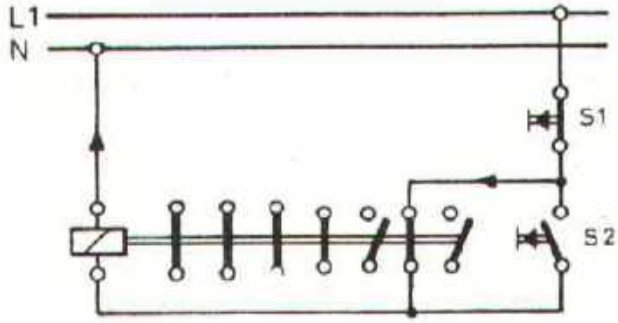



ON

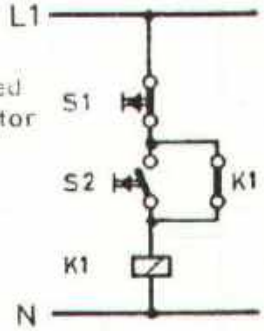
Circuit is closed by pressing S2

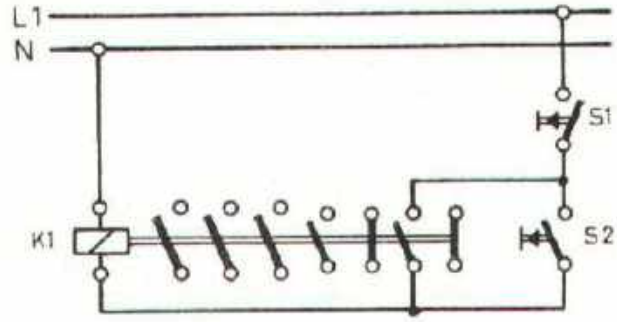



ON

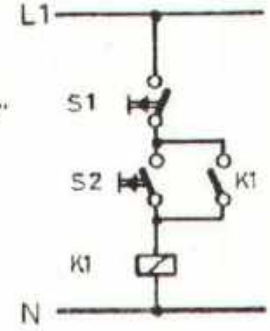
Circuit is kept closed by closer of contactor (self-retaining)




OFF

Circuit disconnected by pressing S1 "opener"




# INTRODUCTION

EP 2.3/4.5.3/3

Contactors

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL

| Letter code | Kind of item | Examples |
|---|---|---|
| A | Assemblies, sub-assemblies | Amplifier with tubes or transistors, magnetic amplifier, laser, maser |
| B | Transducers, from non-electrical quantity to electrical quantity or vice-versa | Thermo-electric sensor, thermo cell, photo-electric cell, dynamo-meter, crystal transducer, microphone, pick-up, loudspeaker, synchros, resolvers |
| C | Capacitors | |
| D | Binary elements, delay devices, storage devices | Combinative elements, delay lines, bistable elements, monostable elements, core storage, register, magnetic tape recorder, disk recorder |
| E | Miscellaneous | Lighting devices, heating devices, devices not specified elsewhere in this Table |
| F | Protective devices | Fuse, over-voltage discharge device, arrester |
| G | Generators, supplies | Rotating generator, rotating frequency converter, battery, supply device, oscillator, quartz-oscillator |
| H | Signalling devices | Optical and acoustical indicators |
| K | Relays, contactors | |
| L | Inductors | Induction coil, line trap |
| M | Motors | |
| P | Measuring equipment, testing equipment | Indicating, recording and integrating measuring devices, signal generator, clocks |
| Q | Mechanical switching devices for power circuits | Circuit-breaker, isolator |
| R | Resistors | Adjustable resistor, potentiometer, rheostat, shunt, thermistor |
| S | Switches, selectors | Control switch, push-buttons, limit switch, selector switch, selector, dial contact, connecting stage |
| T | Transformers | Voltage transformer, current transformer |
| U | Modulators, changers | Discriminator, demodulator, frequency changer, coder, inverter, converter, telegraph translator |
| V | Tubes, semiconductors | Electronic tube, gas-discharge tube, diode, transistor, thyristor |
| W | Transmission paths, waveguides, aerials | Jumper wire, cable, busbar, waveguide, waveguide directional coupler, dipole, parabolic aerial |

continued

| Letter code | Kind of item | Examples |
|---|---|---|
| X | Terminals, plugs, sockets | Disconnecting plug and socket, test jack, terminal board, soldering terminal strip |
| Y | Electrically operated mechanical devices | Brake, clutch, pneumatic valve |
| Z | Terminations, hybrid transformers, filters, equalizers, limiters | Cable balancing network, compandor, crystal filter |

## Letter codes for the designation of general function

| Letter code | General function |
|---|---|
| A | Auxiliary |
| B | Direction of movement (forward, backward, hoist, lower, clock-wise, anti-clock-wise) |
| C | Counting |
| D | Differentiating |
| E | |
| F | Protecting |
| G | Testing |
| H | Signalling |
| J | Integrating |
| K | Jog |
| L | |
| M | Main |
| N | Measuring |
| P | Proportional |
| Q | State (start, stop, limit) |
| R | Reset, erase |
| S | Storing, recording |
| T | Timing, delaying |
| U | |
| V | Speed (accelerating, braking) |
| W | Adding |
| X | Multiplying |
| Y | Analogue |
| Z | Digital |

| STEP NO. | "CLOSER" OR MAKE | "OPENER" OR BREAK | IN CURRENT PATH | SWITCHES ON | SWITCHES OFF | MAIN-TAINS | INTER-LOCKS | IN CURRENT-PATH |
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NAME :

ROLL No. :

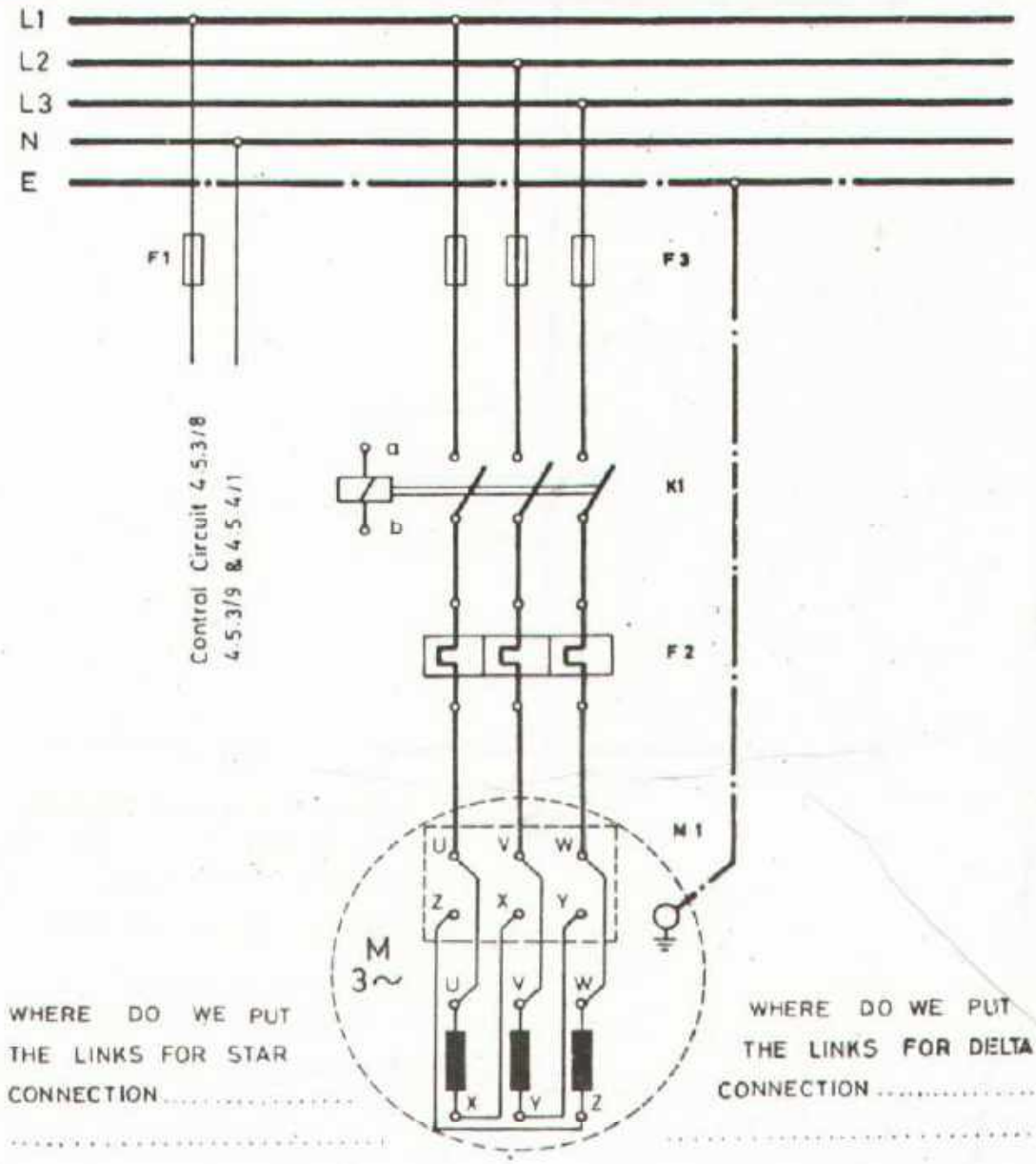
FOR EXERCISE: DESCRIPTION OF CONTROL CIRCUIT

EP 2.3/4 5.3/6
Contactors

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN
GENERAL




WHERE DO WE PUT THE LINKS FOR STAR CONNECTION .....

.....

WHERE DO WE PUT THE LINKS FOR DELTA CONNECTION .....

.....

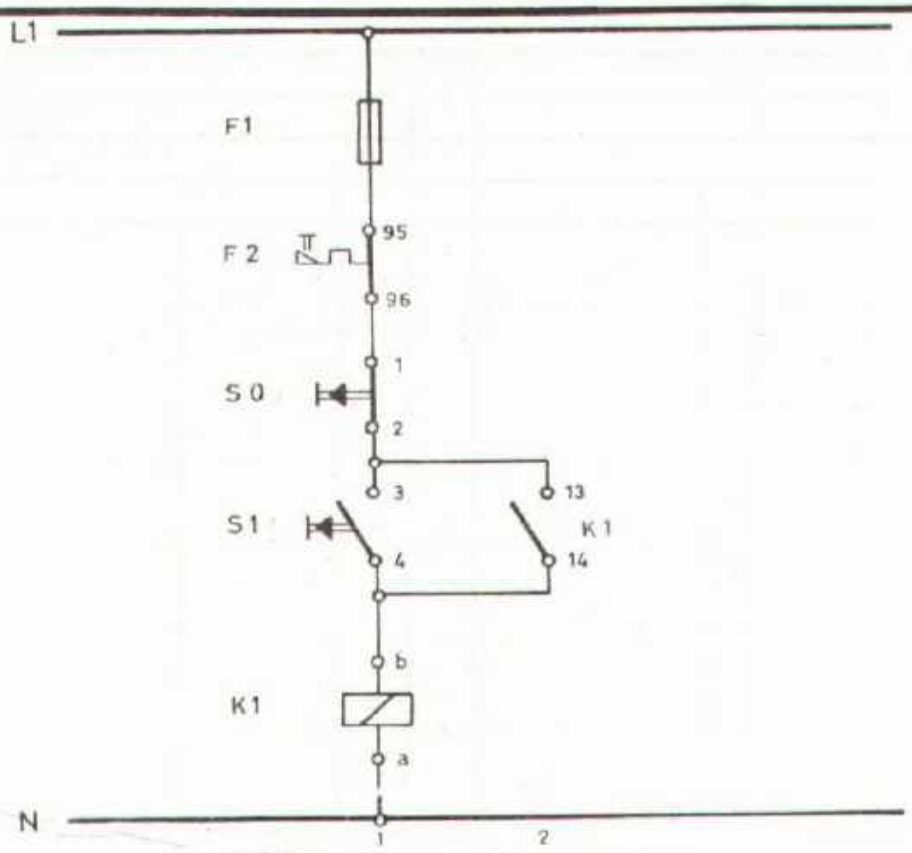
TAKE SUITABLE MATERIAL ( MOTOR ) AND DO YOUR PRACTICAL JOB. EXERCISE SHEET NO 4.5.3/8 OR 4.5.3/9 AND 4.5.4/1 MAY BE USED IN ADDITION.

ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

DRAWING IS ALSO USED FOR EXERCISE NO. 4.5.1/5

| | MOTOR CONNECTION, 3~ ON-OFF | EP 2.3/4.5.3/7<br>Contactors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN GENERAL |




M c o
– 2 –
–
–

IF THIS IS GIVEN IN A DRAWING IT HAS TO BE BELOW THE CONTACTOR CONCERNED WITH.

FOR MAIN CONTACTS (NOT SHOWN IN THIS DRAWING)

FOR "CLOSER" or MAKE CONTACTS

FOR "OPENER" or BREAK CONTACTS

PATH WHERE YOU WILL FIND THE CONTACTS IN THE DRAWING.

ALL CONTACTS CONTROLLED OF e.g. CONTACTOR K1 ARE ALSO MARKED WITH K1.

DESCRIPTION OF PARTS :

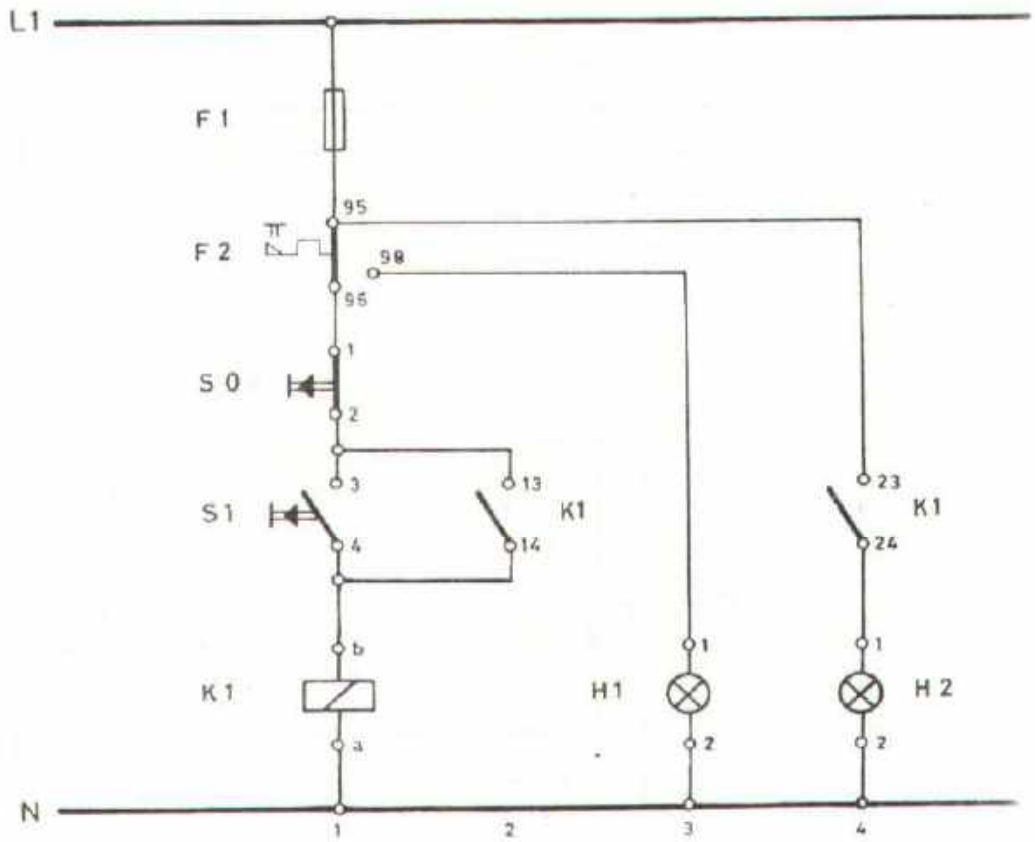
S0 PUSH BUTTON-OFF MOMENTARY CONTACT
S1 PUSH BUTTON-ON
K1 AUTOMATIC CONTACTOR (COIL)
F1 CONTROL CIRCUIT FUSE
F2 THERMAL OVERLOAD SWITCH with LOCK

a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/5
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION EXERCISE.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

31

| | MOTOR CONNECTION, ON-OFF | EP 2.3/4.5.3/8<br>Contactors |
|---|---|---|




M c o — IF THIS IS GIVEN IN A DRAWING IT HAS TO
— 2 — BELOW THE CONTACTOR CONCERNED WITH.
— 4 —
—

DESCRIPTION OF PARTS:

S0 PUSH BUTTON-OFF MOMENTARY CONTACT
S1 PUSH BUTTON-ON " "
K1 AUTOMATIC CONTACTOR (COIL)
F1 CONTROL CIRCUIT FUSE
F2 THERMAL OVERLOAD SWITCH with LOCK
H1 WARNING LAMP (OVERLOAD)
H2 CONTROL LAMP (MOTOR RUNNING)

M c o — FOR MAIN CONTACTS
— 2 — FOR "CLOSER" or MAKE CONTA
— 4 — FOR "OPENER" or BREAK CONT
— PATH WHERE YOU WILL FIND CONTACTS IN THE DRAWING.

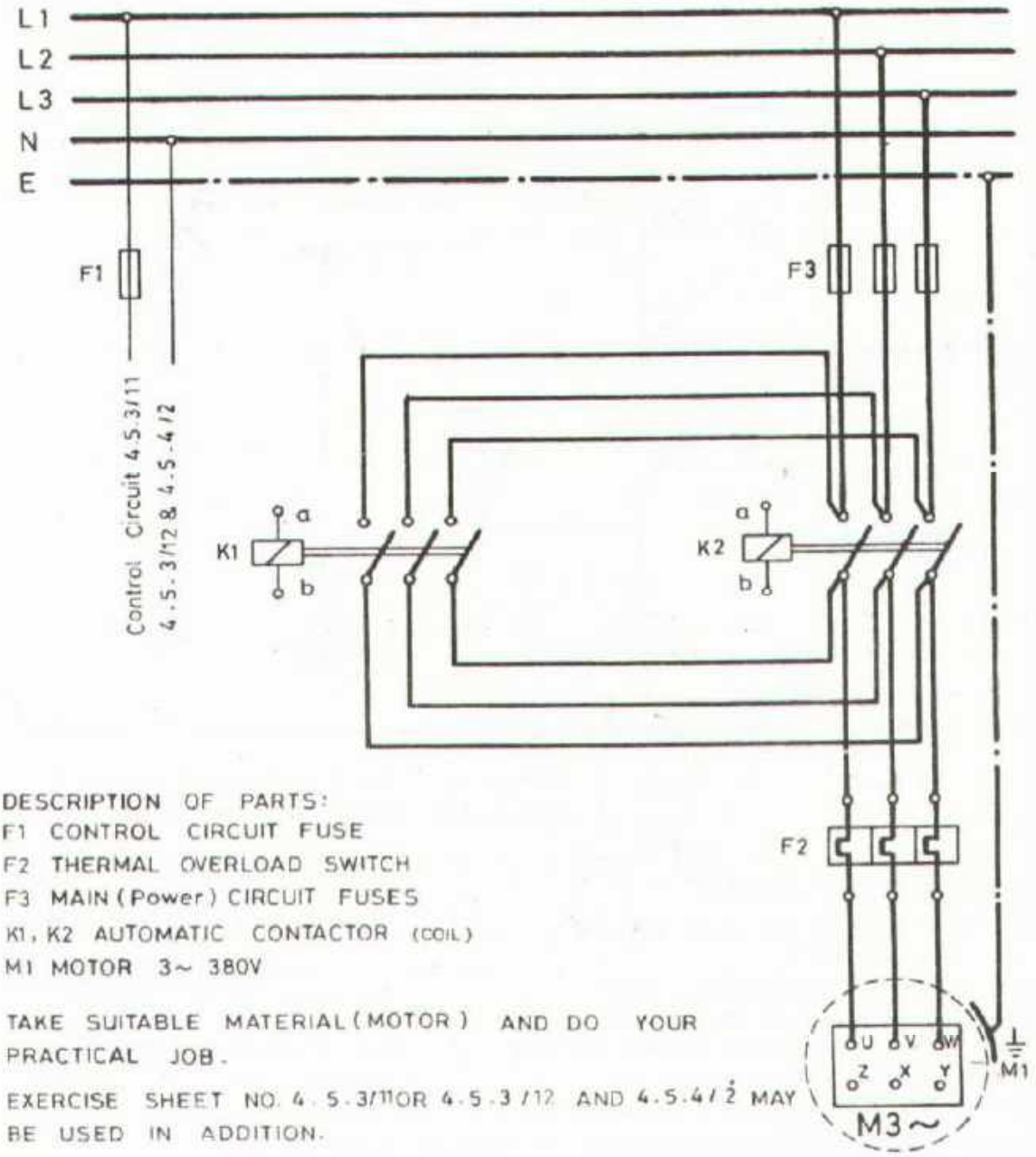
ALL CONTACTS CONTROLLED OF CONTACTOR K1 ARE ALSO MA WITH K1

a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET No. 4.5.3/7 AND 4.5.4/1 MAY BE USED IN ADDITION
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATIC
CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

DRAWING IS ALSO USED FOR EXERCISE No. 4.5.1/5

# MOTOR CONNECTION, ON-OFF

EP 2.3/
Contact




DESCRIPTION OF PARTS:

F1 CONTROL CIRCUIT FUSE

F2 THERMAL OVERLOAD SWITCH

F3 MAIN (Power) CIRCUIT FUSES

K1, K2 AUTOMATIC CONTACTOR (COIL)

M1 MOTOR 3~ 380V

TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.

EXERCISE SHEET NO. 4.5.3/11 OR 4.5.3/12 AND 4.5.4/2 MAY BE USED IN ADDITION.

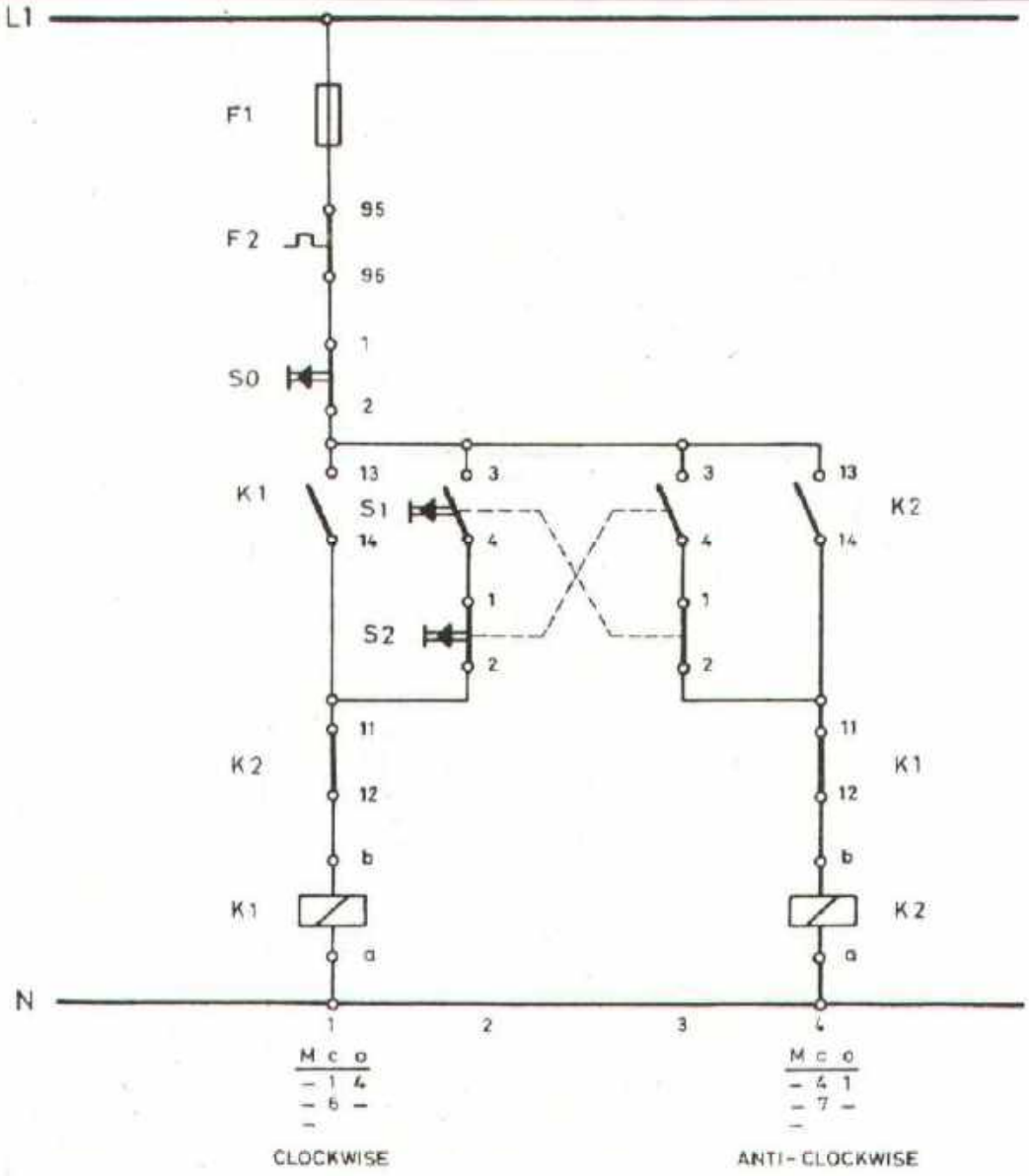
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

NOTE: DO NOT SWITCH DIRECTLY FROM ONE DIRECTION TO THE OTHER, ALLOW MOTOR TO STOP.

DRAWING IS ALSO USED FOR EXERCISE NO 4.5.1/6

| | MOTOR CONNECTION 3~ REVERSING | EP 2.3/4.5.3/10<br>Contactors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |




a,) GIVE DESCRIPTION OF:

F1 ..... K1 , K2 .....

F2 ..... S0 , S1 , S2 .....

b,) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6

c ) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.

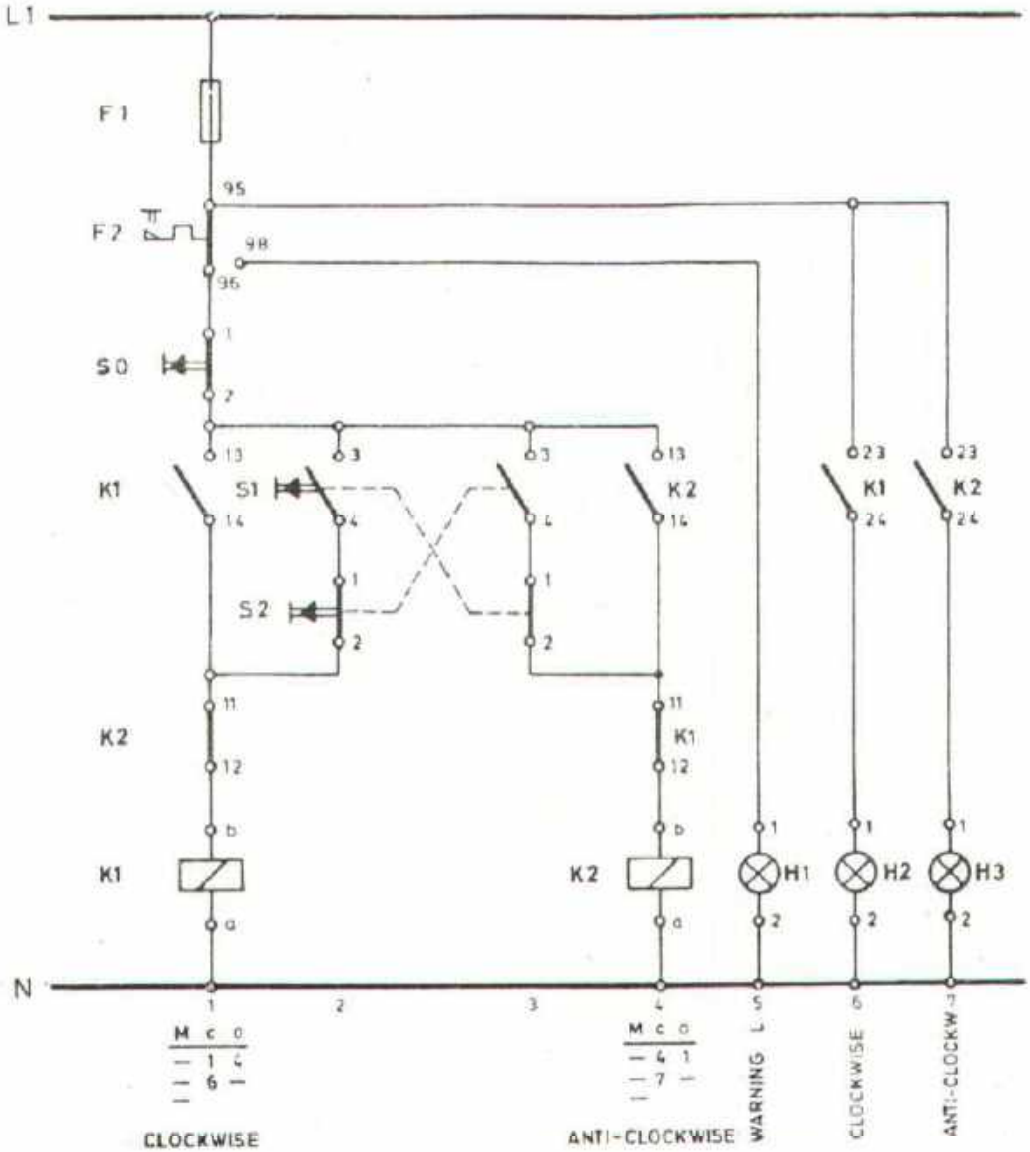
EXERCISE SHEET NO. 4-5-3/10 AND 4.5.4/2 MAY BE USED IN ADDITION.

ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

NOTE : DO NOT SWITCH DIRECTLY FROM ONE DIRECTION TO THE OTHER, ALLOW MOTOR TO STOP.

| | MOTOR CONNECTION, 3~ REVERSING | EP 2.3/4.5.3/11<br>Contactors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN<br>GENERAL |




a.) GIVE DESCRIPTION OF : K1, K2 ..... F1 ..... S0, S1, S2 ..... F2 ..... H1, H2, H3 .....

b.) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6

c.) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.

EXERCISE SHEET NO 4.5.3/10 AND 4.5.4/2 MAY BE USED IN ADDITION.

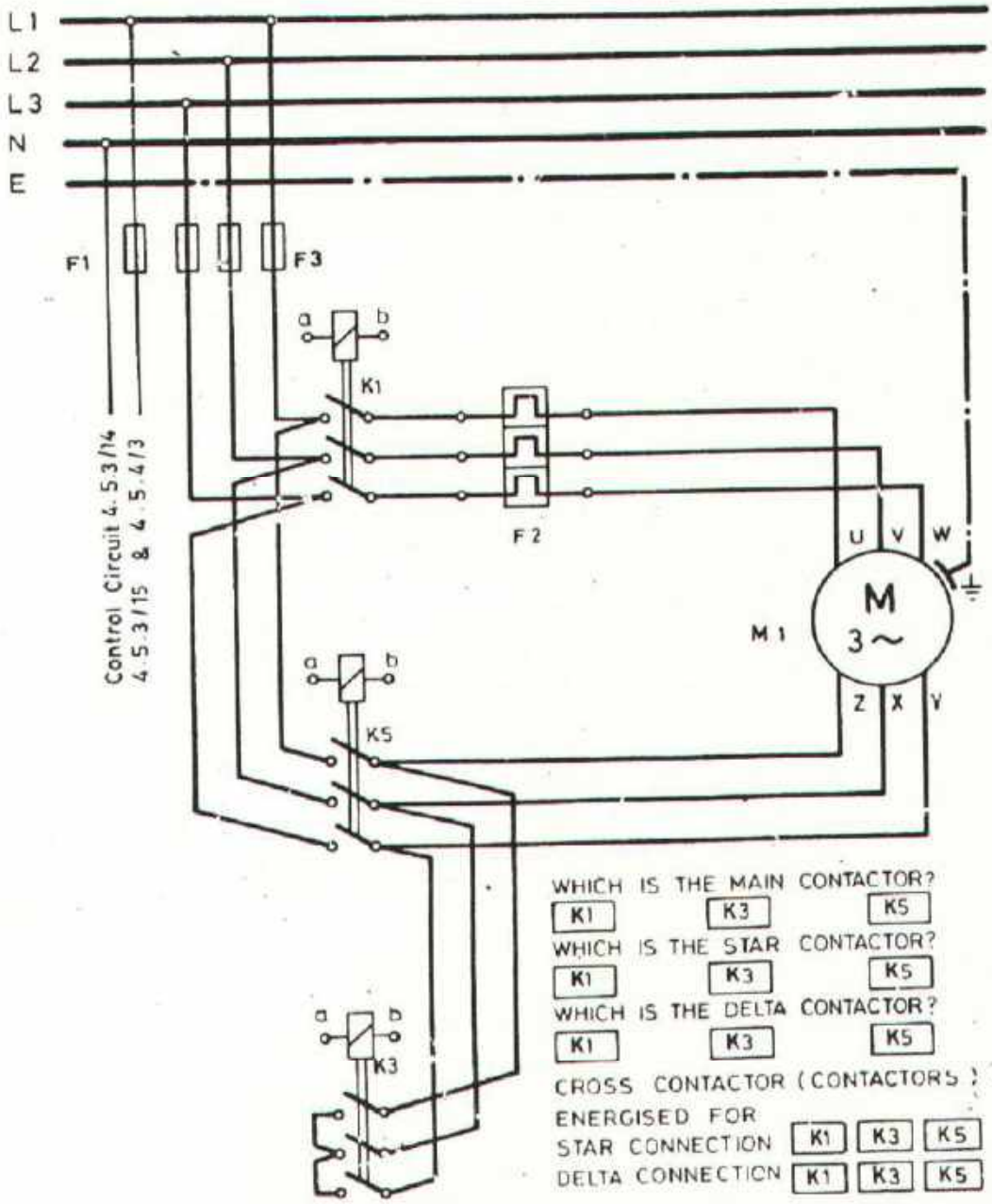
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

NOTE : DO NOT SWITCH DIRECTLY FROM ONE DIRECTION TO THE OTHER, ALLOW MOTOR TO STOP.

DRAWING IS ALSO USED FOR EXERCISE NO. 4.5.1/6

| | |
|---|---|
| MOTOR CONNECTION, 3~ REVERSING | EP 2.3/4.5.3/12 Contactors |




WHICH IS THE MAIN CONTACTOR?
K1 K3 K5

WHICH IS THE STAR CONTACTOR?
K1 K3 K5

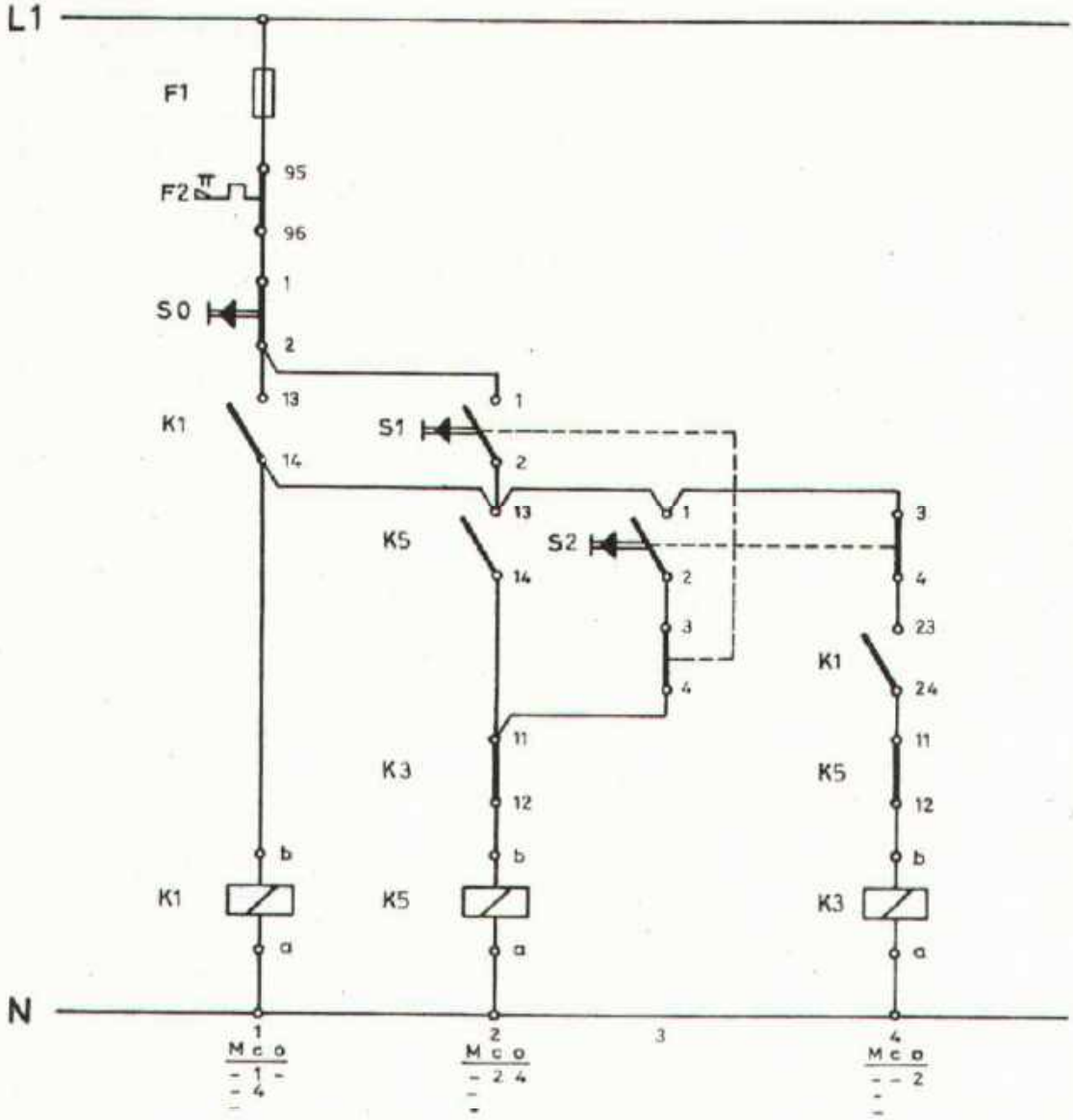
WHICH IS THE DELTA CONTACTOR?
K1 K3 K5

CROSS CONTACTOR (CONTACTORS)
ENERGISED FOR
STAR CONNECTION K1 K3 K5
DELTA CONNECTION K1 K3 K5

TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET No 4.5.3/14 OR 4.5.3/15 AND 4.5.4/3 MAY BE USED IN ADDITION.
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.
CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

DRAWING IS ALSO USED FOR EXERCISE No. 4.5.1/7

| | MOTOR CONNECTION, 3~ STAR-DELTA | EP 2 3/4.5.3/13<br>Contactors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |

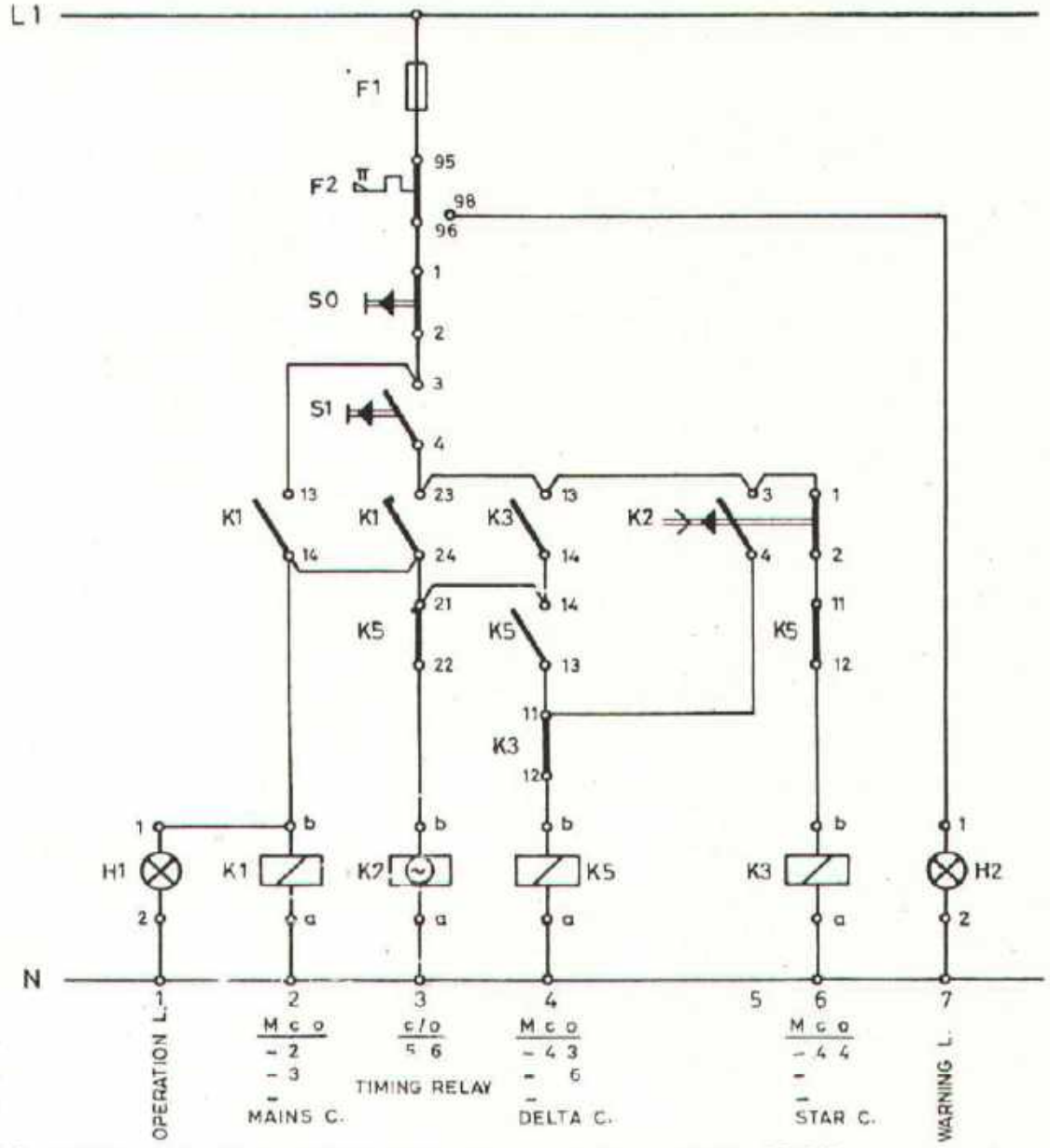



FOR EXERCISE ONLY

WITHOUT TIMING RELAY TO UNDERSTAND THE SEQUENCE OF OPERATION.
a.) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/14
b.) TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET NO. 4.5.3/13 MAY BE USED IN ADDITION.
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | MOTOR CONNECTION, 3~ STAR-DELTA | EP 2.3/4.5.3/14 |
|---|---|---|
| | | Contactors |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING | | ELECTRICIAN |
| PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | GENERAL |



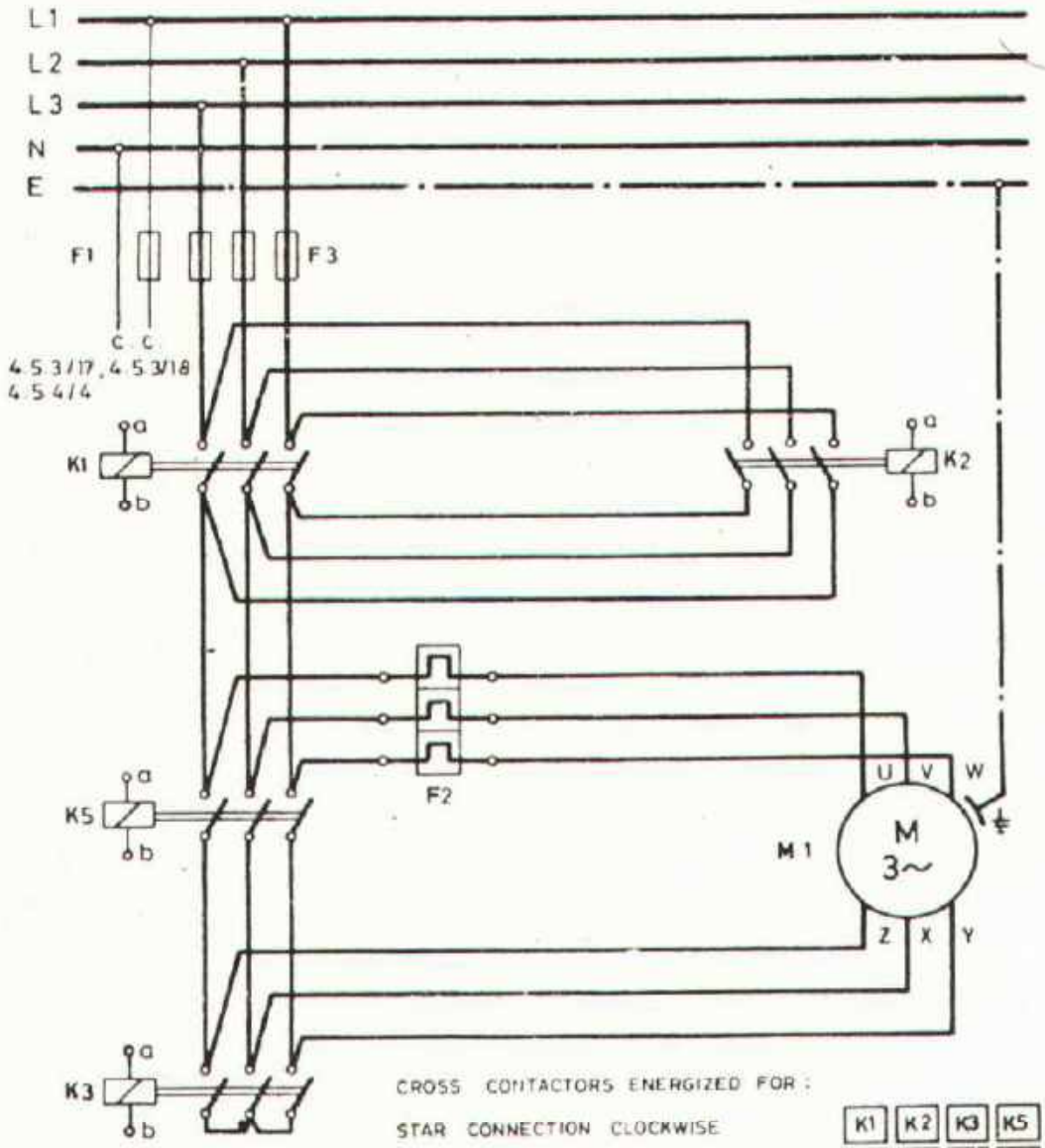

a.) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6

b.) TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB. EXERCISE SHEET NO. 4.5.3/13 AND 4.5.4/3 MAY BE USED IN ADDITION. ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

DRAWING IS ALSO USED FOR EXERCISE NO. 4.5.1/7

| | MOTOR CONNECTION, 3~ STAR-DELTA | EP 2.3/4.53/15<br>Contactors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME<br>43 | ELECTRICIAN<br>GENERAL |



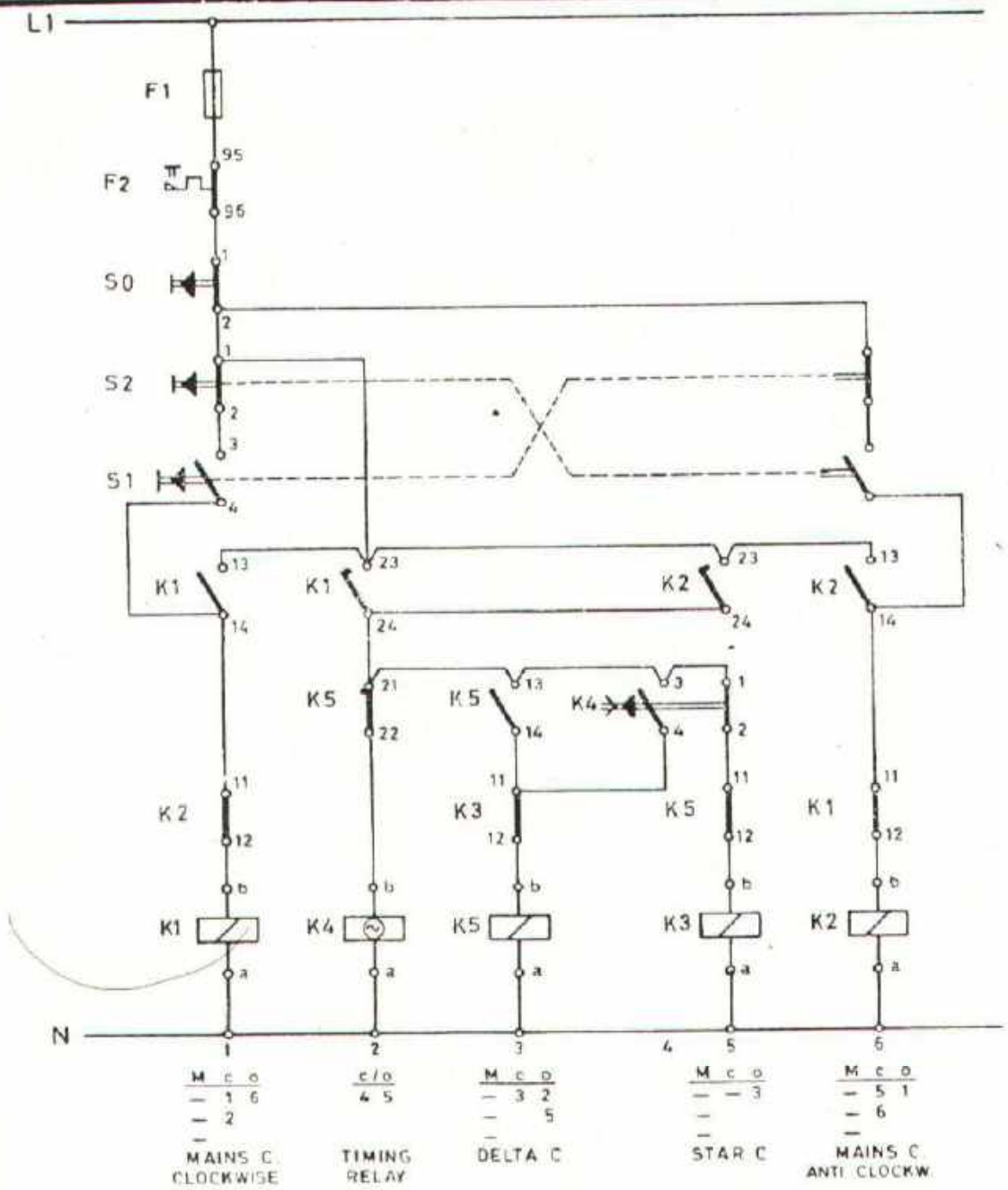

CROSS CONTACTORS ENERGIZED FOR :

| | | | | |
|---|---|---|---|---|
| STAR CONNECTION CLOCKWISE | K1 | K2 | K3 | K5 |
| DELTA CONNECTION CLOCKWISE | K1 | K2 | K3 | K5 |
| STAR CONNECTION ANTI-CLOCKWISE | K1 | K2 | K3 | K5 |
| DELTA CONNECTION ANTI-CLOCKWISE | K1 | K2 | K3 | K5 |

TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET NO. 4.5.3/17 OR 4.5.3/18 AND 4.5.4/4 MAY BE USED IN ADDITION.
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.
CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.
DRAWING IS ALSO USED FOR EXERCISE NO 4.5.1/8

# MOTOR CONNECTION, 3~ STAR DELTA REVERSING

EP 2.3/4.5.3/16
Contactors




a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6

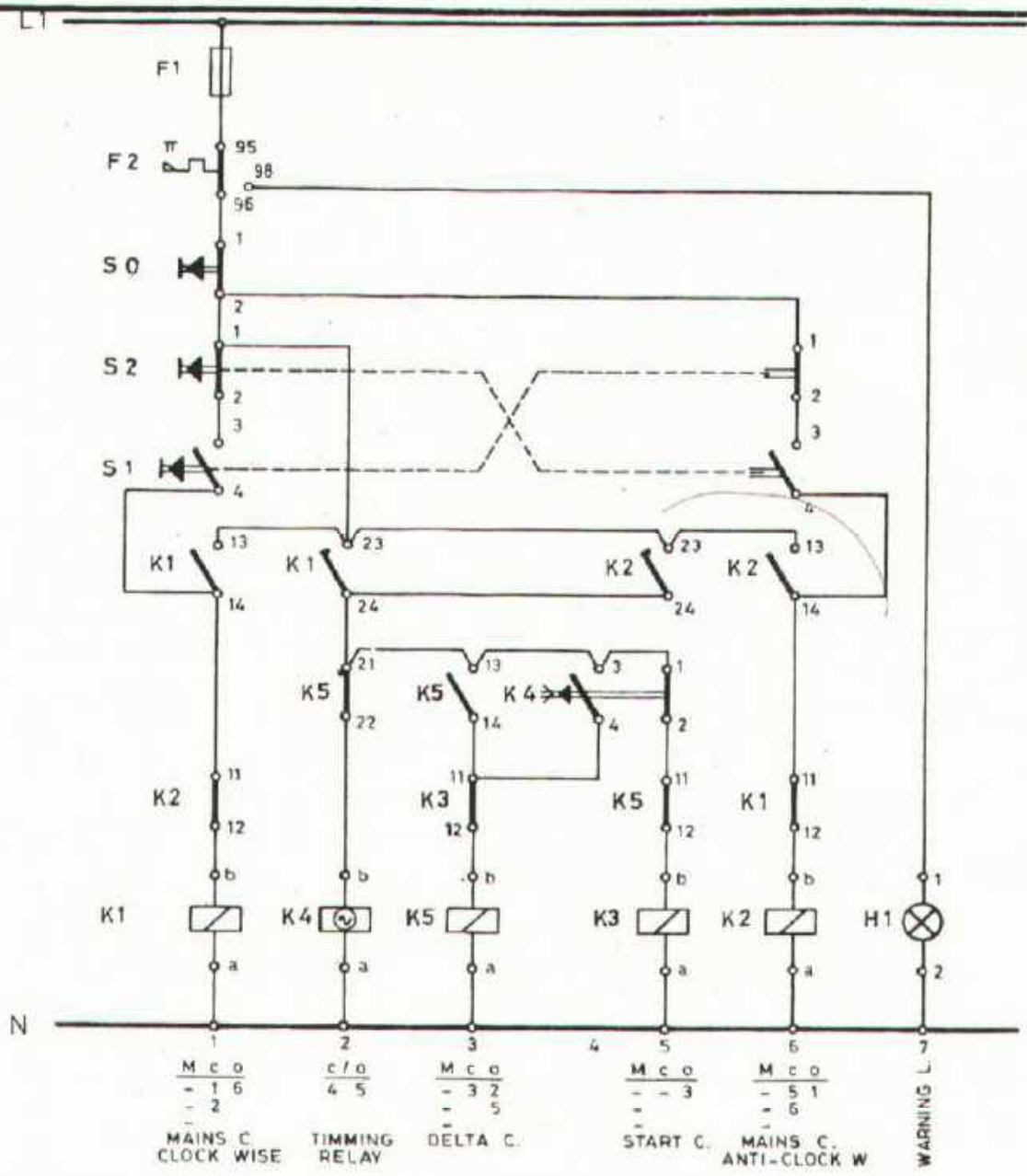
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.

EXERCISE SHEET No. 4.5.3/16 AND 4.5.4/4 MAY BE USED IN ADDITION.

ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR

| | MOTOR CONNECTION, 3~ STAR-DELTA REVERSING | EP 2.3/4 5.3/17 Contactors |
|---|---|---|




a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6

b) EXPLAIN WHY DOES THE CONTROL CIRCUIT CROSS THE DIFFERENT CONTACTS.

c) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.

EXERCISE SHEET No. 4.5.3/10 AND 4.5.4/4 MAY BE USED IN ADDITION.

ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

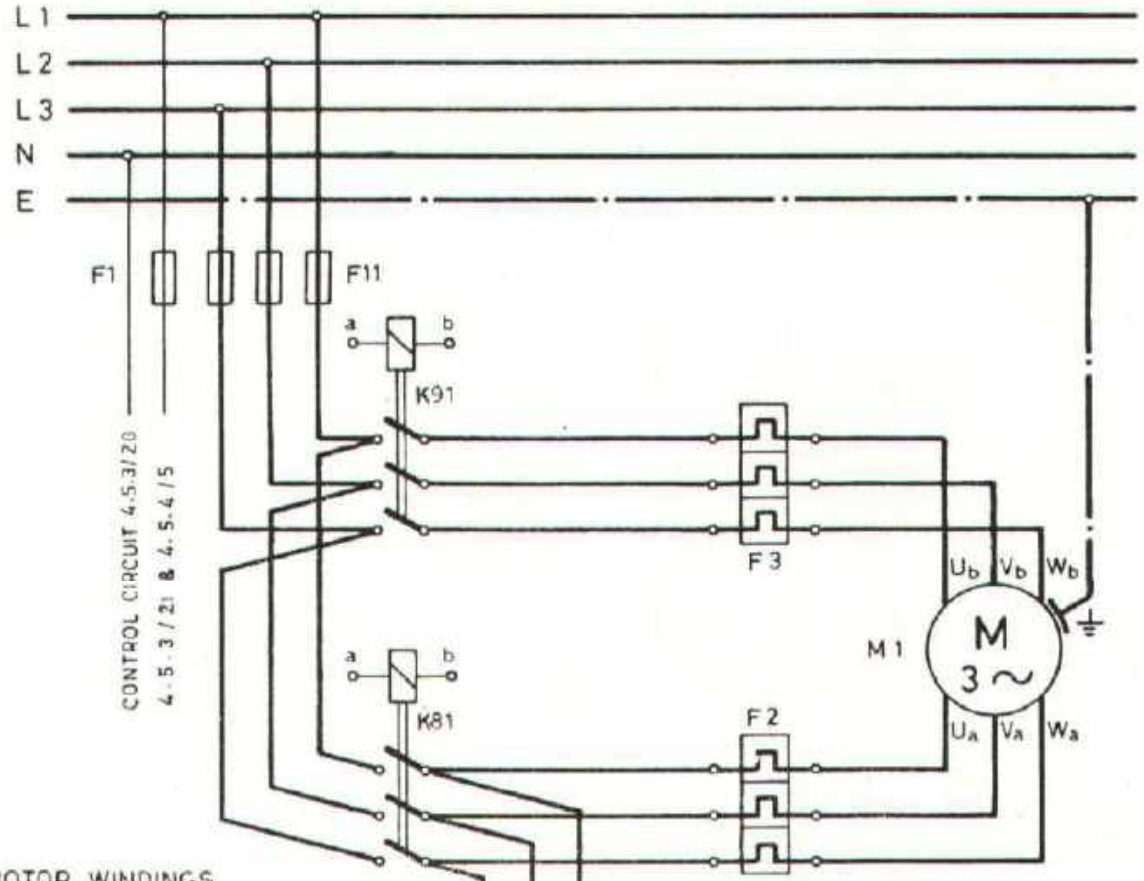
DRAWING IS ALSO USED FOR EXERCISE No. 4.5.1/8

4

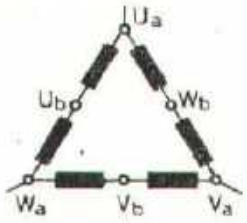
# MOTOR CONNECTION, 3 ~ STAR-DELTA REVERSING

EP 2.3/4.5.3/18

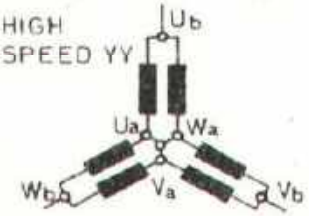
Contac tors




MOTOR WINDINGS
LOW SPEED △




HIGH
SPEED YY




CROSS CONTACTOR (CONTACTORS) CONCERNED
WHICH IS THE MAIN CONTACTOR
FOR LOW SPEED

K81 K91 K93

FOR HIGH SPEED

K81 K91 K93

WHICH CONTACTOR (S) IS (ARE) ENERGIZED FOR

| | | | |
|---|---|---|---|
| LOW SPEED | K81 | K91 | K93 |
| HIGH SPEED | K81 | K91 | K93 |

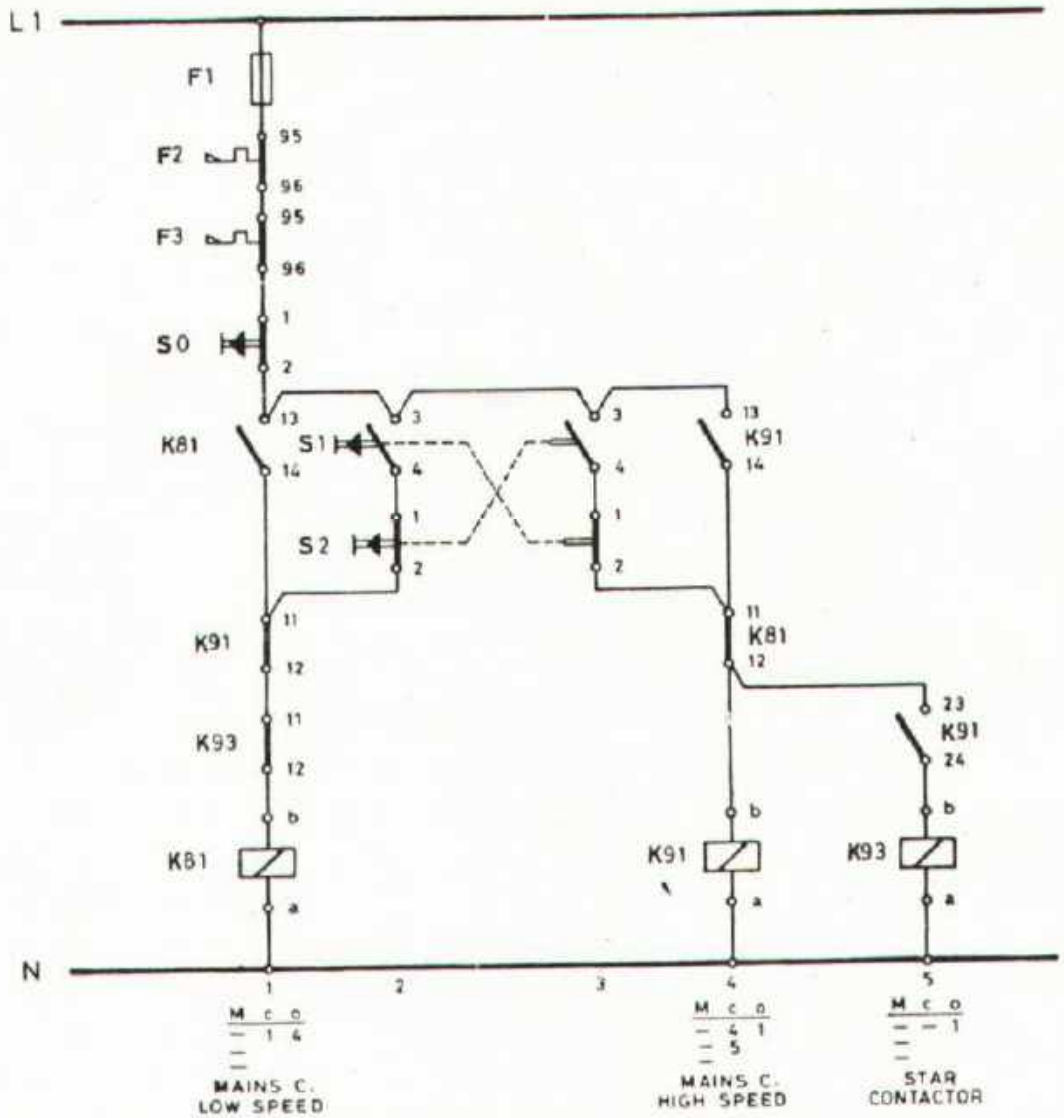
TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET No. 4.5.3/20 OR 4.5.3/21 AND 4.5.4/5 MAY BE USED IN ADDITION.

ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

DRAWING IS ALSO USED FOR EXERCISE No. 4.5.1/9

| | | |
|---|---|---|
| | MOTOR CONNECTION, 3~ 2 SPEEDS TAPPED WOUND, 1 DIRECTION | EP 2.3/4.5.3/19 Contactors |




a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB
EXERCISE SHEET No 4.5.3/19 AND 4.5.4/5 MAY BE USED IN ADDITION
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION

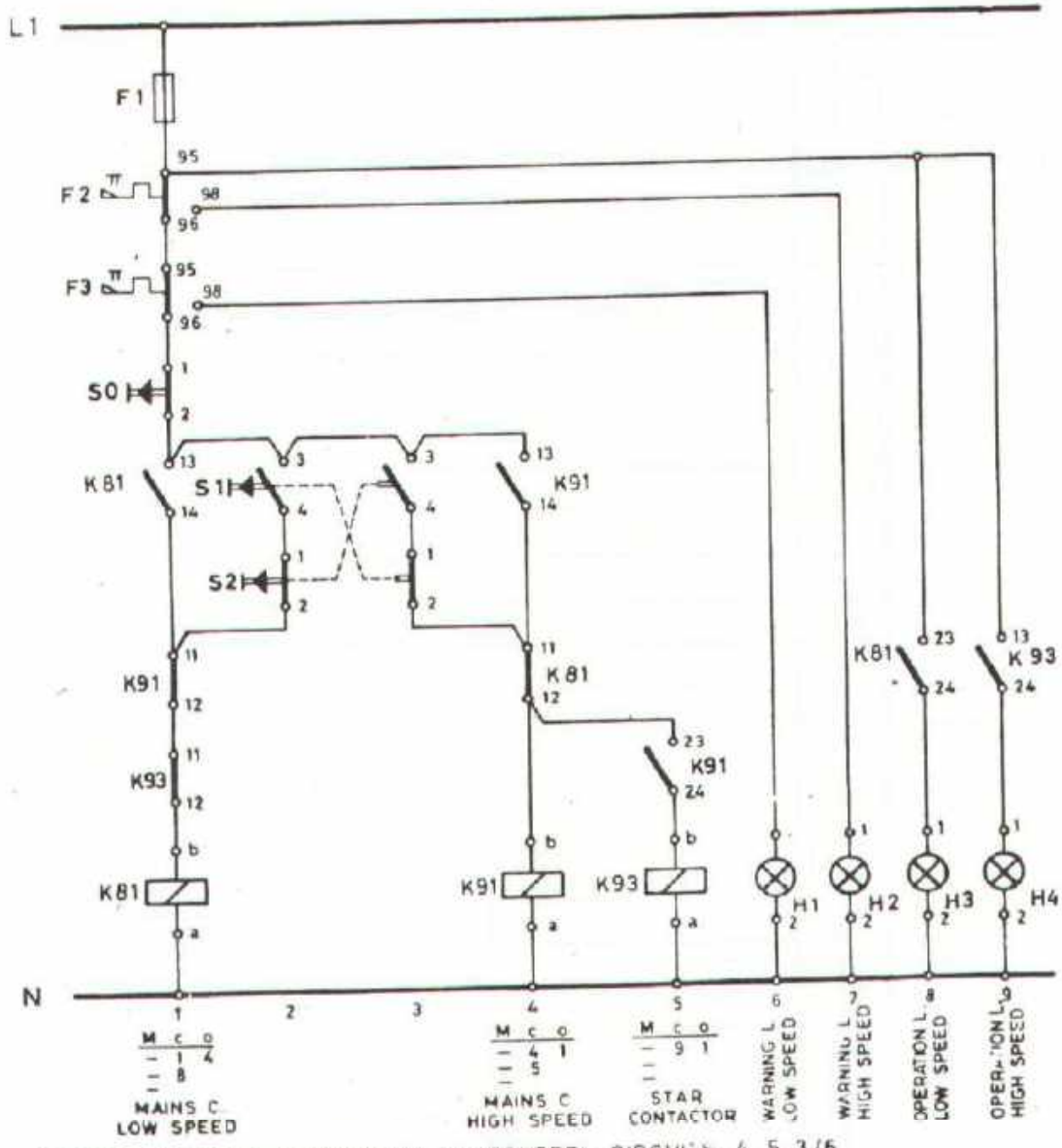
CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

RECORD MOTOR
DATE

TYPE . . . . . .
. . . . . V . . . . / . . . . A.
. . . . . / . KW cos ϕ . . . / . . . .
. . . . . / . . . . (U/min) R.P.M

DISCUSS

| | MOTOR CONNECTION, 3~2 SPEEDS TAPPED WOUND, 1 DIRECTION | EP 2.3/4.5.3/20 Contactors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN GENERAL |

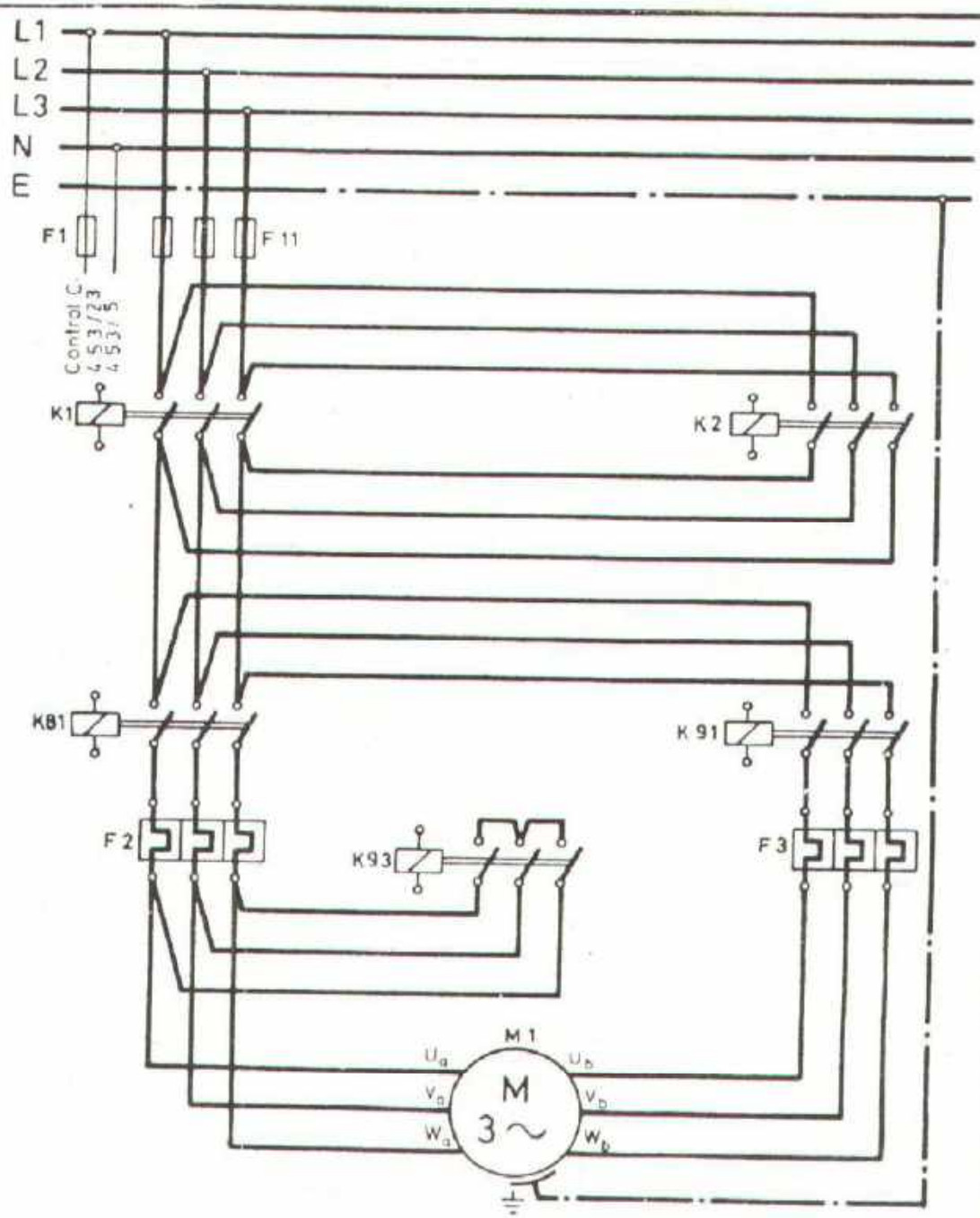



a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4 5 3/6
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB
EXERCISE SHEET No 4.5.3/19 AND 4.5.4/5 MAY BE USED IN ADDITION.
WHY ARE TWO OVERLOAD PROTECTION SWITCHES INSTALLED ?
WHAT FOR IS THE INTERLINK SYSTEM PRACTISED ON SWITCHES AND CONTACTORS ?
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

14 CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

DRAWING IS ALSO USED FOR EXERCISE No 4.5.1/9

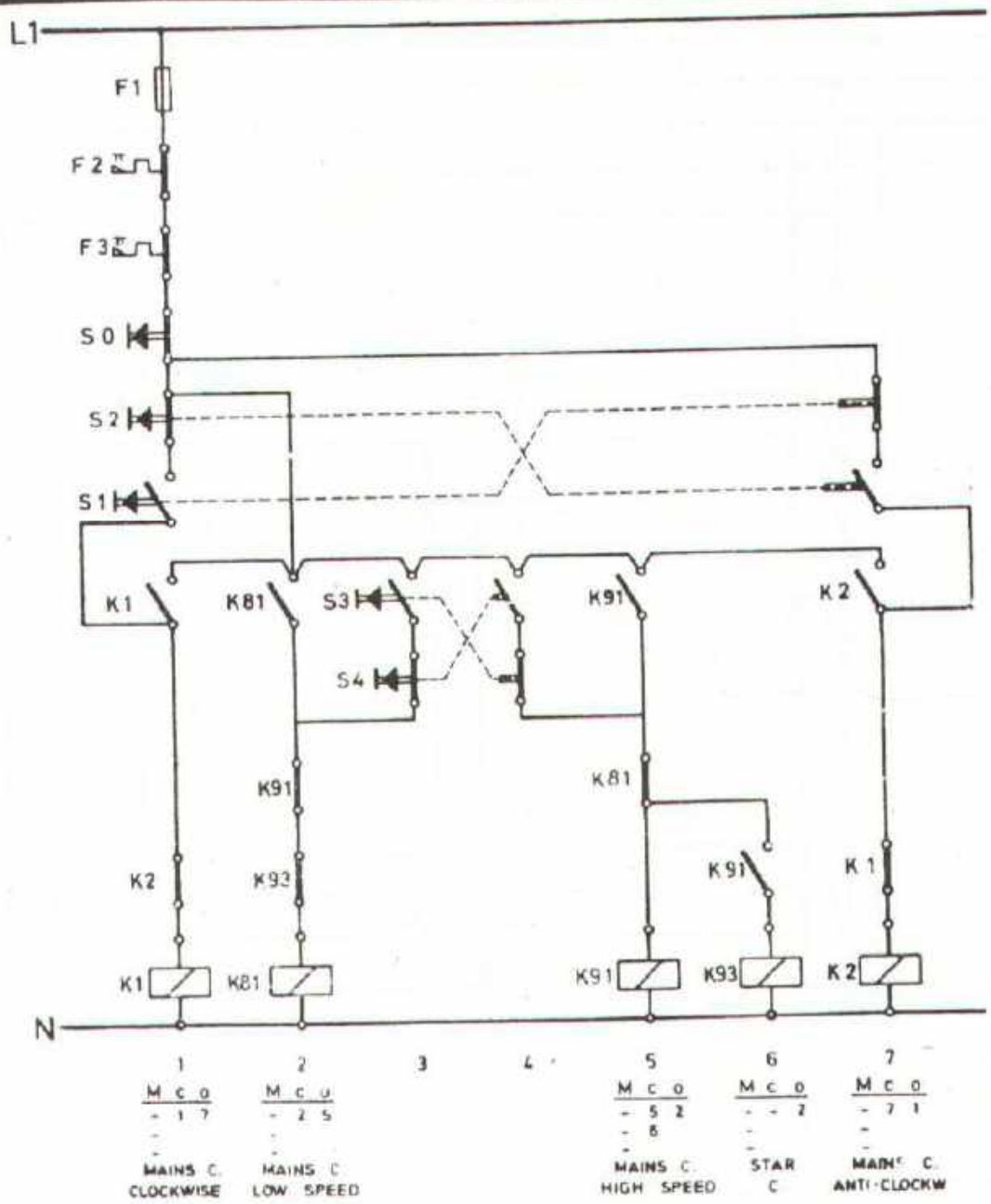
| | | |
|---|---|---|
| | MOTOR CONNECTION, 3~ 2 SPEEDS TAPPED WOUND, 1 DIRECTION | EP 2 3/4 5.3/21<br>Contactors |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |




TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB
EXERCISE SHEET No 4.5.3/23 AND 4.5.4/6 MAY BE USED IN ADDITION.
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

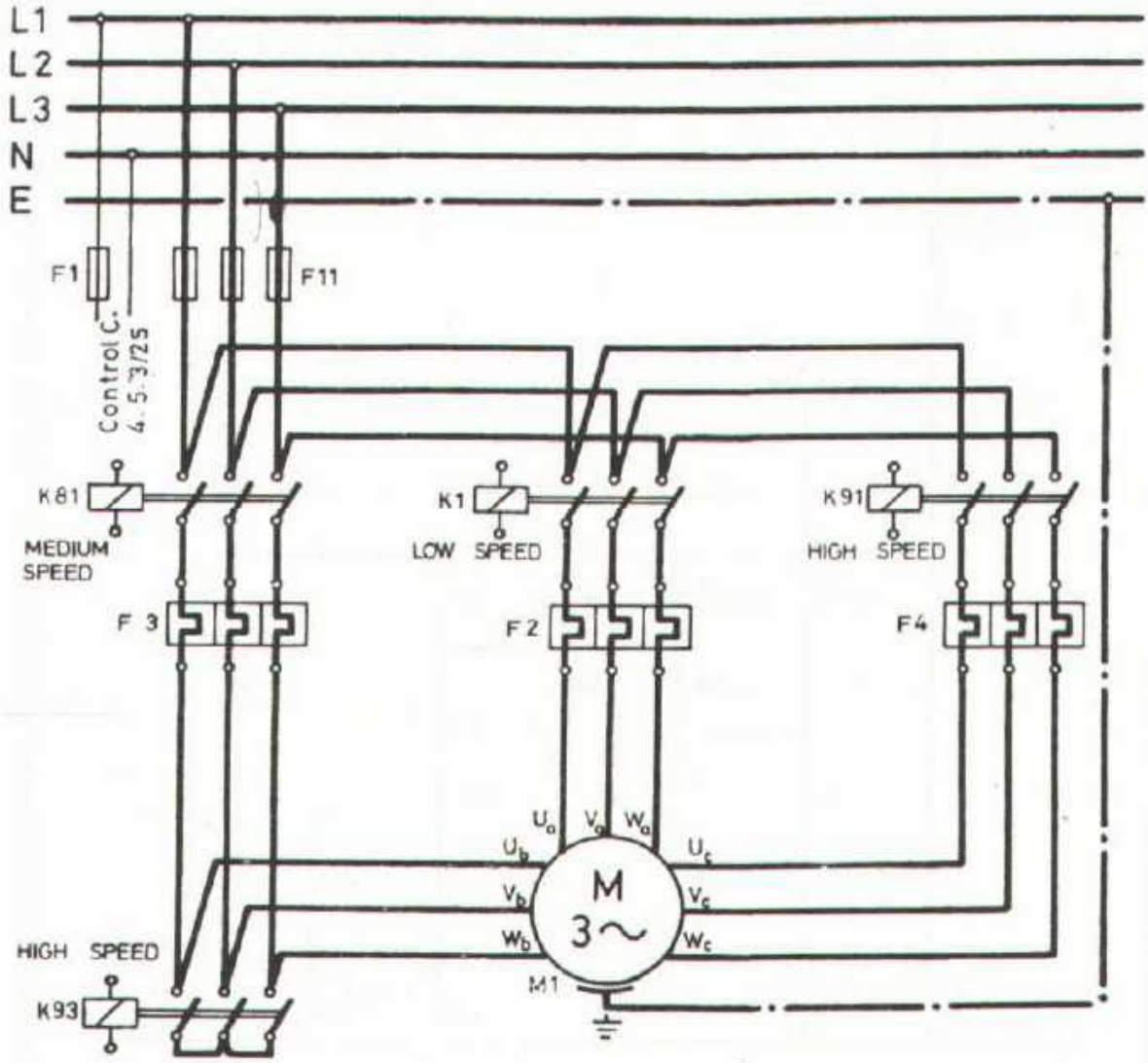
| | MULTI-SPEED, TAPPED WOUND, 2 DIRECTIONS, 2 SPEEDS | EP 2.3/4.5.3/22 Contactors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN GENERAL |




a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET No 4.5.3/22 AND 4.5.4.6 MAY BE USED IN ADDITION
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR

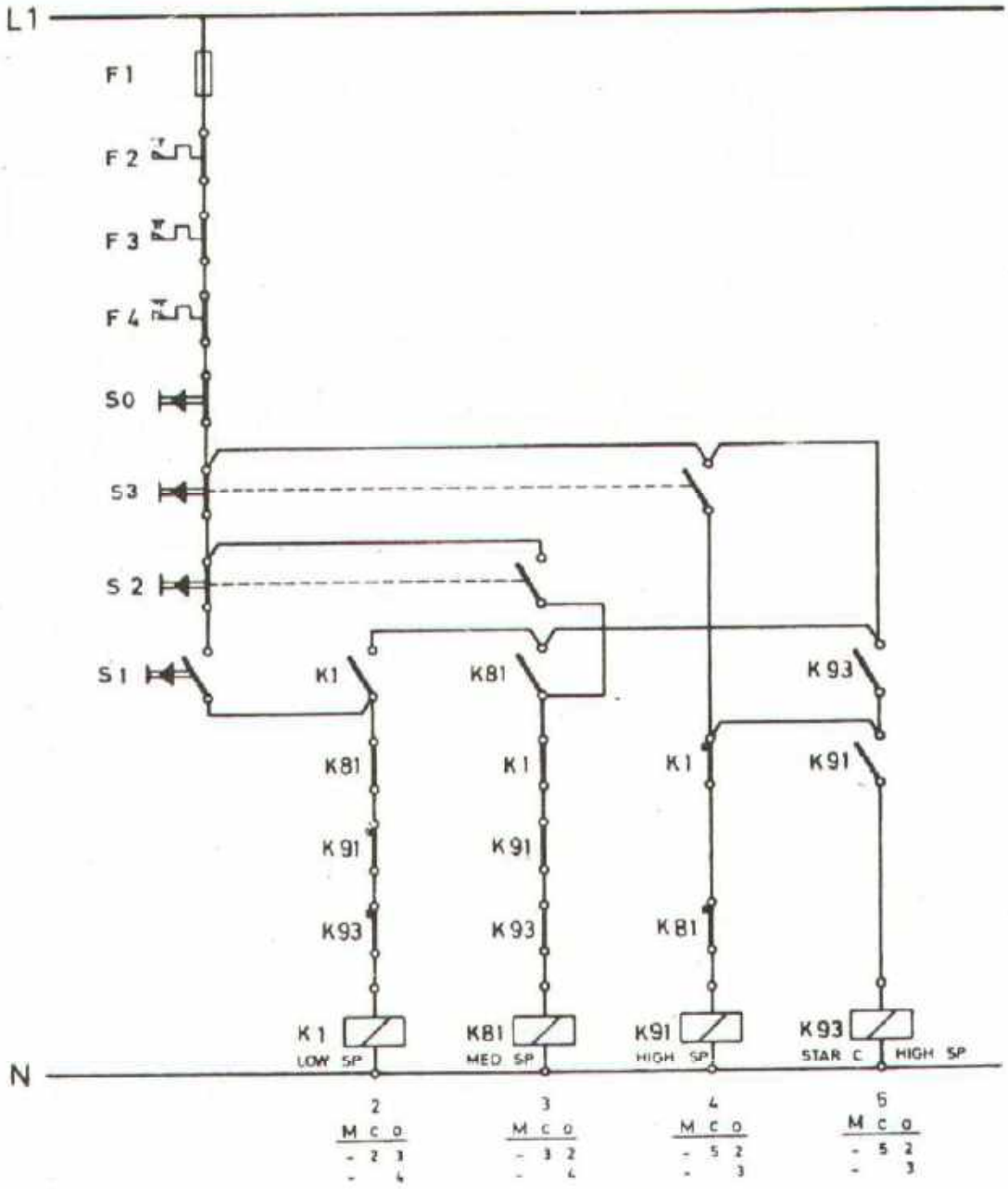
| | MULTI-SPEED, TAPPED WOUND, 2 DIRECTIONS, 2 SPEEDS | EP 2.3/4 5.3/23 Contactors |
|---|---|---|
| | DEVELOPMENT-CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN GENERAL |




TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET NO. 4.5.3/25 MAY BE USED IN ADDITION.
ACCORDING TO INSTRUCTOR DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | MULTI-SPEED, 2 WINDINGS, 1 DIRECTION, 3 SPEEDS, TAPPED W. | EP 2.3/4.5.3/24 Contactors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |




a.) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6

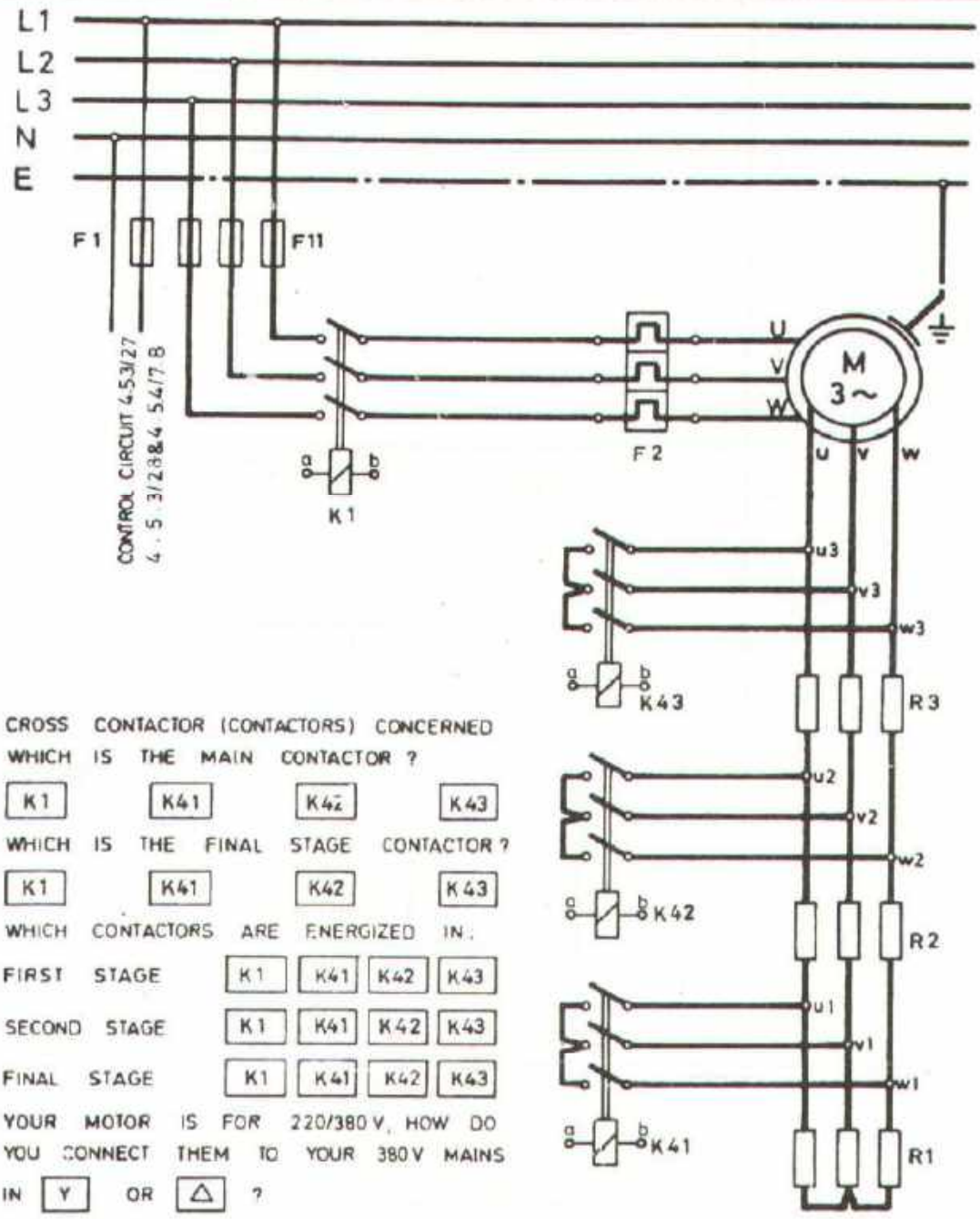
b.) TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB

EXERCISE SHEET NO. 4.5.3/24 MAY BE USED IN ADDITION

ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | MULTI-SPEED, 2 WINDINGS<br>1 DIRECTION 3 SPEEDS, TAPPED WD. | EP 2.3/4.5.3/25<br>Contactors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |




CROSS CONTACTOR (CONTACTORS) CONCERNED

WHICH IS THE MAIN CONTACTOR ?

[K1] [K41] [K42] [K43]

WHICH IS THE FINAL STAGE CONTACTOR ?

[K1] [K41] [K42] [K43]

WHICH CONTACTORS ARE ENERGIZED IN.

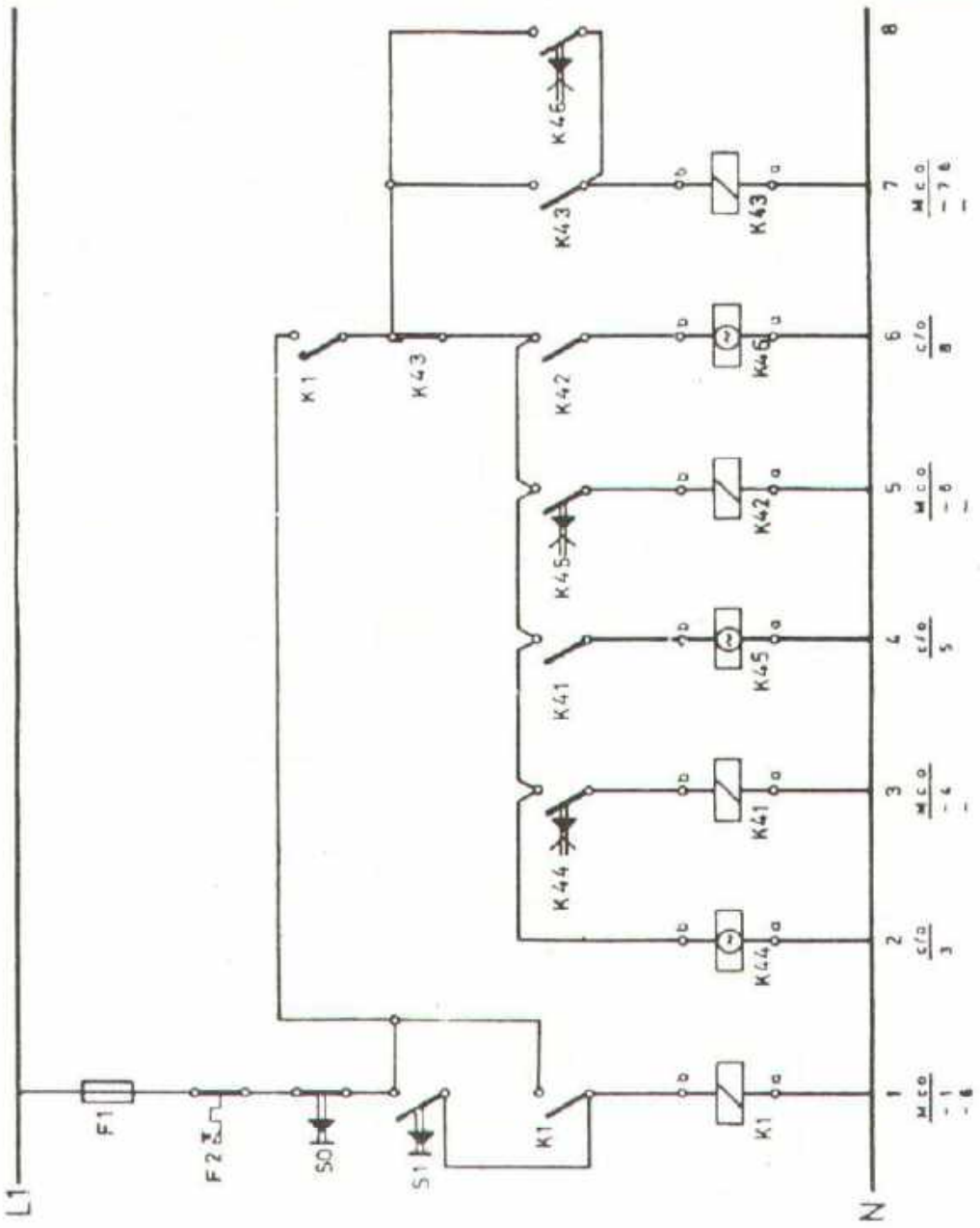
| | | | | |
|---|---|---|---|---|
| FIRST STAGE | K1 | K41 | K42 | K43 |
| SECOND STAGE | K1 | K41 | K42 | K43 |
| FINAL STAGE | K1 | K41 | K42 | K43 |

YOUR MOTOR IS FOR 220/380 V, HOW DO YOU CONNECT THEM TO YOUR 380 V MAINS

IN [Y] OR [△] ?

TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET No. 4.5.3/27 OR 4.5.3/28 AND 4.5.4/7-8 MAY BE USED IN ADDITION.
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.
CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

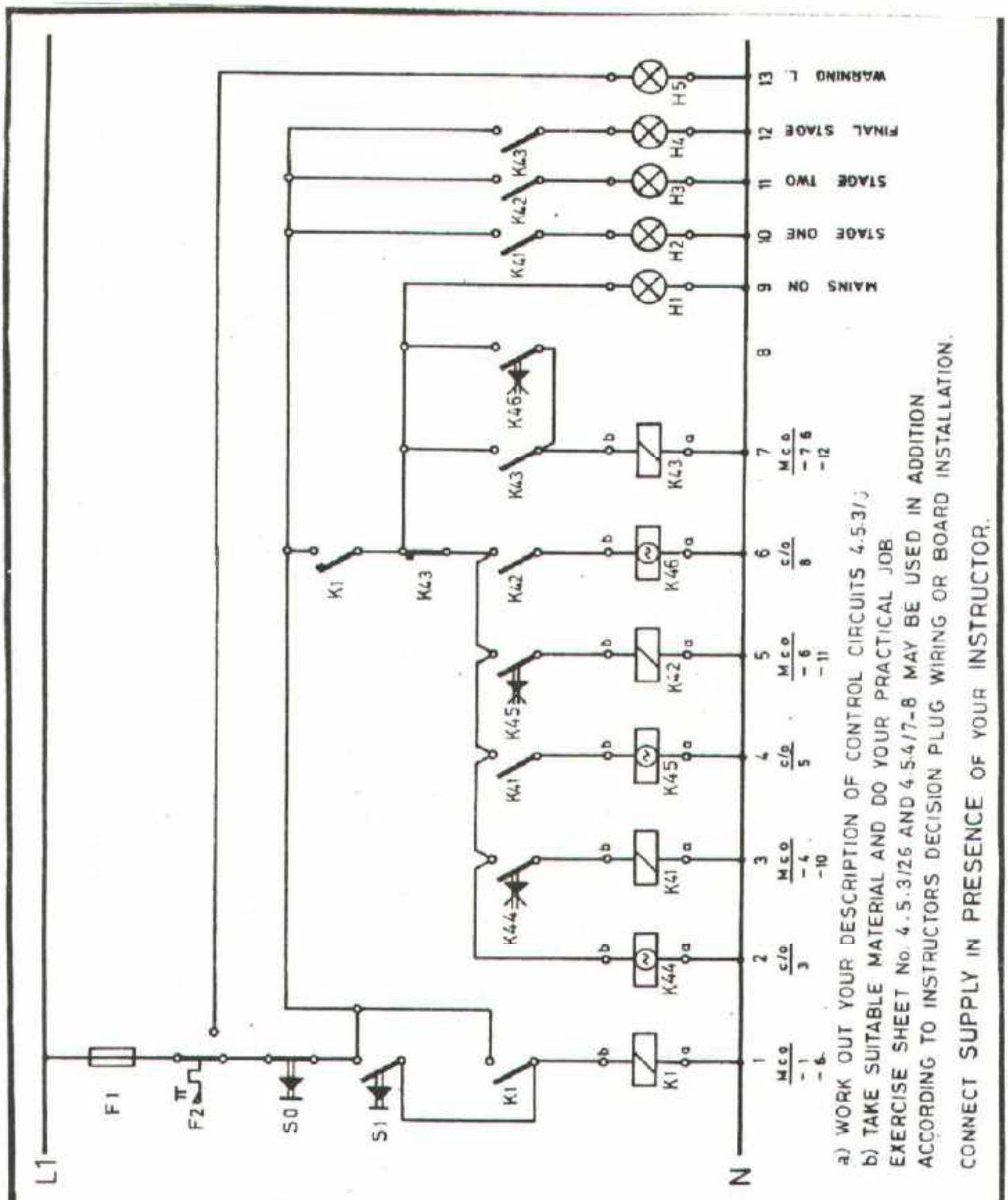
| | 3 PHASE SLIPRING ROTOR STARTER | EP 2.3/4.5.3/26 |
|---|---|---|
| | | Contactors |




a) WORK OUT YOUR DESCRIPTION OF CONTROL CIRCUITS 4.5.3/6
b) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
EXERCISE SHEET No 4.5.3/26 MAY BE USED IN ADDITION
ACCORDING TO INSTRUCTORS DECISION PLUG WIRING OR BOARD INSTALLATION.

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

| | 3 PHASE SLIPRING ROTOR STARTER | EP 2.3/4.5.3/27<br>Contactors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN<br>GENERAL |




# 3 PHASE SLIPRING ROTOR STARTER W CONTROL L

EP 2.3/4.5.3/28

Contactors

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN

GENERAL

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

57

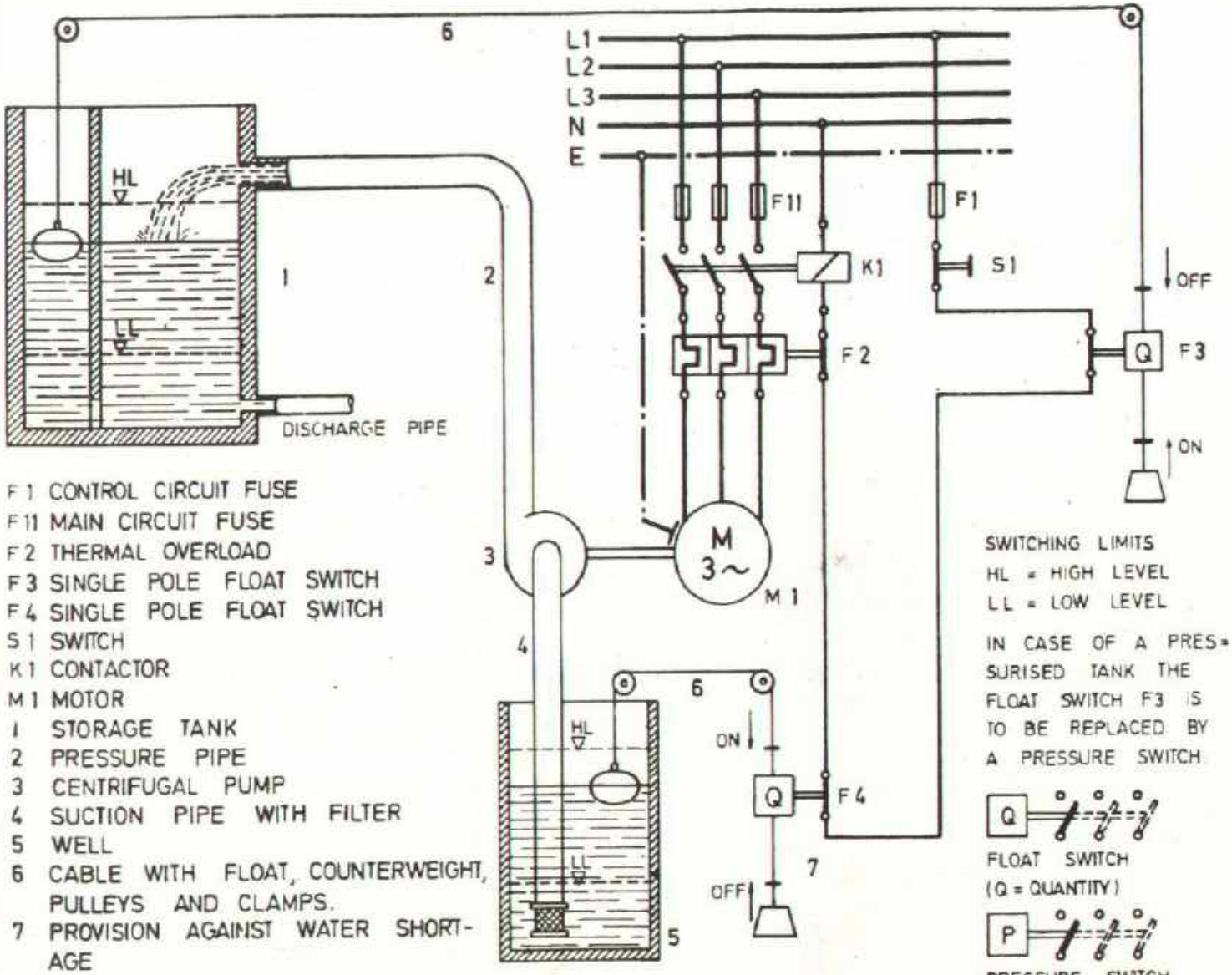
ELECTRICIAN

GENERAL

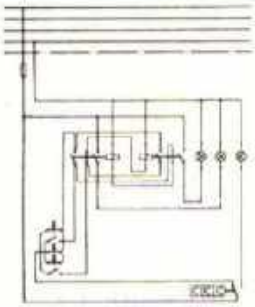
# AUTOMATIC PUMP CONTROL

EP 2.3/4.5.3/2

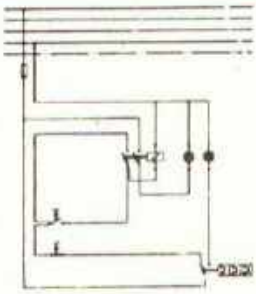
Contactors



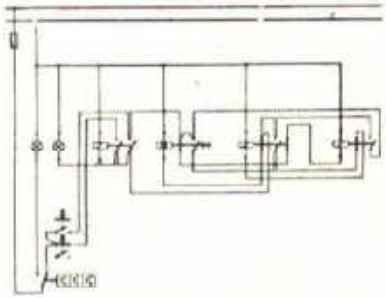

F 1 CONTROL CIRCUIT FUSE
F 11 MAIN CIRCUIT FUSE
F 2 THERMAL OVERLOAD
F 3 SINGLE POLE FLOAT SWITCH
F 4 SINGLE POLE FLOAT SWITCH
S 1 SWITCH
K 1 CONTACTOR
M 1 MOTOR
1 STORAGE TANK
2 PRESSURE PIPE
3 CENTRIFUGAL PUMP
4 SUCTION PIPE WITH FILTER
5 WELL
6 CABLE WITH FLOAT, COUNTERWEIGHT, PULLEYS AND CLAMPS.
7 PROVISION AGAINST WATER SHORTAGE



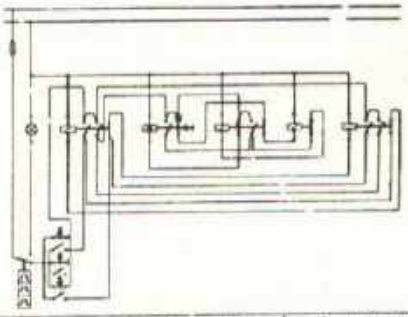
1 CONTACTOR ON-OFF



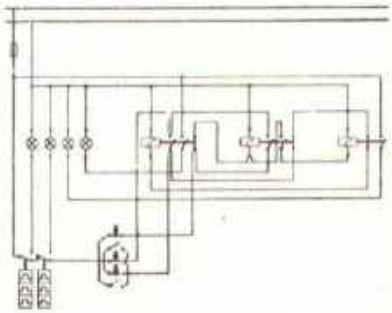
2 CONTACTOR REVERSING



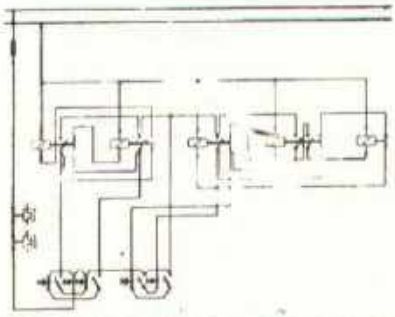
3 CONTACTOR ⅄ △



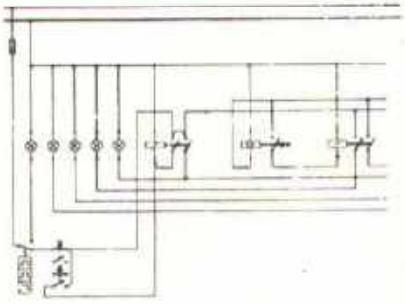
4 CONTACTOR ⅄ △ REV.



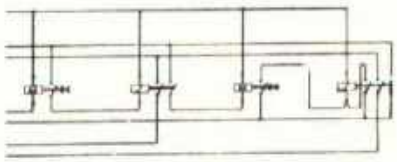
5 CONTACTOR 1 DIR. 2 SPEEDS



6 CONTACTOR 2 DIR. 2 SPEEDS



7 CONTACTOR ROTOR STARTER



8 CONTACTOR ROTOR STARTER W.L

3

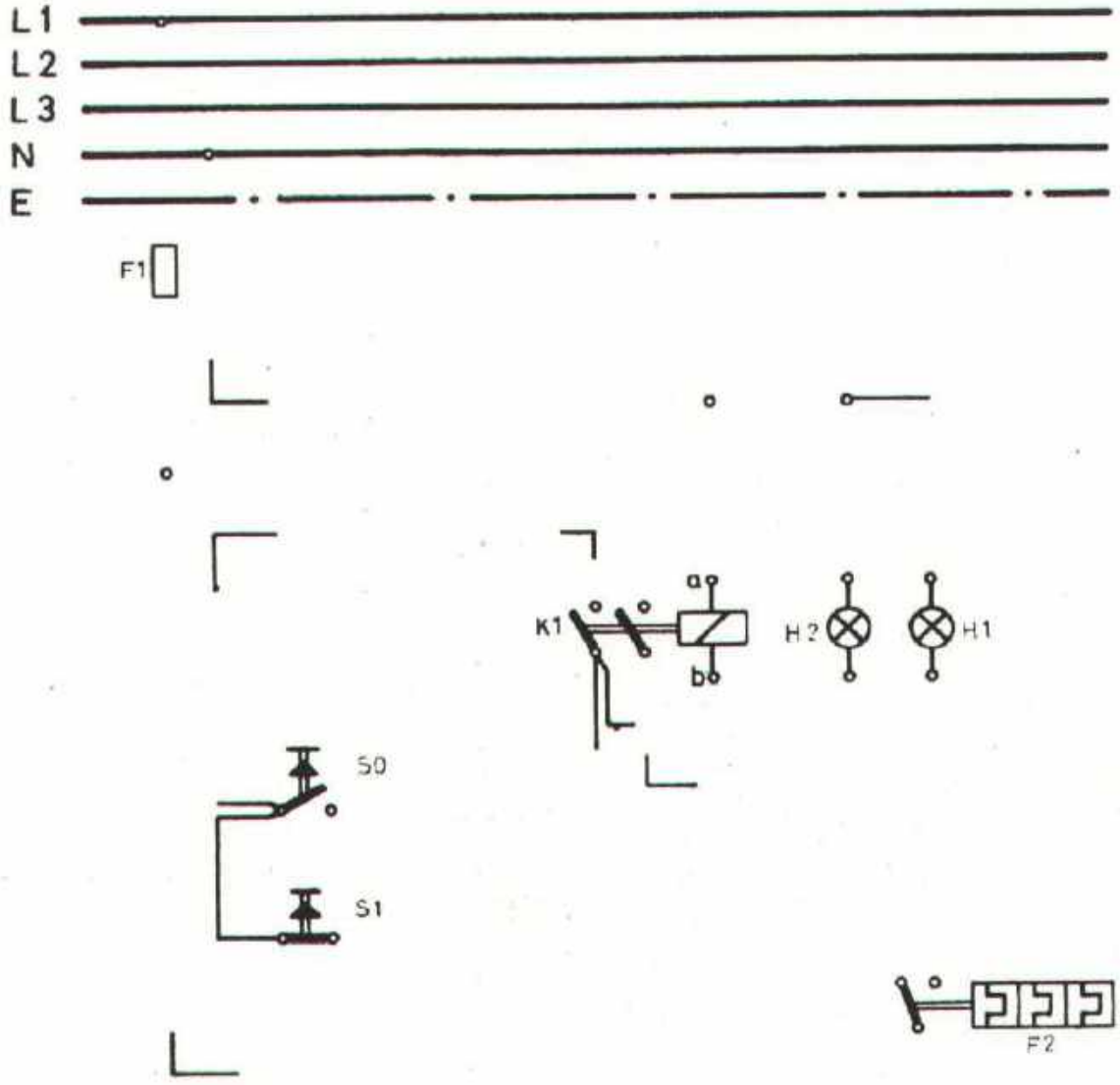
LAYOUT

EP 2.1/4.5.47
Circuits III

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK GERMAN TECHNICAL TRAINING PROGRAMME

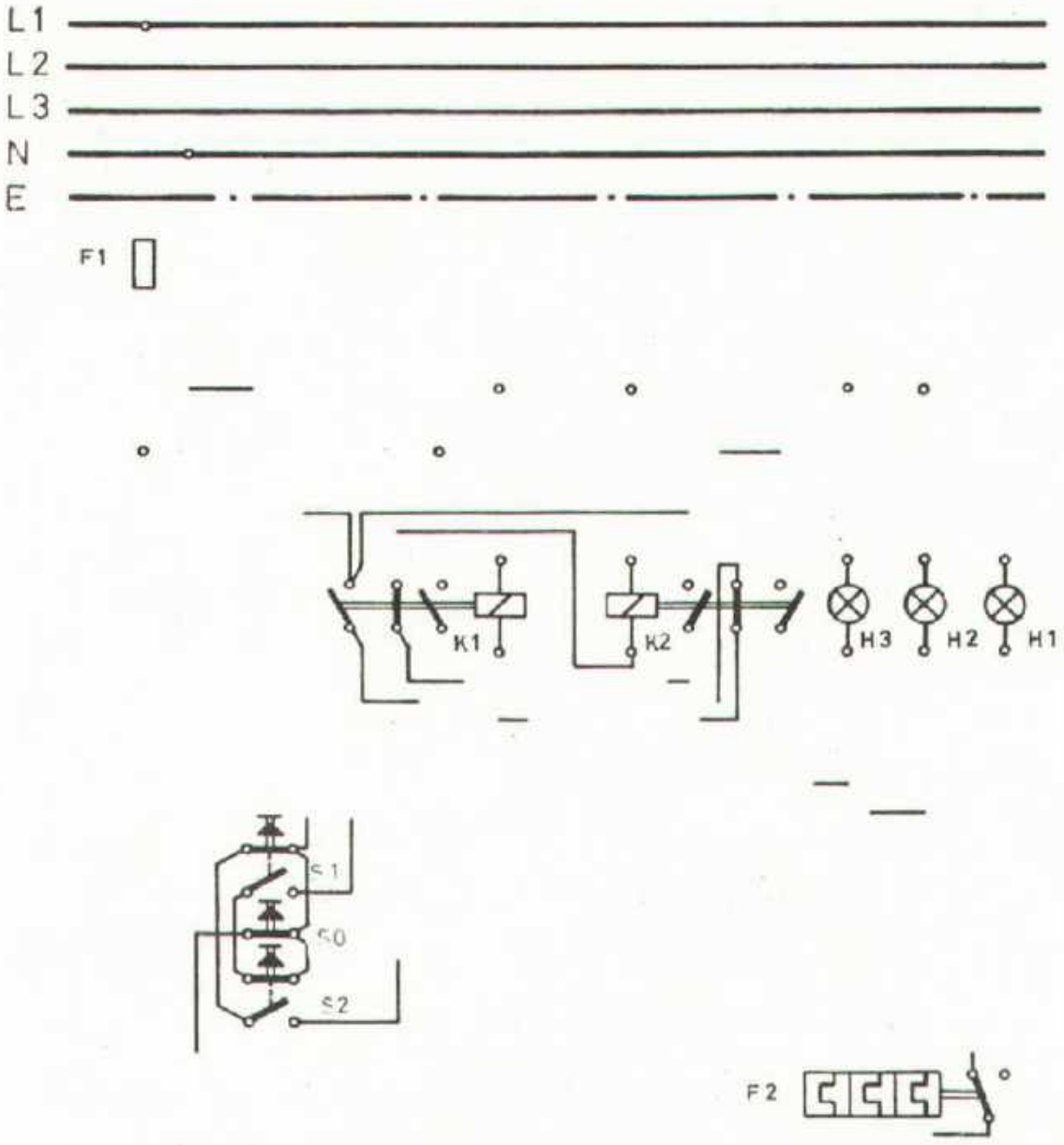
ELECTRICIAN
GENERAL




a.) COMPLETE THE WIRING DIAGRAM OF THE ON-OFF CONTROL-CIRCUIT ACCORDING TO YOUR CURRENT PATH DIAGRAM 4.5.3/10

b.) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB WITH THE HELP OF DIAGRAMS 4.5.3/8, 4.5.3/10 AND YOUR COMPLETED AND CHECKED DIAGRAM 4.5.4/1

| | 3 PHASE ON-OFF WITH CONTROL LAMPS | EP 2.3/4.5.4/1 Circuits III |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |




a.) COMPLETE THE WIRING DIAGRAM OF THIS CONTROL CIRCUIT ACCORDING TO YOUR CURRENT PATH DIAGRAM 4.5.3/13

b.) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB WITH THE HELP OF DIAGRAMS 4.5.3/11, 4.5.3/13 AND YOUR COMPLETED AND CHECKED DIAGRAM 4.5.4/2

| | 3 PHASE REVERSING WITH CONTROL LAMPS | EP 2.3/4.5.4/2 Circuits III |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |

| | | |
|---|---|---|
| | STAR-DELTA WITH CONTROL LAMPS | EP 2.3/4.5.4/3 |
| | | Circuits III |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING | | ELECTRICIAN GENERAL |
| PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | |

a.) COMPLETE THE WIRING DIAGRAM OF STAR-DELTA REVERSING CONTROL CIRCUIT ACCORDING TO YOUR CURRENT PATH DIAGRAM 4.5.3/19

b.) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB WITH THE HELP OF DIAGRAMS 4.5.3/17, 4.5.3/19 AND YOUR COMPLETED AND CHECKED DIAGRAM 4.5.4/4.

# STAR-DELTA REVERSING WITH CONTROL LAMP

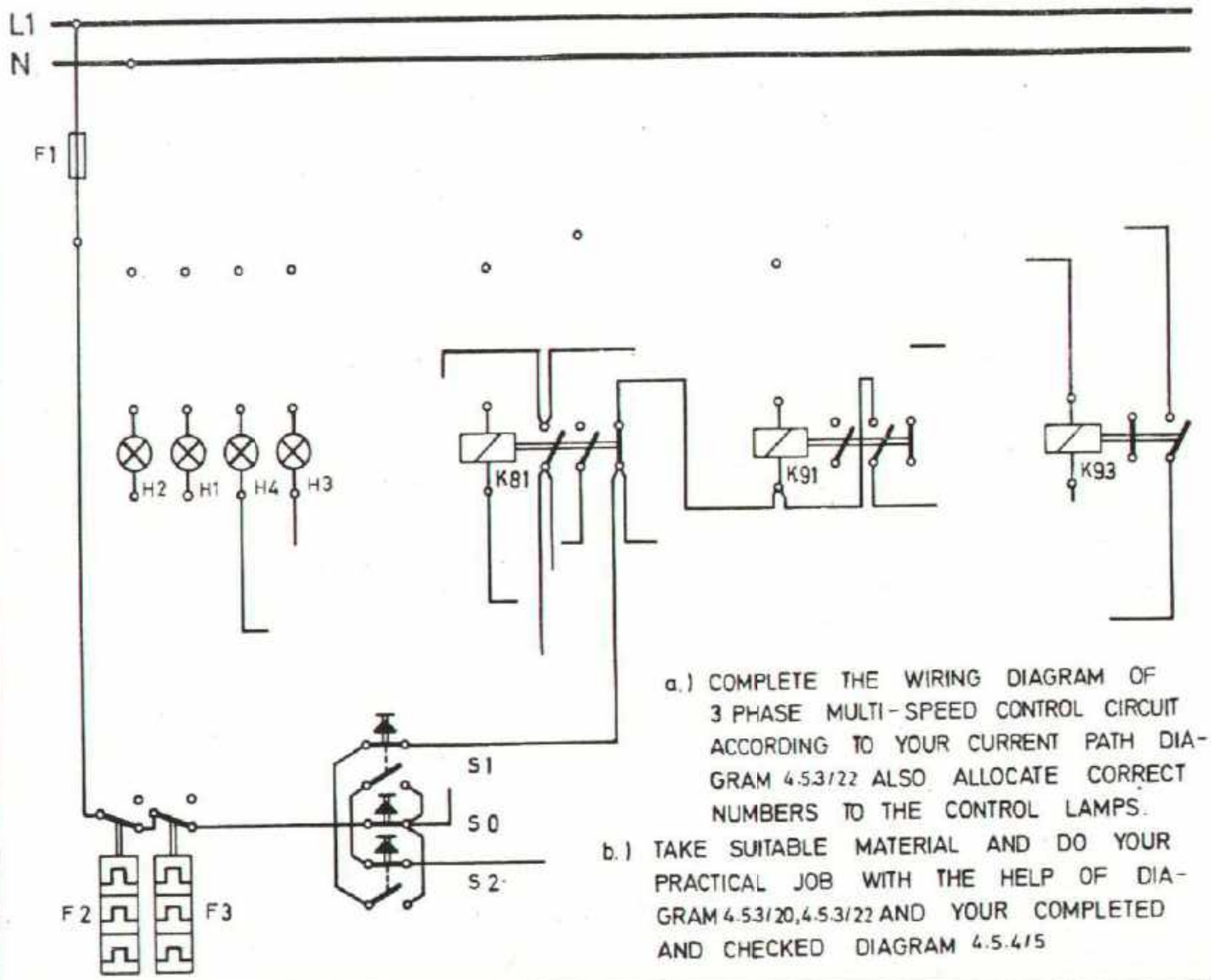
EP 2.3/4.5.4/4

Circuits III

# MULTI-SPEED, 1 DIRECTION, 2 SPEEDS

EP 2.3/4.5.4/5
Circuits III

ELECTRICIAN
GENERAL




a.) COMPLETE THE WIRING DIAGRAM OF 3 PHASE MULTI-SPEED CONTROL CIRCUIT ACCORDING TO YOUR CURRENT PATH DIAGRAM 4.5.3/22 ALSO ALLOCATE CORRECT NUMBERS TO THE CONTROL LAMPS.

b.) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB WITH THE HELP OF DIAGRAM 4.5.3/20, 4.5.3/22 AND YOUR COMPLETED AND CHECKED DIAGRAM 4.5.4/5

# MULTI-SPEED TAPPED WOUND 2 DIRECTIONS, 2 SPEEDS

EP 2.3/4.5.4/6

Circuits III

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ELECTRICIAN GENERAL

| | | |
|---|---|---|
| | 3 PHASE SLIPRING ROTOR STARTER W, CONTROL LAMPS | EP 2.3/4.5.4/7 |
| | | Circuits III |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING | | ELECTRICIA |
| PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | GENERAL |

CONTINUATION OF SHEET 2.3/4.5.4/7

a.) COMPLETE THE WIRING DIAGRAMS 4.5.4/7•4.5.4/8 OF 3 PHASE SLIPRING ROTOR STARTER CONTROL CIRCUIT ACCORDING TO YOUR CURRENT PATH DIAGRAM 4.5.3/29

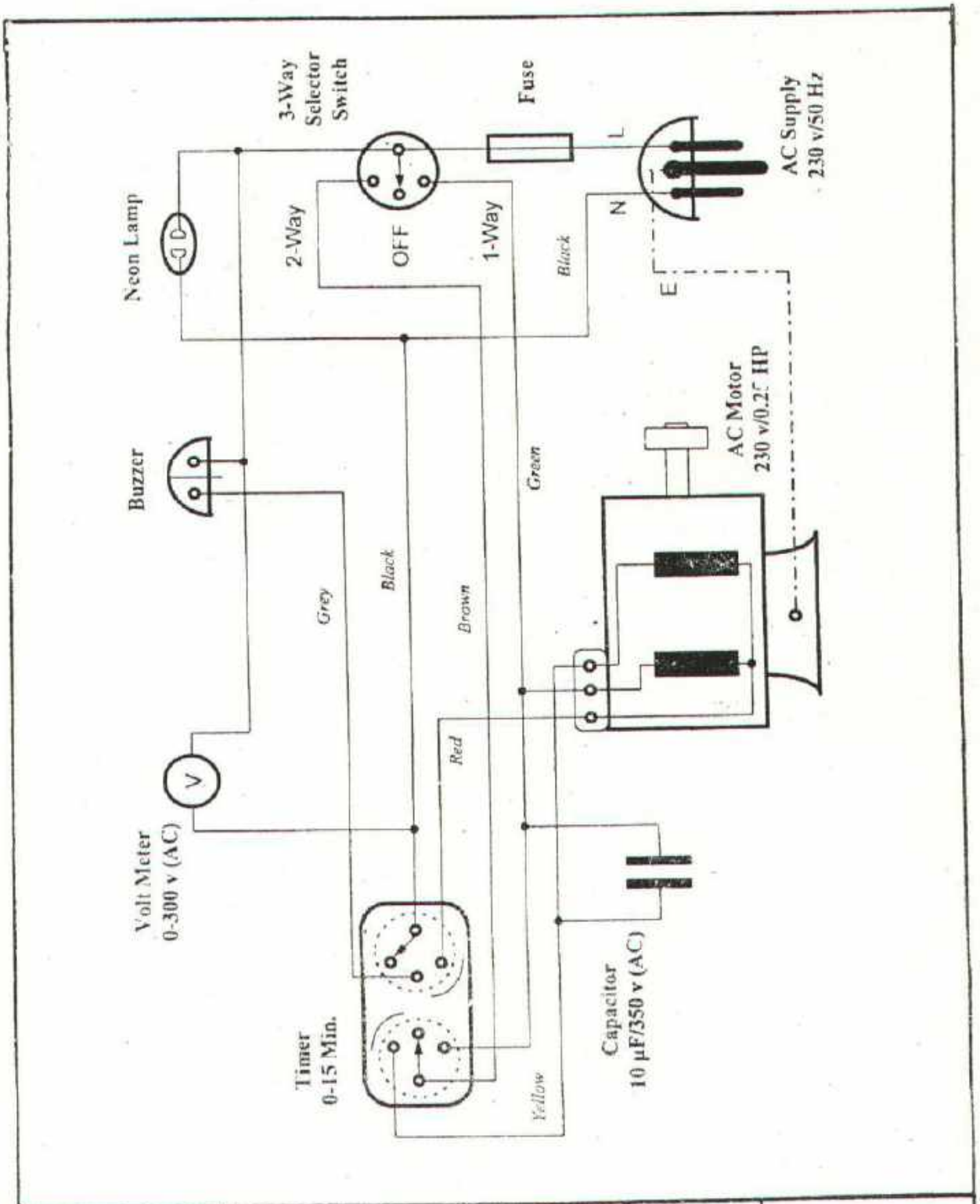
b.) TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB WITH THE HELP OF DIAGRAMS 4.5.3/27, 4.5.3/29 AND YOUR COMPLETED AND CHECKED DIAGRAMS 4.5.4/7 AND 4.5.4/8

TO BE COMPLETED WITH SHEET 2.3/4.5.4/7

# 3 PHASE SLIPRING ROTOR STARTER W, CONTROL LAMPS

EP 2.3/4.5.4/8

Circuits III




| | | |
|---|---|---|
| WIRING DIAGRAM | ELECTRIC WASHING MACHINE | EP 2.3/4.5.4/9 |
| | | CIRCUITS - III |

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

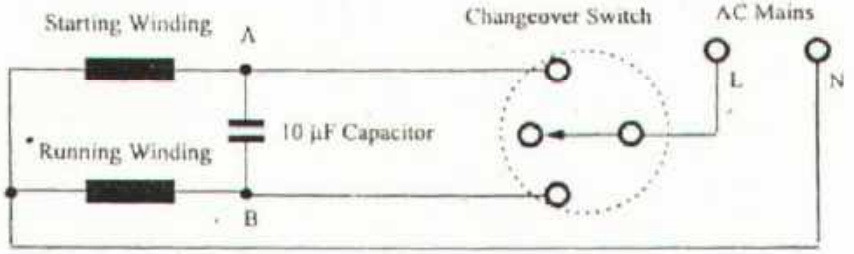
Electrician General

# THE WASHING MACHINE

## Major Electrical Parts With Brief Description

1. **Motor:**

This is the most active component of a Washing Machine. It is a Single Phase AC Motor with power rating of 0.25 to 0.5 HP. It is a Capacitor Start Capacitor Run Motor with the provision to rotate in forward & reverse direction. The basic theory to rotate the motor in forward & reverse direction is as follows:-




i. The two terminals of Starting and Running Windings are directly connected to the Neutral through a common wire while the other two terminals are interconnected through a 10 µF capacitor.

ii. Now, if the phase wire of the mains is connected to point "A", the motor will (for example) run in forward direction, and, if the phase is connected to point "B", then the motor will change its direction to the reverse mode.

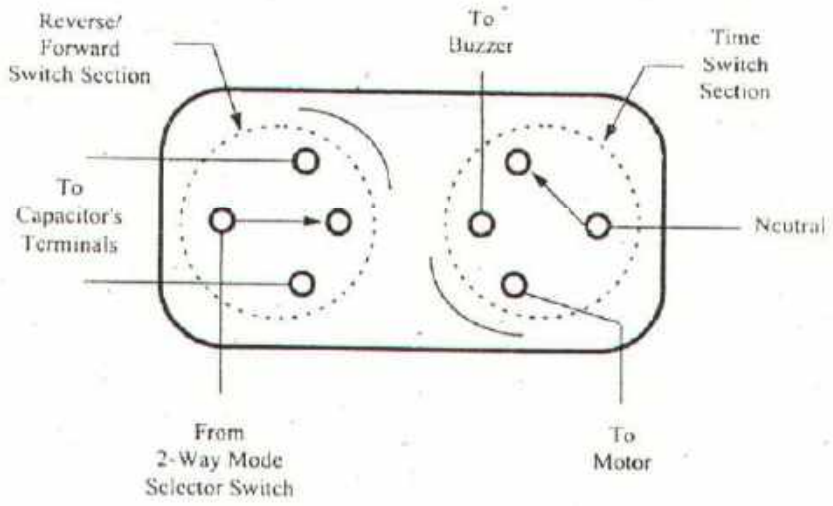
2. **Three Way Selector Switch:**

It is a Three Way Four Terminal Rotary Type Changeover Switch. Its function is to turn the machine OFF/ON as well as to run the motor either in "ONE WAY" or "TWO WAY" mode.

The sliding terminal of this switch is connected to the phase wire while the outermost two terminals are engaged with "ONE WAY" and "TWO WAY" lines respectively. The middle one is the "OFF" terminal and kept in "No Connection" status.

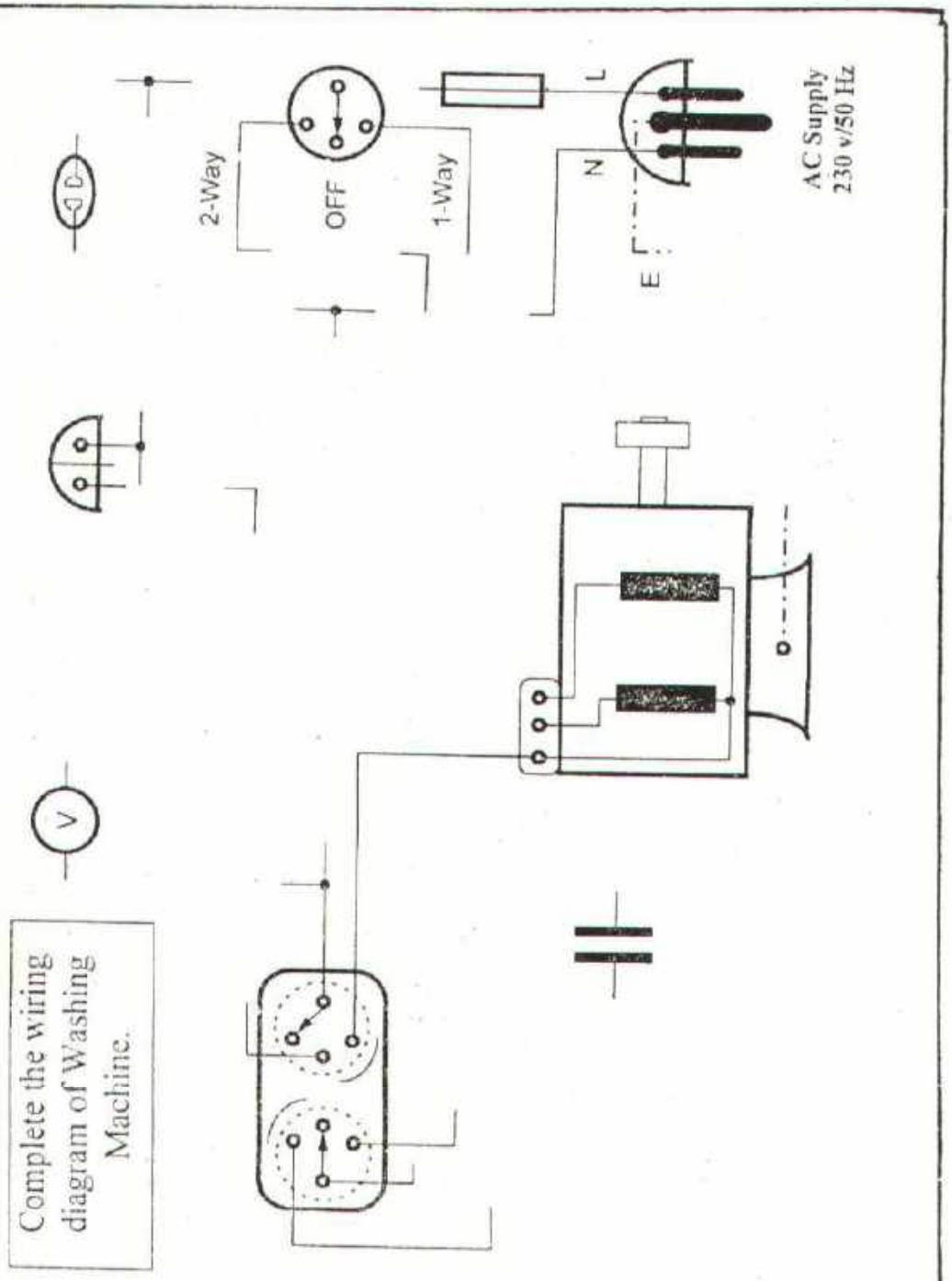
3. **Timer:**

It is a Mechanical Timer (0.....15 Minutes, generally) with six leads of electrical outlets/contacts. It contains two separate Three Way Four Terminal Switches. The function of each one is briefly described in following lines:-




i. **Time Switch:** The function of this section is to turn the machine/motor in "ON" condition within the time limits (0.....15 Minutes) selected by turning the Timer Knob manually from the Machine Panel. This action will connect the Neutral Wire to the motor and after selected time, the Neutral Point will shift to Buzzer terminal. After 10 seconds of buzzing, the Neutral point switch over/rests to OFF terminal turning the machine to OFF condition.

ii. **Reverse/Forward Switch:** When the timer is ON, this portion acts as a Three Way Changeover Switch. The Phase Wire changes over its contact from one terminal of the capacitor to the other (See the basic theory of Reverse & forward rotation) automatically if the Mode selector switch is in "TWO WAY" position. In case the machine is in "ONE WAY " mode, this changing over function becomes effectless.




| TASK SHEET | ELECTRIC WASHING MACHINE | EF 2.3/4.5.4/9B |
|---|---|---|
| | | CIRCUITS - III |

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Electrician General

# SERVICING ELECTRICAL MOTORS

DISMANTLING ELECTRICAL MOTORS

REMOVAL OF BALL BEARINGS

INSTALLING OF BEARINGS (2)

REMOVAL OF BUSHES AND SLEEVE BEARINGS

CLEANING OF BALL BEARINGS / TRANSPORTATION

SKIMMING OF ARMATURE

ASSEMBLING OF ELECTRICAL MOTORS

TEST SHEET (MECHANICAL)

TEST SHEET (ELECTRICAL)

CHECK LIST

TYPES OF BEARINGS

TYPES OF LUBRICATION NIPPLES

OIL SEALS

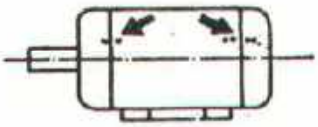
BEARINGS

PARTS OF ELECTRICAL MOTORS

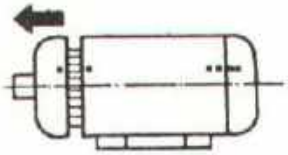
CONSTRUCTION TYPES OF ELECTRICAL MOTORS

SEQUENCE OF OPERATION

1. Place all motor parts in a box !
2. Work very carefully to avoid damage.
3. Place motor on a clean, level and solid surface, e.g. work bench, concrete floor. Do not open the motor on dirt floor for dirt and dust will enter the motor and cause damage.
4. Clean the outside to remove all dirt and grease with a dry rag, cloth, duster or a brush and some petrol or kerosene oil. DO NOT USE WATER.
5. Mark the exact position of both the ENDSHIELDS and the MOTOR FRAME with a sharp centre punch, scriber or a file. This will help maintain the true bearing alignment when reassembling the motor and prevent mixing up the parts.



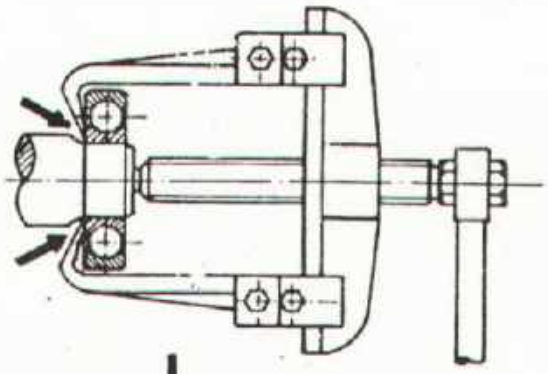
6. Take out carbon BRUSHES, if the motor has any, to avoid damaging them.
7. Open nuts or screws with the PROPER SPANNER, or correct size SCREWDRIVER. DO NOT USE PLIERS. If the screws or nuts are very tight, apply light hammer blows and soften with petrol or kerosene. ATTENTION: If the nuts or screws are firmly rusted the stud is likely to be twisted off.
8. Open ENDSHIELD on shaft extension side first. On the opposite side very often the motor lead wires are attached or the centrifugal switch is mounted. Be careful not to tear off the wires from the motor windings or damage the centrifugal switch.



9. Clean inside of the motor carefully with compressed air, rags etc. or a small paint brush with some petrol or kerosene oil. DO NOT USE WATER and do not use too much cleaning fluid directly on the windings as it may damage the insulation.

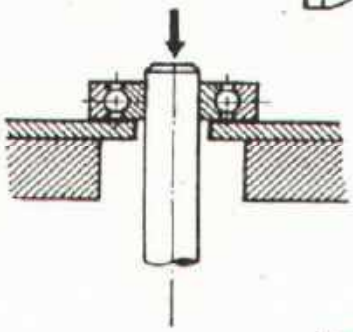
   The use of sharp edged tools, e.g. screwdriver, scraper, knives, inside the motor is NOT permitted. For scratching use small pieces of wood or plastic only.
10. Place all parts of the motor in one box. Do not mix parts from other motors or tools with it. If parts are not kept in a box they will get lost resulting in an irrepairable motor.

The ballbearing is removed from the shaft with a "puller".

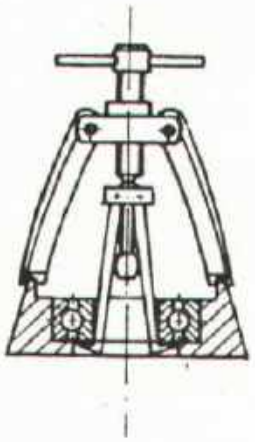


Note: It is very important that only the ring which sits on the shaft is pressed by the puller.

Two strips of flat iron across a vice may be used to remove the bearing. Drive out the shaft with light hammer blows using protective pieces such as wood, copper or aluminium on the shaft end in order to prevent damage to the shaft.

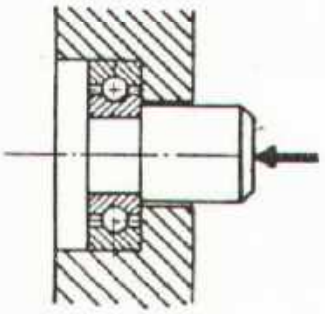


Puller for removing ballbearings from bores.

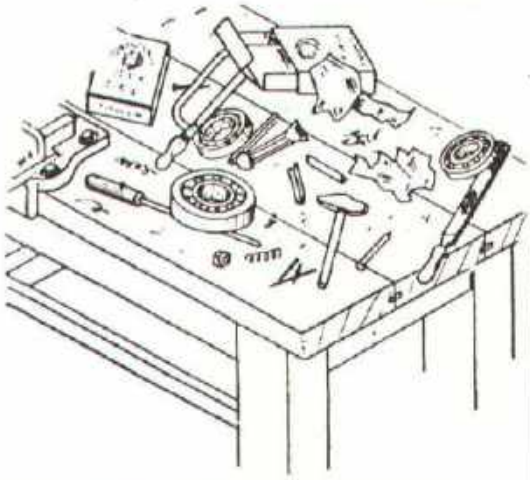


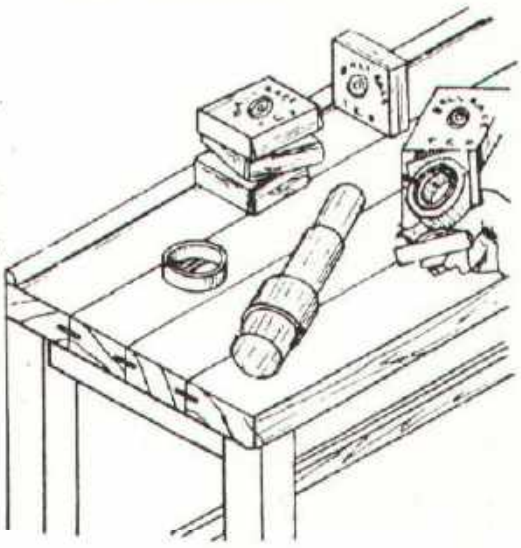
Careful hammerblows on a piece of soft material, alu, wood etc., may be used to drive the bearing out.

Avoid excessive pressure on the inside ring for it may damage the bearing.



| | REMOVAL OF BALL BAERINGS | EP 2.3/4. 5.6/2 |
|---|---|---|
| | | Serv. E. Motors |





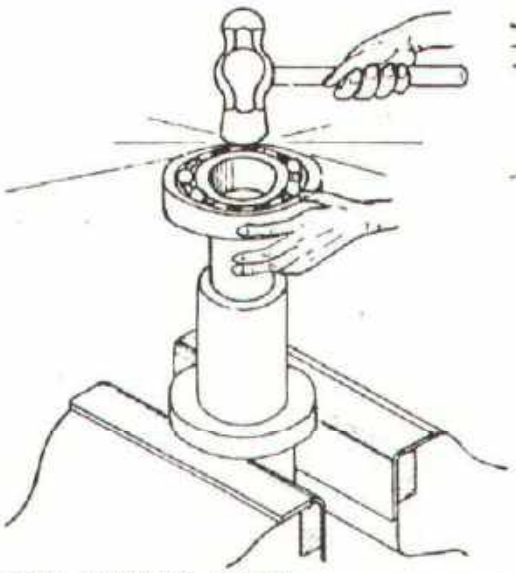
KEEP YOUR WORK-BENCH CLEAN

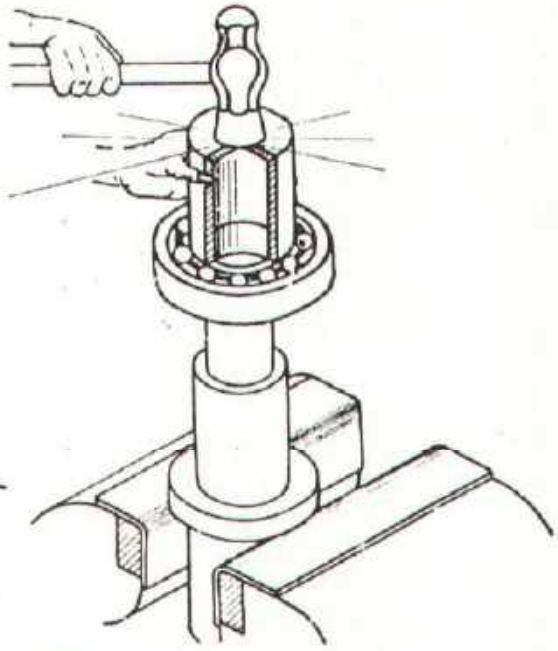
WRONG

PACKAGE SHOULD NOT BE OPENED AND NEW BEARING EXPOSED TO DIRT BEFORE BEING INSTALLED.

RIGHT

PACKAGE SHOULD BE KEPT CLEAN, AND BEARING SHOULD NOT BE REMOVED UNTIL NEEDED.





KEEP BEARINGS CLEAN

INSTALL BEARING PROPERLY

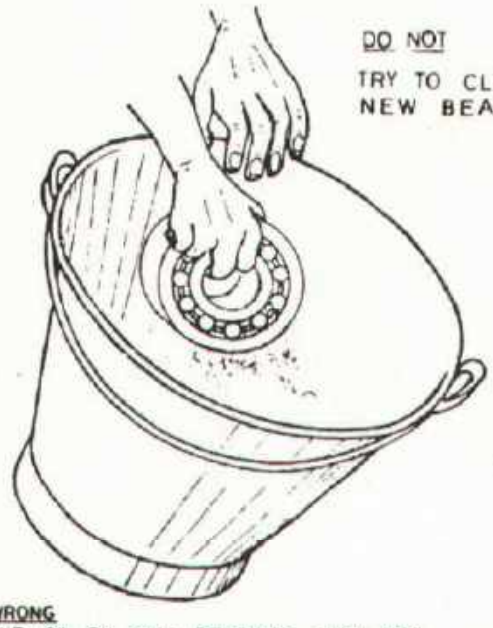
WRONG

BEARING SHOULD NOT BE DRIVEN ONTO SHAFT BY BLOWS ON OUTER CASE.

RIGHT

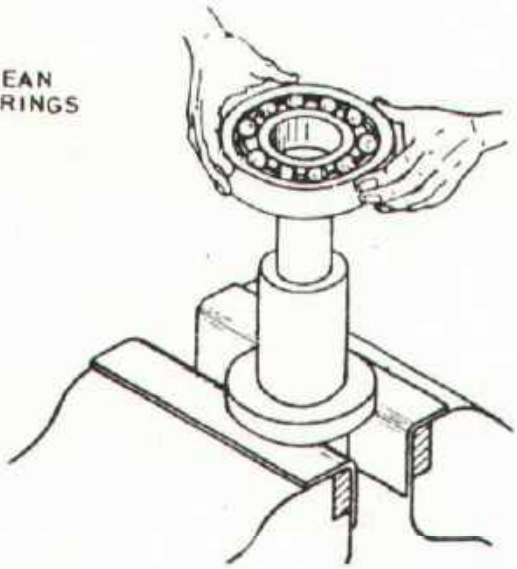
BEARING SHOULD BE LIGHTLY TAPPED ONTO SHAFT BY BLOWS ON TUBE WHICH FITS AGAINST INNER SLEEVE.

| | | |
|---|---|---|
| | INSTALLING OF BEARINGS | EP 2.3/4.5.6/3<br>Serv. E. Motors |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |



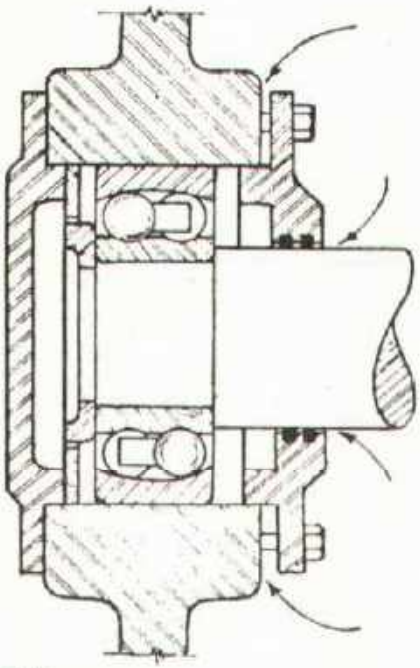
DO NOT

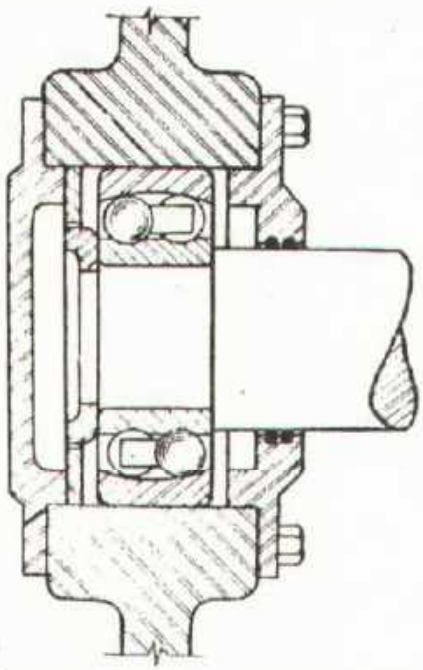
TRY TO CLEAN
NEW BEARINGS



WRONG
THE OIL ON NEW BEARINGS MUST NOT BE REMOVED.

RIGHT
THE NEW BEARINGS SHOULD BE FITTED IMMEDIATELY AFTER ITS REMOVAL FROM THE PACKAGE.





WRONG
LOOSE COVER-PLATES PERMIT DIRT TO ENTER HOUSINGS, CAUSING RAPID BEARING FAILURE.

RIGHT
COVER-PLATES PROPERLY INSTALLED, PREVENTING THE ENTRANCE OF DIRT.

PROTECT OPERATING BEARINGS

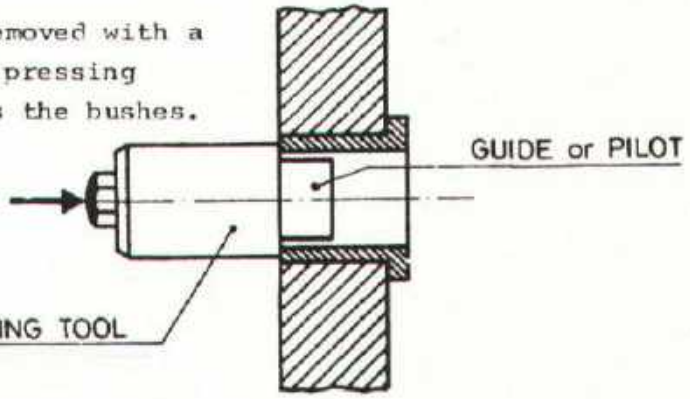
# INSTALLING OF BEARINGS

EP 2.3/4.5.6/4

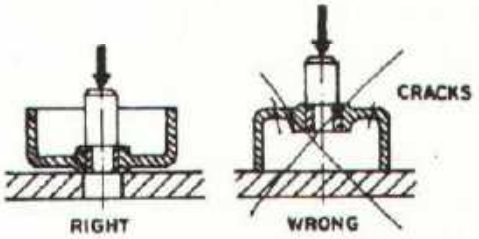
Serv. E. Motors

Bushes are usually removed with a press and a suitable pressing tool, the same size as the bushes.

The pressing force can be applied with a press or hammer blows.

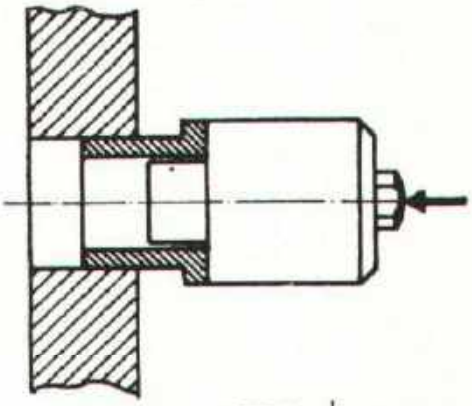



To press in and out bushes place endshields on firm support to avoid cracking or damage.

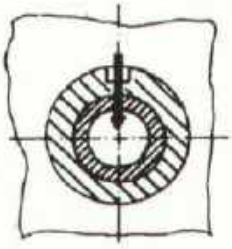



MOUNTING OF SLEEVE BEARINGS

ought to be done with a pressing motion of a correct size pressing tool only. If no press is available a vice can be used also.

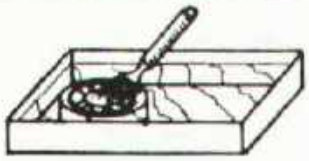


For highest accuracy, especially for thin walled bearings, the bearing blank is first pressed into the endshields and then bored and reamed to size.



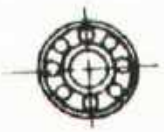
Check the right position of the lubricating hole. If necessary drill the hole after assembling the bearing.

Cleaning a ball bearing (not applicable for new bearings)



Clean with brush and kerosene or petrol.

Dry with a clean cloth.

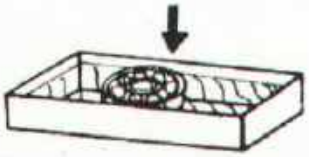


Check if clean.

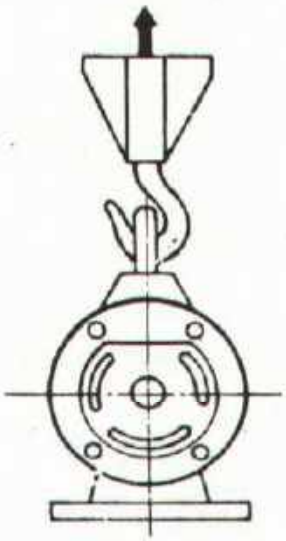
Apply protective oil film and wrap in clean cloth or paper till further use.

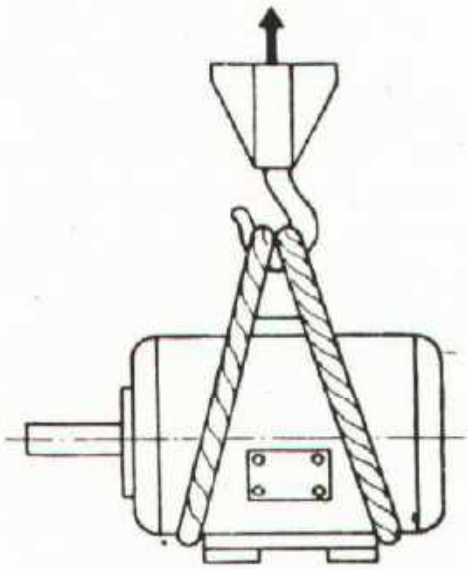
Check if clean.


Dry with compressed air.



Rinse with fresh petrol or kerosene.





Transportation of heavy motors (lifting)

Attention: Prevent accidents.
Always secure load. Do not stand under lifted load.

| | CLEANING OF BALL BEARINGS TRANSPORTATION | EP 2.3/4.5.6/6 Serv.El.Motors |
|---|---|---|
| | DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | ELECTRICIAN GENERAL |

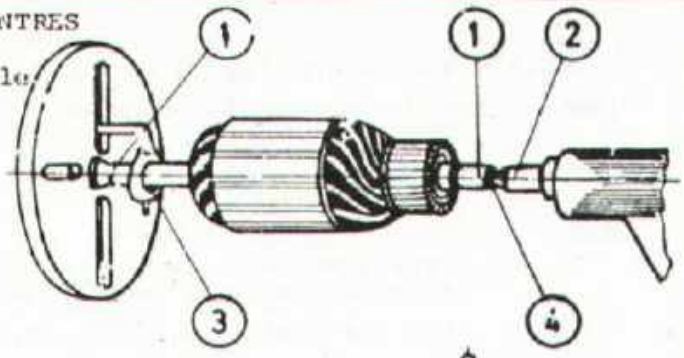
1) MOUNT ROTOR BETWEEN CENTRES

(1) shaft w. centre hole

(2) dead centre

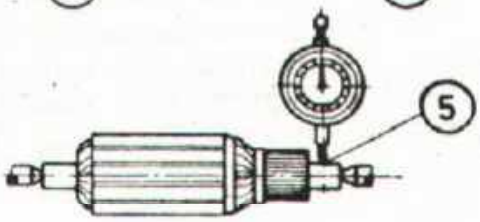
(3) lathe dog

(4) lubricant




2) CHECK TRUENESS WITH DIAL INDICATOR

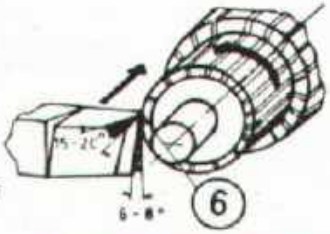
(5)




3) CAREFULLY TURN LIGHT CUT

(6)

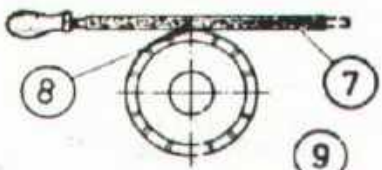
| | | |
|---|---|---|
| ▽ | = 35 m/min | 115 ft/min |
| ▽▽ | = 50 m/min | 165 ft/min |
| ▽ | = 0.3 - 0.5 mm/Rev. | 0.012 - 0.020" |
| ▽▽ | = 0.05 - 0.1 mm/Rev. | 0.002 - 0.004" |




4) SMOOTHEN WITH EMERY SHEET REMOVE ANY BURRS

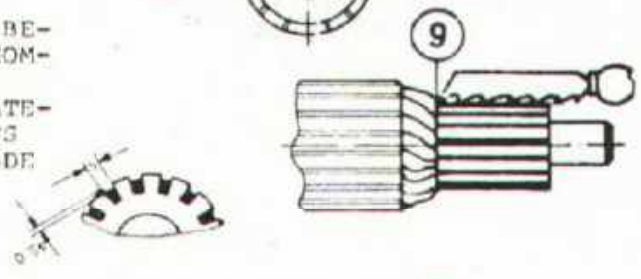
(7) smooth file

(8) emery cloth




5) MICA INSULATION MUST BE BELOW THE SURFACE OF THE COMMUTATOR.
REMOVE THE INSULATING MATERIAL BETWEEN THE SEGMENTS WITH A SPEC. HACKSAW BLADE OF THE SAME THICKNESS !

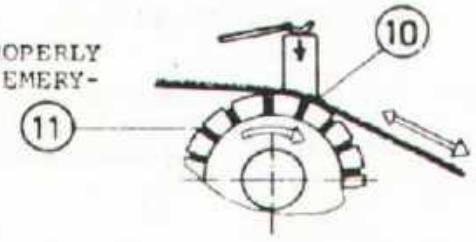
(9) hacksaw blade
mind the winding!




6) TO SEAT THE CARBONBRUSH PROPERLY ON THE COMMUTATOR DRAW AN EMERY-SHEET BETWEEN BRUSH AND COMMUTATOR !

(10) emery cloth

(11) undercut mica

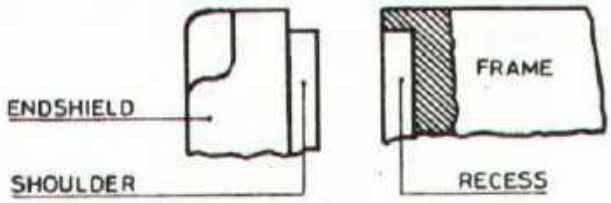



| | SKIMMING OF ARMATURE | EP 2.3/4.5.6/7<br>Serv.El Motors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |

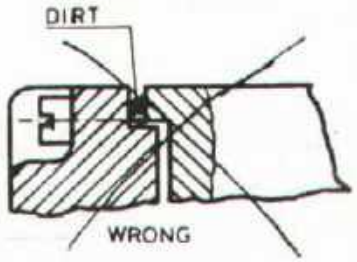
In general the assembling of an E-motor is in the reversed order of the disassembling sequence.

NOTE:

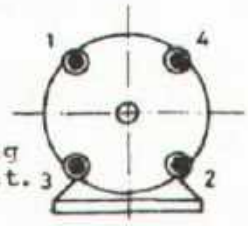
- Make sure that every part of the motor is clean and in good working order.
- Fit the centrifugal switch carefully, if any.
- Do not damage any motor windings.
- Apply grease to ballbearings only immediately before final assembling.
- The recess on the frame and the shoulder on the endshields MUST be clean and free from any deposit.




- Dirt will cause misalignment.




- Tighten bolts or nuts crosswise.
- Use wooden hammer to tap endshields with light hammer blows while turning the shaft to obtain maximum alignment.



QUALITY CONTROL

All serviced and repaired motors are to be checked thoroughly both mechanically and electrically.

ONLY MOTORS IN PERFECT CONDITION ARE TO BE RELEASED !

**Checklist:** (mechanical)

| | | correct | tight too low (small) | loose too high (big) |
|---|---|---|---|---|
| 1) | Noise | ☐ | ☐ | ☐ |
| 2) | End play | ☐ | ☐ | ☐ |
| 3) | Rotor running free | ☐ | ☐ | ☐ |
| 4) | Bearing fits | ☐ | ☐ | ☐ |
| 5) | Lubrication, grease nipples, oil supply | ☐ | ☐ | ☐ |
| 6) | Temperature bearings | ☐ | ☐ | ☐ |
| 7) | Temperature motor frame | ☐ | ☐ (fair) | ☐ (unusable) |
| 8) | Condition of shaft, key way, pulley, bearing seals | ☐ | ☐ | ☐ |
| 9) | Bolts, nuts tightened | ☐ | ☐ | ☐ |
| 10) | Test run 30 min. | ☐ | ☐ | ☐ |

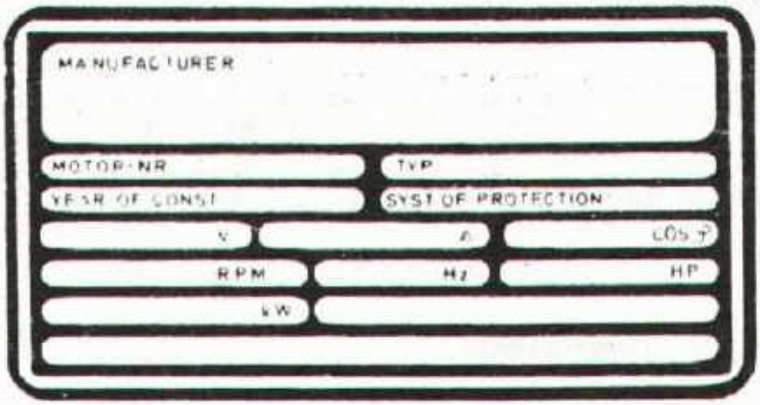
Final remarks:

Signature / Date

QUALITY CONTROL

All serviced and repaired motors are to be checked thoroughly both mechanically and electrically.

ONLY MOTORS IN PERFECT CONDITION ARE TO BE RELEASED !




Type of motor: A.C. D.C. single phase polyphase

Checklist (electrical)

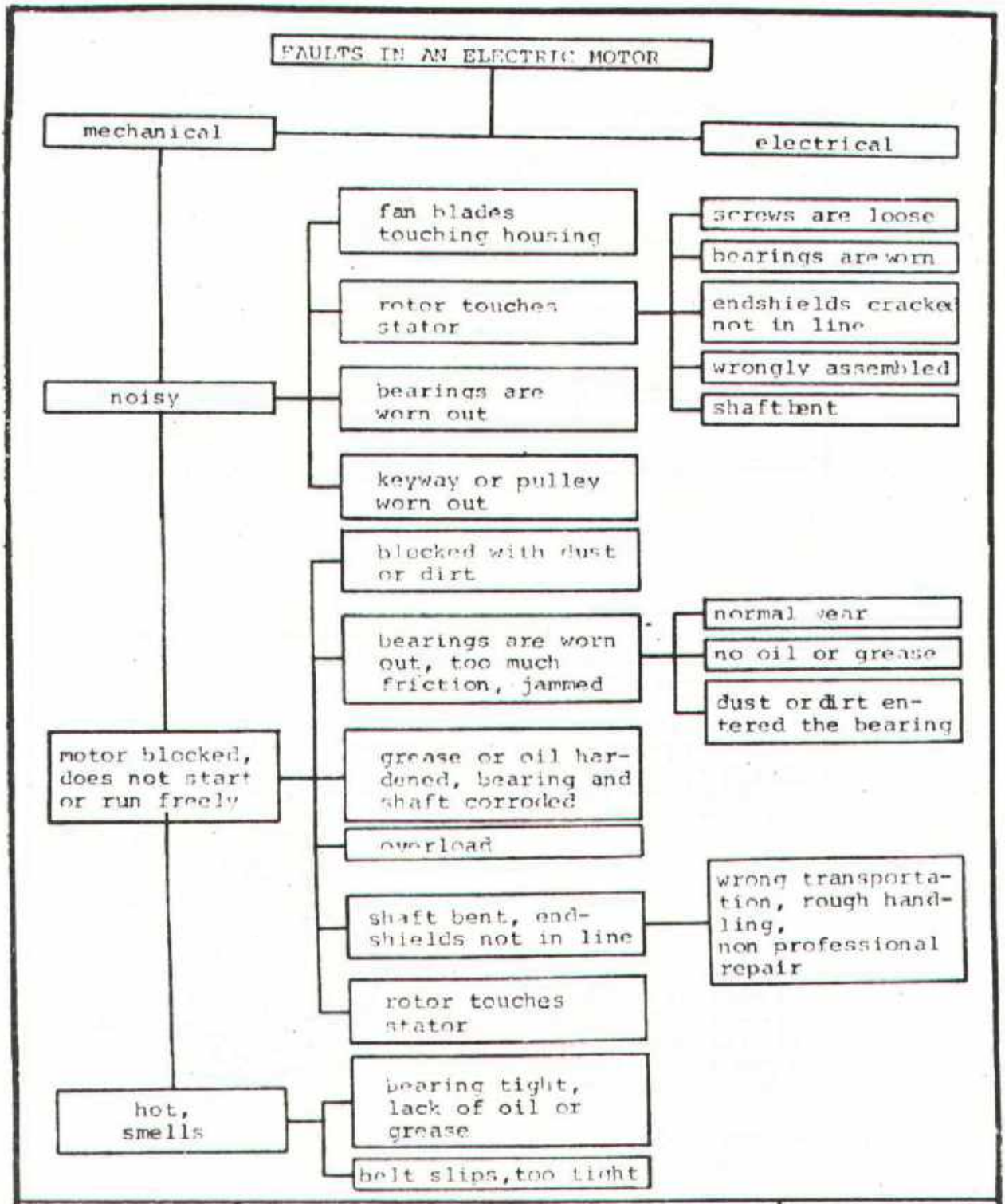
1) Fill in above type plate:
2) Measure and check:
   - Voltage: _____ V
   - Current _____ A
   - Resistance: _____ Ω
   - Revolution: _____ RPM
   - Insulation:
   - Earth:

| | good | too low | too high |
|---|---|---|---|
| 3) Temperature: | ☐ | ▨ | ☐ |
| 4) Noise: | ☐ | ▨ | ☐ |
| 5) Power output: | ☐ | ☐ | ☐ |
| 6) Testrun 30 min.: | ☐ | ☐ | ☐ |

Remarks:

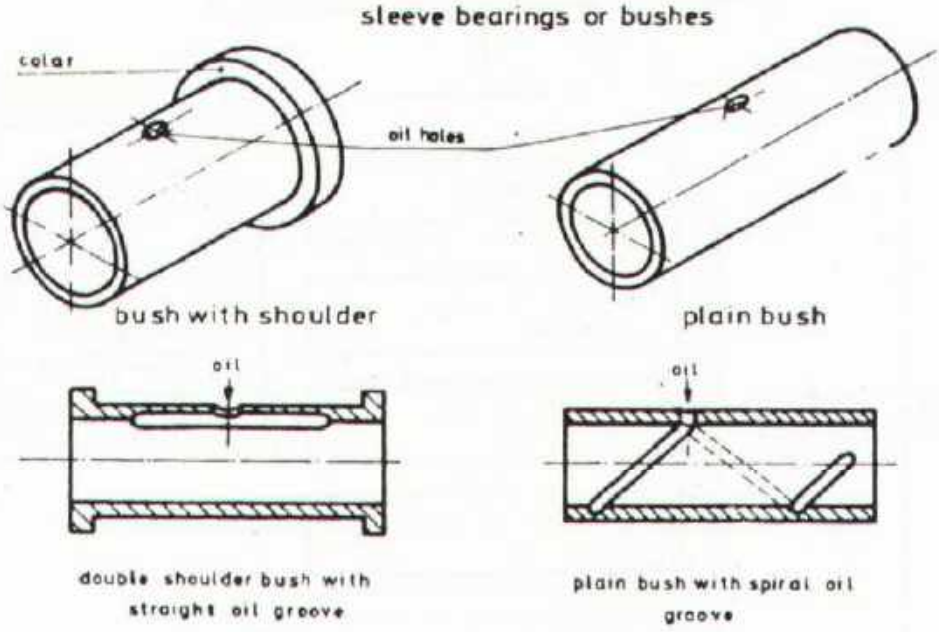
Signature / Date

| | TEST SHEET (ELECTRICAL) | EP 2.3/4 5.6/10 Serv.El.Motors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |




| | CHECKLIST | EP 2.3/4 5.6/11 |
|---|---|---|
| | | Serv.El. Motors |

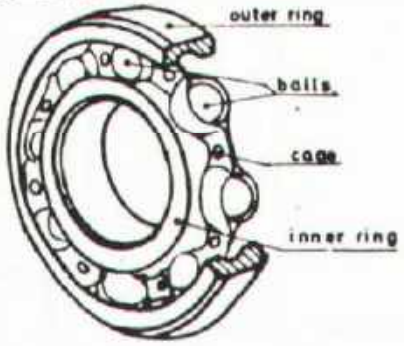
sleeve bearings or bushes




SLEEVE BEARINGS or BUSHES are turned from brass, gun metal bronze or special bearing metals. Sleeve bearing motors are usually oil lubricated and are generally used in horizontal position.

"OIL LESS" bushes are considered as permanently lubricated. In this arrangement the shaft passes through a sintered (powdered metal which is pressed and baked in an oven) bushing which has been impregnated with oil. No lubrication is needed. Used in fans etc.

ball bearing




BALL BEARINGS are manufactured from special steel and are precisely machined and ultra precisely ground. The balls and the actual running faces are highly polished.

SEALED BEARINGS contain lifetime lubrication and should not be opened.

## LUBRICATION OF ELECTRIC MOTORS

Moving parts need to be lubricated to reduce friction which causes heat.

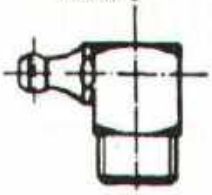
Heat may spoil the bearing.

Bearings in electric motors need a constant supply of clean oil or grease. The lubricant is supplied through specially designed oil supply holes commonly fitted with the following oil or grease nipples:

Form A

Form B

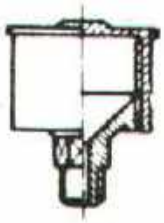
Form C



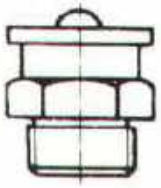
ball-valve grease nipples

To be served with a grease gun only.

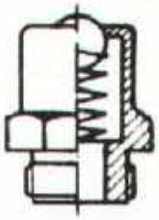
NOTE: clean nipples carefully before lubricating.



stauffer type grease cup



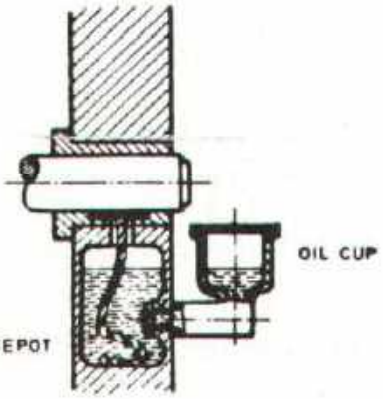
oil nipple



oil nipple

wick oiler (lubricater)

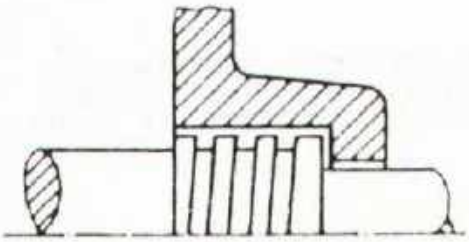

sight feed lubricater



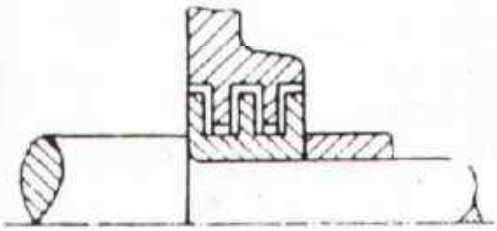

wick oiler (lubricator)

| | TYPES OF LUBRICATION NIPPLES | EP 2.3/4.5.6/13 Serv.El.Motors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN GENERAL |

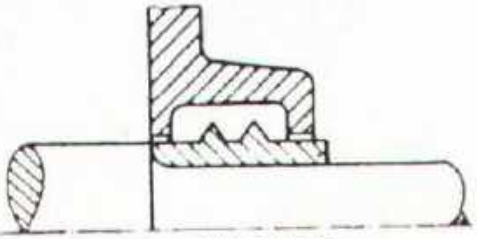
## NON CONTACTING OIL SEAL



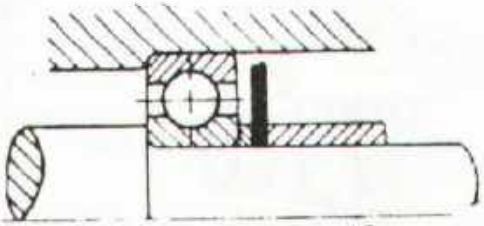
CONVEYOR SPIRAL



LABYRINTH BOX

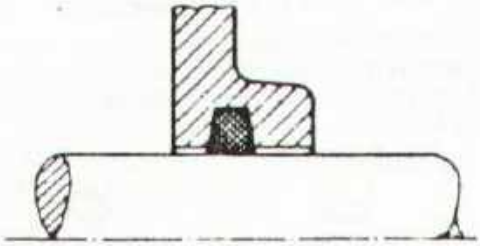


OIL THROWER



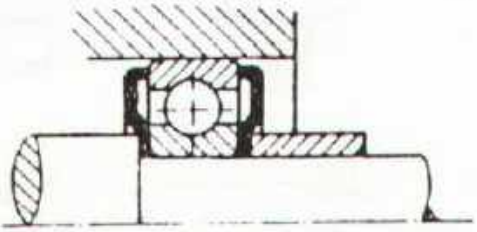
RETAINING RING

## CONTACTING OIL SEAL

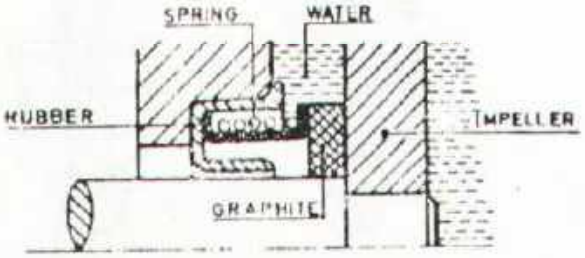


FELT RING SEAL

ELASTIC OIL SEAL



SEALED BALL BEARING




WATER PUMP SEAL

| | ELECTRIC MOTORS<br>OIL SEALS | EP2.3/4.5.6/14<br>Serv.El.Motors |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAN INDIAN TECHNICAL TRAINING PROGRAMME | | ELECTRICIAN<br>GENERAL |

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

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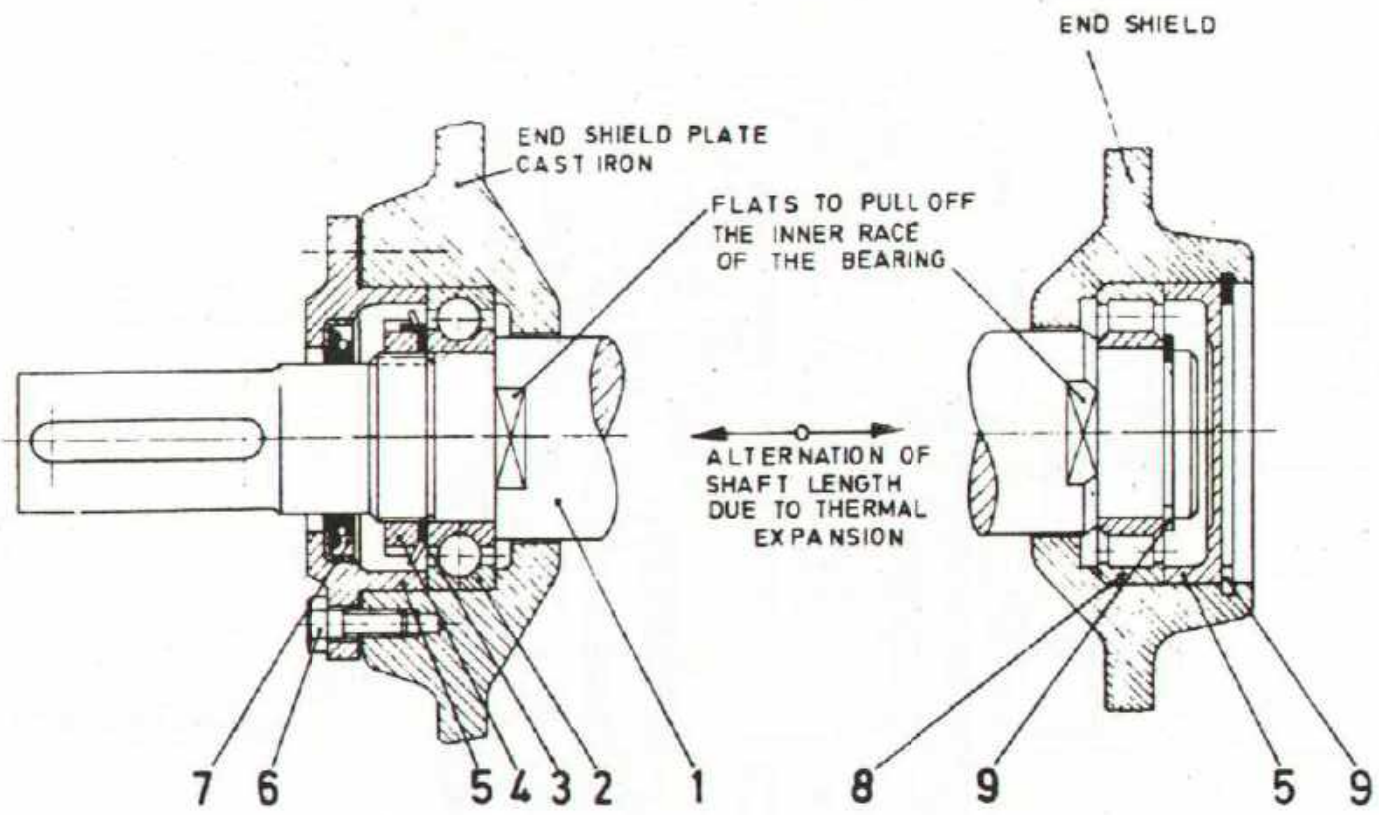
ELECTRICIAN GENERAL

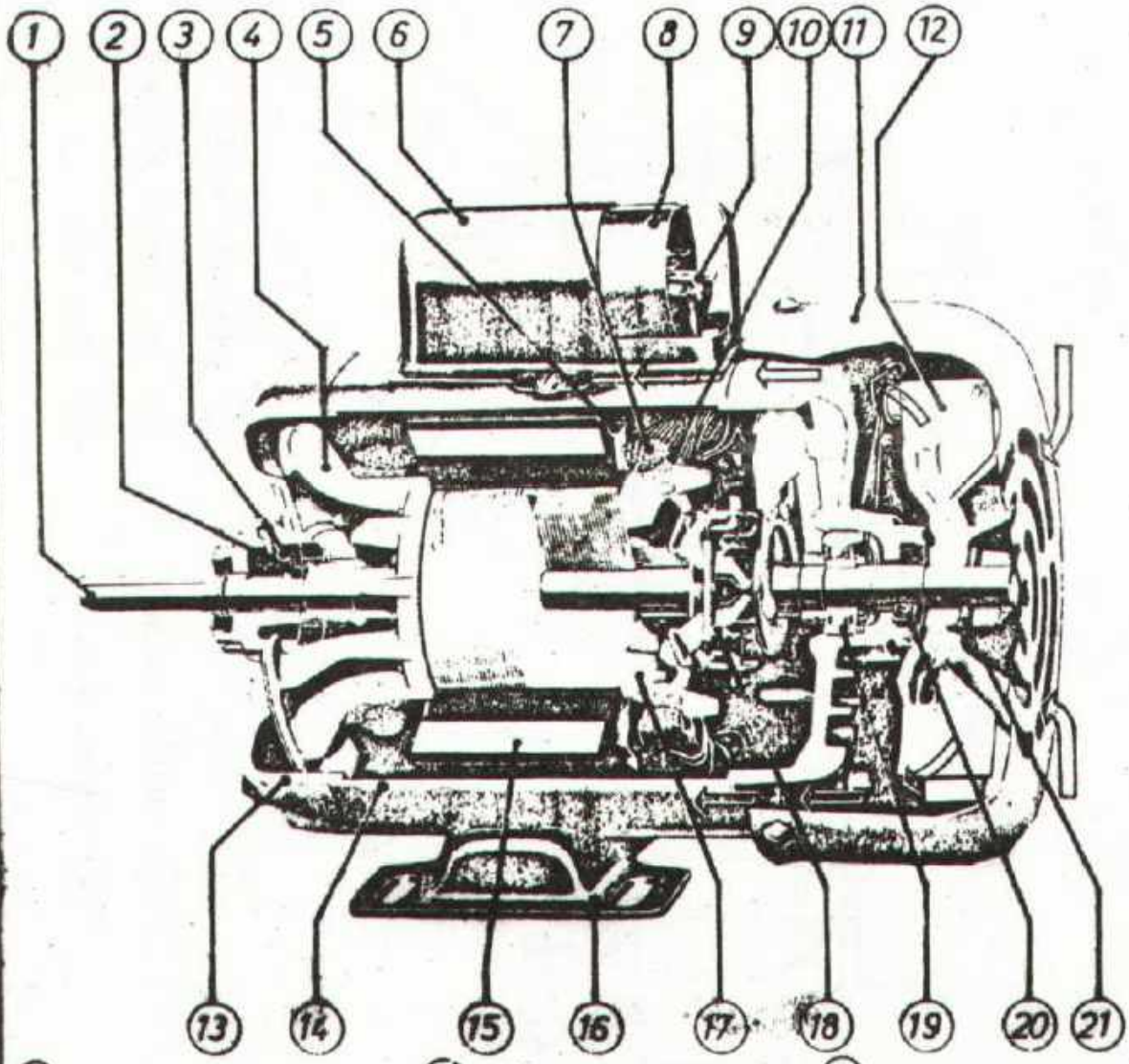
Serv E. Motors

EP 2 3/4.5.6/15

# BEARINGS




1. SHAFT
2. BALL BEARING
3. LOCK WASHER
4. GROOVED NUT
5. BEARING COVER
6. COVER BOLT
7. SEAL - FELT / FIBRE
8. CYL. ROLLER BEARINGS
9. LOCK RING




1 _____
2 _____
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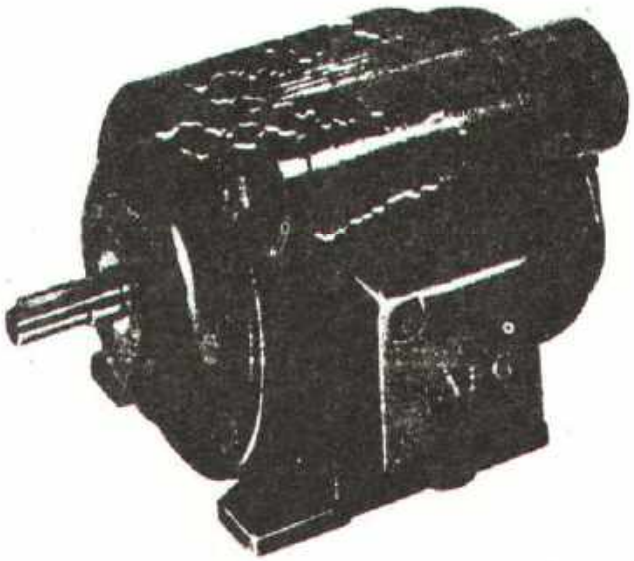
19 _____
20 _____
21 _____

# PARTS OF ELECTRIC-MOTOR

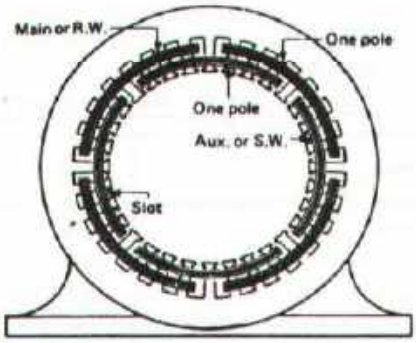
EP 2.3/4.5.6/16
Serv.El. Motors

# single phase motor

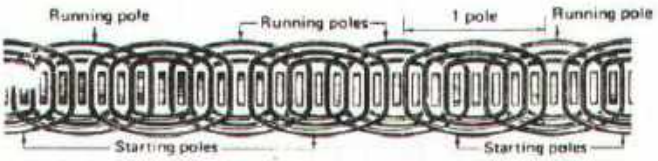


Taking data is one of the most important operations.
It consists of noting certain specific information concerning the old winding, so that no difficulty will be encountered when the motor is rewound. The information is recorded before and during the process of stripping the stator core of its windings. The best procedure is to obtain as much data as possible before the stripping operation. The information that should be obtained for both the running and starting windings includes (1) name-plate data, (2) the number of poles, (3) the pitch of the coil (the number of slots that each coil spans), (4) the number of turns in each coil, (5) the size of the wire on each winding, (6) the kind of connection (that is, series or parallel), (7) the position of each winding in relation to the other winding, (8) the type of winding (whether hand, form or skein), (9) slot insulation, both size and kind, and (10) number of slots.

To determine the number of poles in the motor count the number of sections in the running winding. In the figure the four sections of the running winding indicate a four-pole motor. If there were six sections in the running winding, it would indicate a six-pole motor. The number of poles in an induction motor governs the speed of the motor, and it is therefore essential that the correct number be recorded.




Should the winding assembly be cut at one point and rolled flat, the winding would appear as the figure shows.




Notice the location of the running winding with respect to the starting winding. The starting winding overlaps two poles of the running winding. This is always true in single-phase motors, regardless of the number of poles or the number of slots in the motor. Noting and recording the location of the running winding with respect to the starting winding is highly important. If they are placed in any different location in rewinding, the motor may not start properly. Actually, the running and starting windings are separated by 90 electrical degrees. This is true no matter how many poles the motor has. However, the number of mechanical degrees between windings will differ with the number of poles in the motor. In the four-pole motor the windings are 45 mechanical degrees apart, and in a six-pole motor they are 30 mechanical degrees apart.

The type of connection is the next item to be recorded. This can only be obtained if one is familiar with methods of winding and connecting the poles to each other.
Single-phase motors are connected in a variety of ways, such as single voltage, dual voltage, externally reversible, two speed, etc. In order to be able to record the kind of connection in the motor, the trainee must have a knowledge of the various connections to be found in this type of motor. It is advisable for the beginning that a complete connection diagram including the coils is drawn by the trainee and checked by the instructor.

Information regarding the number of turns of wire in each coil must be obtained and recorded. This is done by counting the turns as they are unwound or by cutting the coils on one end and counting the ends. It is important to note also whether or not there is more than one strand per conductor. Sometimes two strands of a smaller wire are used instead of one strand of a larger size. The size of wire, as determined by a micrometer, must also be recorded. These data are noted as the windings are removed from the stator.

Sample of a data sheet for single-phase motors

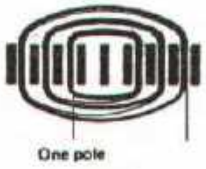
| Make: ..... | Type: ..... | Fabr. No: ..... | Code: ..... |
|---|---|---|---|
| kW | Volts | Amps | No. of poles |
| Cycle (Hz) | rpm | Phase | No. of slots |
| Insul. class | Model | Frame | Time rating |

| Winding | Size wire | No. of circuits | Pitch | Turns |
|---|---|---|---|---|
| Running | | | | |
| Starting | | | | |

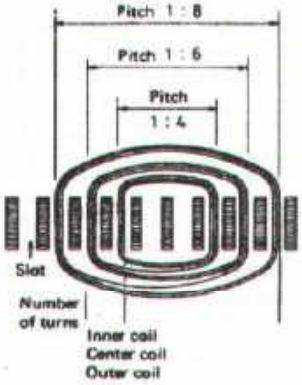
| Slot No. | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 1 |
|---|---|
| Running | |
| Starting | |
| Rotation | Clockwise / Counter clockwise |

| Slot insulation | | End room of winding | | Remarks: |
|---|---|---|---|---|
| Material | Thickness | Side A | Side B | |
| | | | | |

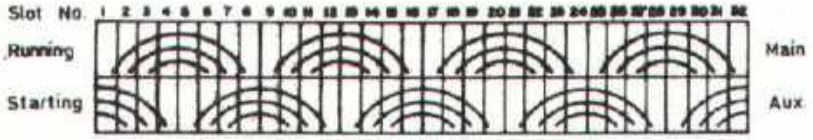
If a pole of either the running or starting winding of the motors is examined closely, it will be found to consist of different separate coils that have been wound one at a time, as illustrated in the figure beside.




Also, each coil is wound in two slots that are separated by one or more other slots. The number of slots separating the sides of a coil, including the slots in which the winding lies, is called the pitch, or span, of a coil and is recorded as 1 : 4, or 1 : 6, or 1 : 8, as the case may be. This is shown in the figure beside. These coils protrude a certain distance from the ends of the slots. This is called the end room. This distance should be measured and recorded. It is important that the new coils do not extend beyond the slots any further than this distance; otherwise the end plates may press against the coils and cause a ground.



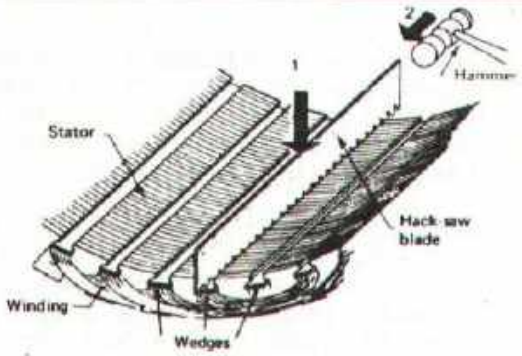

The next step is to record the information thus far obtained regarding the positions of the windings and the pitch of the coils. It may be recorded by showing all the slots and the windings as shown in the figure below.



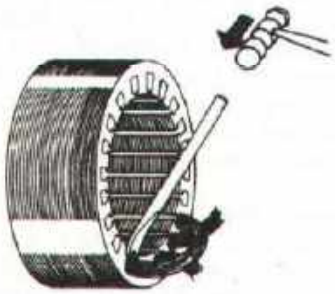

This shows a motor with 32 slots. In this method, the spans of all the coils are recorded merely by drawing curved lines in the proper slots. This is recorded first for the starting winding because it is on top and more visible than the running winding. The pitch of the running winding coils can be seen more easily if the ends of the starting winding are lifted. Each of the curved lines represents one coil of a pole.

Another item of the data that should be recorded is the location of the running-winding poles with respect to the frame itself. In some motors the center of each main pole is identified by a change in the slot size. This is sufficient for properly locating the poles in rewinding. However, in the absence of the odd-sized slot, the position must be clearly indicated by punch-marking the center slot or slots.

If only the starting winding needs replacing, its coils can usually be removed easily by cutting the wires on one side of the stator and then pulling them out from the other side. Sometimes the wires can be lifted from the slots after removing the wedges that hold them in place. The wedges can be removed by using a power hacksaw blade as shown in the figure. The blade is first tapped with a hammer so that the teeth are embedded in the wedge; then it is driven out in the direction in which the teeth point.




If the entire stator must be rewound it would be very difficult and time consuming to remove the windings from the core. The windings are usually extremely hard because of the varnish. Usually the coils on the back side of the stator are cut off with a chisel as shown in the figure. Then the stator is placed in a burn-off oven for some time at approximately 200°C. The oven may be gas fired or electric. It is important that the heating be controlled to prevent warping of the frames and damage to the lamination plating. Removing the rest of the coils is relatively simple because the remaining coils may be pushed through the slots from the other side of the winding.

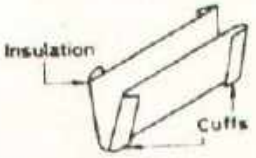


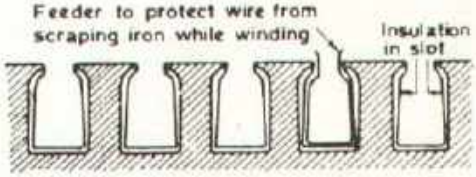
During the process of stripping the number of turns in each of the coils of one or two poles of the starting and running winding must be counted. This information is then recorded on the data sheet. At this time, also, the size of the wire of both the running and starting windings is measured, usually by means of a micrometer after it is stripped of its insulation. It is then recorded on the data sheet.

The procedure of stripping other types of motors is similar.

Before placing the winding in the slot some form of insulation must be installed so that the wires do not touch any part of the iron core. Different types of material are available for this purpose.

The insulation is cut as shown in the figure. It must be approximately 5 mm longer than the slot and is then shaped to fit the walls of the slot. The ends of the insulation are often cuffed to prevent them from sliding in the slot and possibly being the cause of a grounded coil. This insulation material is manufactured and sold in rolls and sheets in assorted widths and thicknesses. Cuffed insulation is cut to a length to fit the slots; an insulation cutter is used for this purpose. For the average size of fractional-horse power motors, insulation paper approximately 0.15 to 0.35 mm thick is suitable for slot insulation. The insulation between the running and starting winding is generally 0.15 mm thick. The figure also shows the manner of installing a feeder strip of insulation that covers the edges of the slot while winding. This feeder may be removed after winding the coil or its ends may be folded over and left in the coil.




Cuffed insulation installed in slots

| Trade Training | SLOT INSULATION | EP 2.3/4.15.7/5 |
|---|---|---|
| | | Single-phase motor |

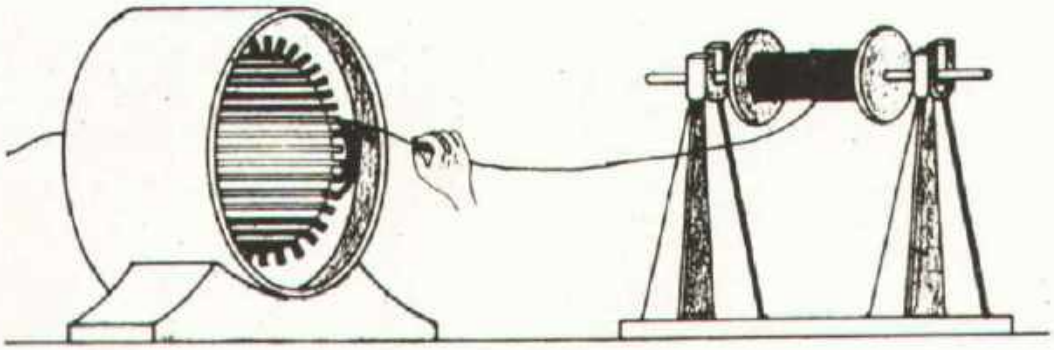
## Hand Winding

Hand winding may be employed for both the running and the starting winding. There are two main advantages to this type of winding:

1. a tighter winding is possible, especially where room is limited,
2. a winding form is unnecessary.

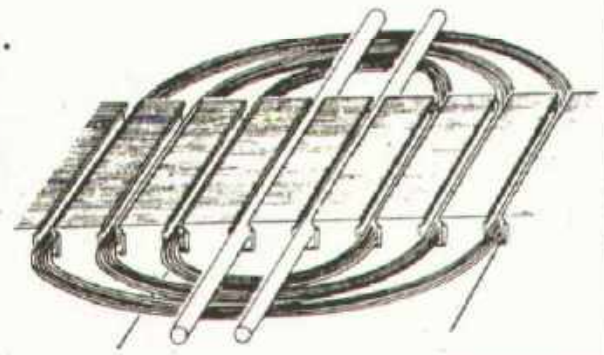
By this method the wires are placed in the slots, one turn at a time, starting with the inner coil and continuing until all the coils of the poles are wound.

The stator and spool off wire are arranged as shown in the figure.



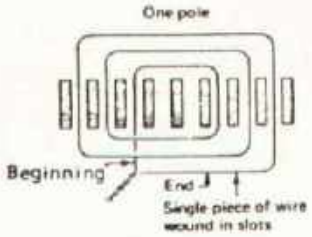
The inner coil is wound with the required number of turns. After all the turns have been put on the inner coil, the next coil is wound in the same direction.

The wire should not be cut until the entire pole is finished. It is desirable before starting the winding to place dowel pins (or wooden wedges) in the empty centre slots of the pole as shown in the figure. This prevents the coils from coming out of the slots while winding.



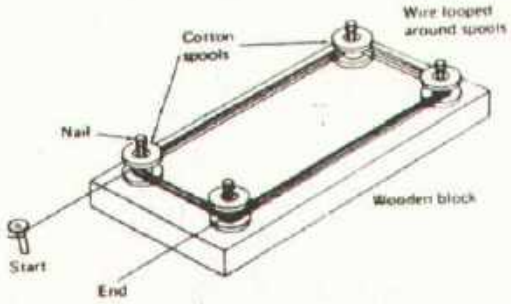
## Skein Winding

The skein-winding method is used mainly for the starting winding. This type of winding uses one long coil for each pole. The coil is made large enough to be wound in to all the slots necessary to complete the individual sections of a pole.
The size of the skein can be found by winding a single piece of wire in the slots, as shown in the figure.
Enough room should be allowed so that the winding to be put in will fit. The two ends are twisted together and the wire removed from the slots.

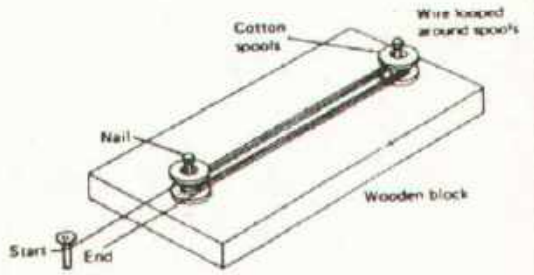



The wire is shaped into a rectangular or oblong form as shown in the figure.

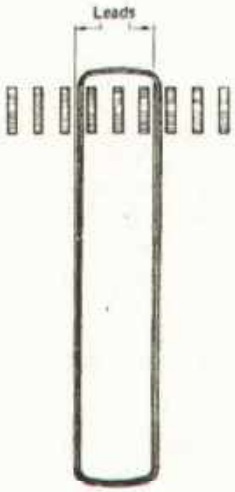

A form is then used for winding the skein coil. Acutally the shape of the coil does not matter too much as long as the circumference is the same. A form is shown in the figure.
The required number of turns of the skein is then wound around the form with the ends of the wire being left free. Before removing the coil from the form, tie it at several places to prevent unraveling.



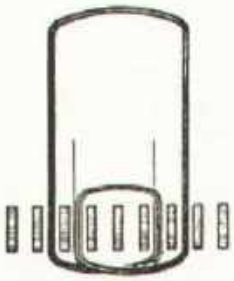

Another method of winding makes use of two small empty spools which can be nailed to the top of the workbench. The turns are wound around the spools as shown in the figure.



The coil is removed from the form and placed in the slots of the smallest pitch in the manner illustrated in the figure.




After this the coil is twisted and placed in the slots of the next larger pitch.



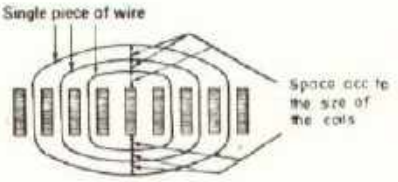
Completed pole.

| Trade Training | WINDING OF COILS | EP 2.3/4.15.7/8 |
|---|---|---|
| | | Single-phase motor |

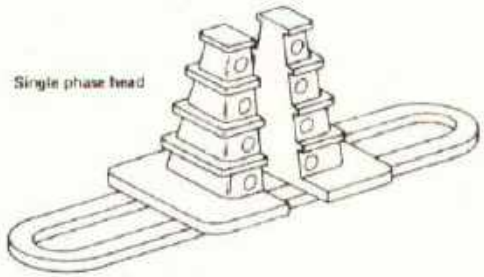
## Form Winding

In form winding the coils are first made on a wooden or metal form and then removed from the form and placed in the slots. This is the most common method of winding a single-phase motor

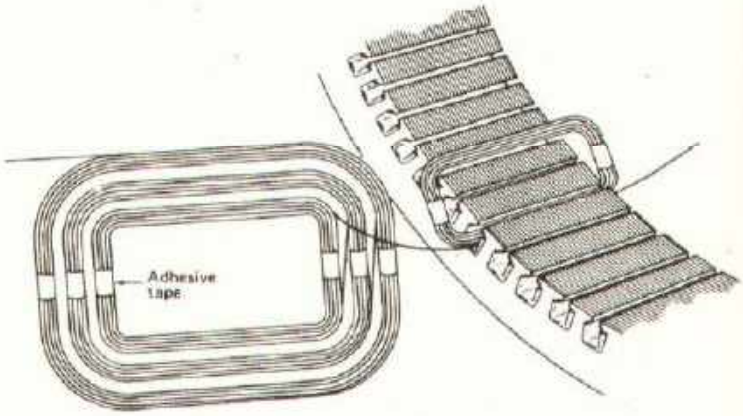
The first step is to obtain the size for the form from the core of the stator. A single piece of wire is shaped for the inner coil. The same procedure is repeated for the next larger coil, but sufficient length has to be given to provide enough space between the first and second coil. The size of the additional coils is obtained in the same manner.




Blocks of wood having a thickness of about three quarters of the depth of the slots are cut and shaped for each size and bolted together as illustrated in the figure.
The required number of turns of wire are wound on the blocks, starting with the smallest. The coils are tied with tape to keep the turns in position and are then removed from the form.



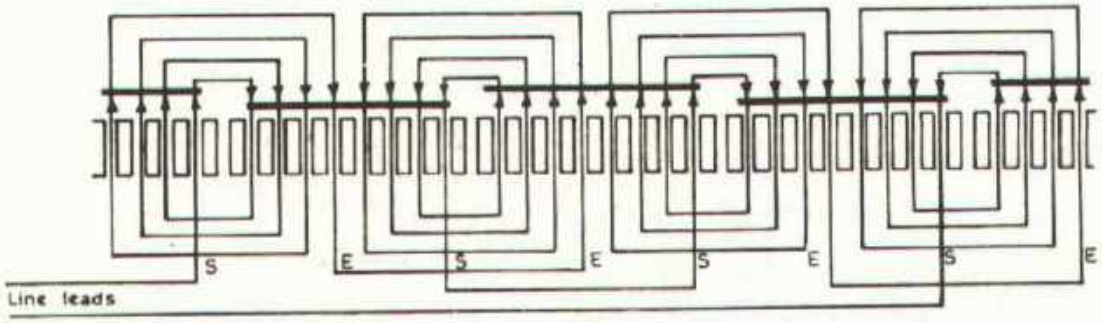

The coils are now placed in the slots.



## Connecting the Windings

After all the poles of the motor have been wound, the next step is to connect the windings. Regardless of the number of poles, it is essential that adjacent ones be of opposite polarity. This is accomplished by connecting them in such manner that the current will flow through the first pole in a clockwise direction and through the second pole in a counterclockwise direction, and likewise in alternate directions through the remaining poles (figure).

Running winding 4 pole motor




Four-pole motors connected in series are by far the most common in use today. Therefore, this connection will be explained. It should be remembered that if the running winding is connected in series, the starting winding is connected in the same manner. There are exceptions to this, but they are not often encountered.

## Series Connection for the Four Poles of the Running Winding

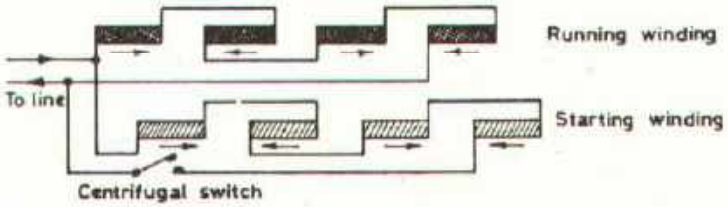
Connect the wires as illustrated, namely the end lead of pole 1 to the end lead of pole 2. Next connect the beginning lead of pole 2 to the beginning lead of pole 3, as shown in the figure. Continue, by joining the end lead of pole 3 to the end lead of pole 4. The power line leads are then connected to the beginning lead of pole 1 and 4.

Notice that each pole is wound in the same manner, but that the poles are connected so that alternate polarity is maintained in adjacent poles.

After experience has been gained in winding the running poles, the trainees will be able to wind all the poles without cutting the wire after one is finished. Care must be taken to alternate the direction of winding for each pole; thus the first pole should be wound clockwise; the second counterclockwise; and the third clockwise and so on.

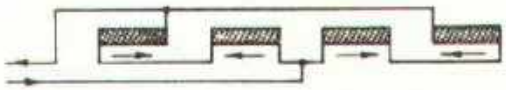
## Series Connection for the Starting Winding

The starting winding of a single-phase motor is often wound bifilar or with a resistance wire such as iron- or nickel-chromium steel wire. This type of starting winding should not be replaced by copper wire, because the motor might not start any more.
The poles of the starting winding are connected so that they too alternate in polarity. The method of connecting them to each other is the same as that described for the running winding. The only difference is that the centrifugal switch is placed either in series with the lead from pole 4 or between pole 2 and pole 3.
The figure shows the proper connection for both the running and the starting winding in a simpler form by a block diagram.




## Parallel Connections

Although the majority of single-phase motors are series connected, there are some that are parallel connected by manufacturers. These are known as two-parallel or two-circuit connections. A two-parallel connection is one in which there are two circuits for each winding, as shown in the figure below.



However, regardless of the number of circuits in the running winding, the connections must be such that the adjacent poles have opposite polarity.

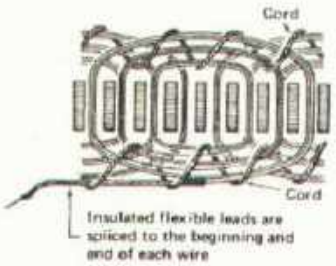
In order to determine whether the polarity of the pole is correct after the connections have been completed, a low voltage direct current is connected to the winding and a compass is moved inside the stator from one pole to the next. If the connections are correct, the compass needle will reverse itself at each pole.

One method of splicing the wires that connect the poles is to remove the insulation from the ends of the two wires, twist the ends securely together and solder. After this the splice is taped. Another method utilizes fibre glass or varnished sleeving instead of tape as shown in the figure. The entire operation requires less time than taping and produces a neater splice.

Sleeving over welded joint

Instead of soldering the splice welding by a welding transformer with a carbon pole is very common. Not only time is saved but also material such as tin and soldering paste.

One of these methods should be used in splicing the coils of both the running and starting windings. After all the coils have been properly connected, flexible leads are spliced to the wires of both the running and the starting windings that are to be connected to the power line. Again, the preferred splicing is that in which the fibre glass sleeving is used. In addition, care must be taken to tie the leads to the windings with twine, as shown in the figure, so that if the leads for any reason are pulled, they will not be torn from the winding. The entire winding is then tied together with a suitable cord or tape, such as nylon, linen or cotton. This keeps the winding from unraveling, makes it compact and prevents, to a certain extent, the wires from vibrating and moving.




Insulated flexible leads are spliced to the beginning and end of each wire

## Testing the New Winding

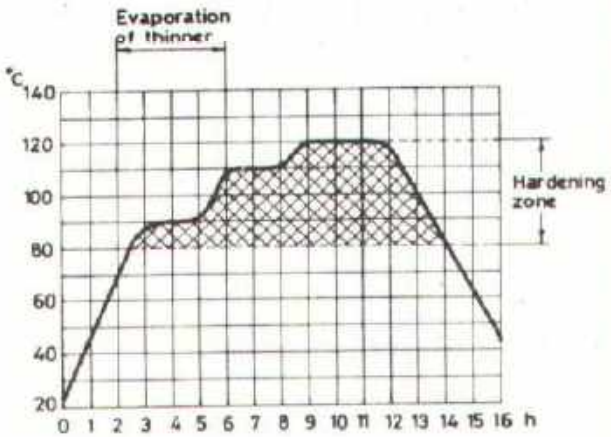
After the rewinding and connections have been completed, it is important that the windings and connections be thoroughly tested for shorts, grounds, open circuits, and incorrect connections. This must be done before varnishing and baking so that any trouble that is discovered may be corrected more readily.

## Baking and Varnishing

When all the connections between poles of the windings have been completed and tested and the flexible leads to the power line attached and tied, the stator should be placed in a baking oven at a temperature of approximately 100 °C and preheated for a short period of time, approximately 1 hour. This removes moisture from the windings and increases the penetration of the varnish. The stator is then dipped into a container of insulation varnish compatible with the type of magnet wire used. It is important to remember that the varnish must be thin enough to penetrate the winding and thick enough to leave an adequate film when baked. The varnish may become thickened due to evaporation of the thinning fluid. If this happens, use a thinner recommended by the manufacturer.

After the winding has soaked in the varnish for approximately one-half hour or until all bubbling has ceased, it is removed from the container and allowed to drip. After it has stopped dripping it is again placed into the baking oven and baked for several hours as shown in the diagram. In using any type of varnish, make certain the manufacturer's recommendations and directions are followed. When the stator is removed from the oven, the inner surface of the core should be scraped to remove the adhering varnish, so that there will be sufficient space for the rotor to turn freely.

Drying diagram for synthetic-resin varnish




Dipping and baking bonds the entire winding into a solid mass that is not subject to movement. It seals the windings against moisture and foreign material and increases the mechanical and dielectric strength of magnet wires.

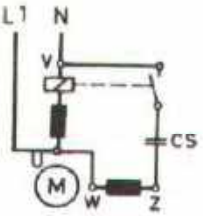
There are other types of varnishes that do not require baking and are called air drying varnishes. Here again the manufacturer's recommendations should be followed. Also a solventless epoxy resin or polyester varnish that can be applied to windings in less than 20 minutes is in use. These varnishes are completely solventless and give the same protection that ordinary varnishes provide. The winding is heated first by applying approximately half voltage. The resin is then poured through the heated windings while the stator is kept in a horizontal position. The resin is permitted to trickle through the slots. After the pouring has been completed, the winding is kept heated by sending current through the coils for about 5 minutes. This permits the resin to cure and gel quickly. The entire process should take less than one-half hour.

The construction of the capacitor motor is similar to that of the single-phase motor, but an additional unit, called a capacitor is connected in series with the starting winding. This type of motor operates such machines as refrigerators, compressors, oil burners and air conditioners.

A capacitor motor is a single-phase induction motor with a main winding arranged for direct connection to a source of power and an auxiliary winding connected in series with the capacitor. There are three types of capacitor motors, as follows:

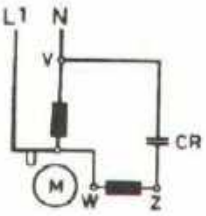
## Capacitor Start Motor with Current Relais

A capacitor start motor is a capacitor motor in which the capacitor phase is in the circuit only during the starting period.



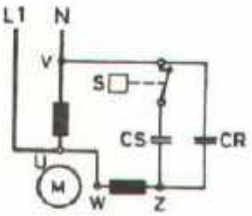

## Permanent-split Capacitor Motor

A permanent-split capacitor motor is a capacitor motor having the same value of capacitance for both the starting and running conditions.




## Two-value Capacitor Motor

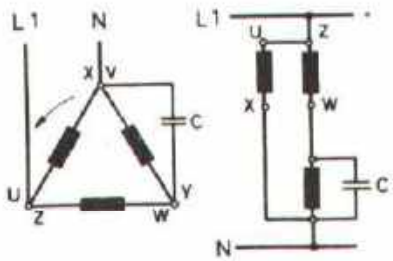
A two-value capacitor motor is a capacitor motor using different values of effective capacitance for the starting and running conditions.



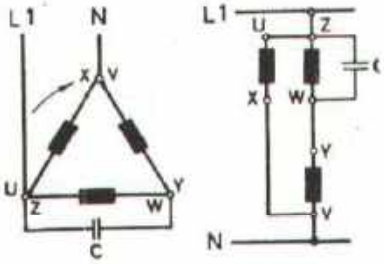
Three-phase motors are operated on a single-phase supply with the help of a capacitor which develops a phase displacement.

Delta Connection

anticlockwise rotation

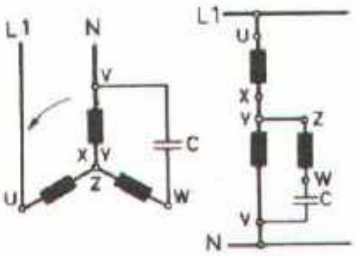



clockwise rotation

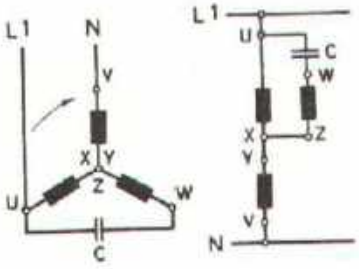



Star Connection

anticlockwise roation




clockwise rotation




Thumb Rule to Calculate the Capacity of the Phase-Shifting Capacitor

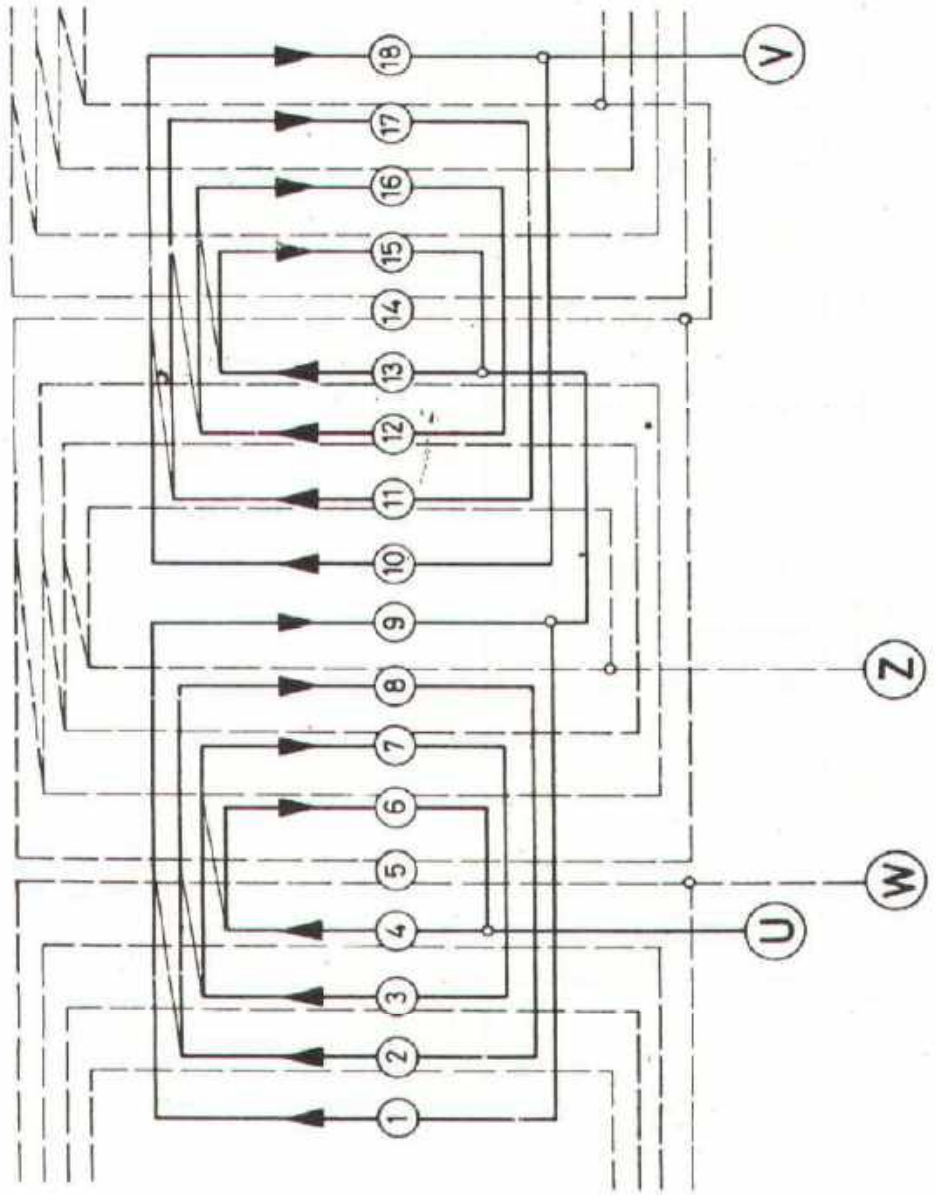
For 220 V~ approximately 80 µF are required per kW

For 110 V~ approximately 250 µF are required per kW

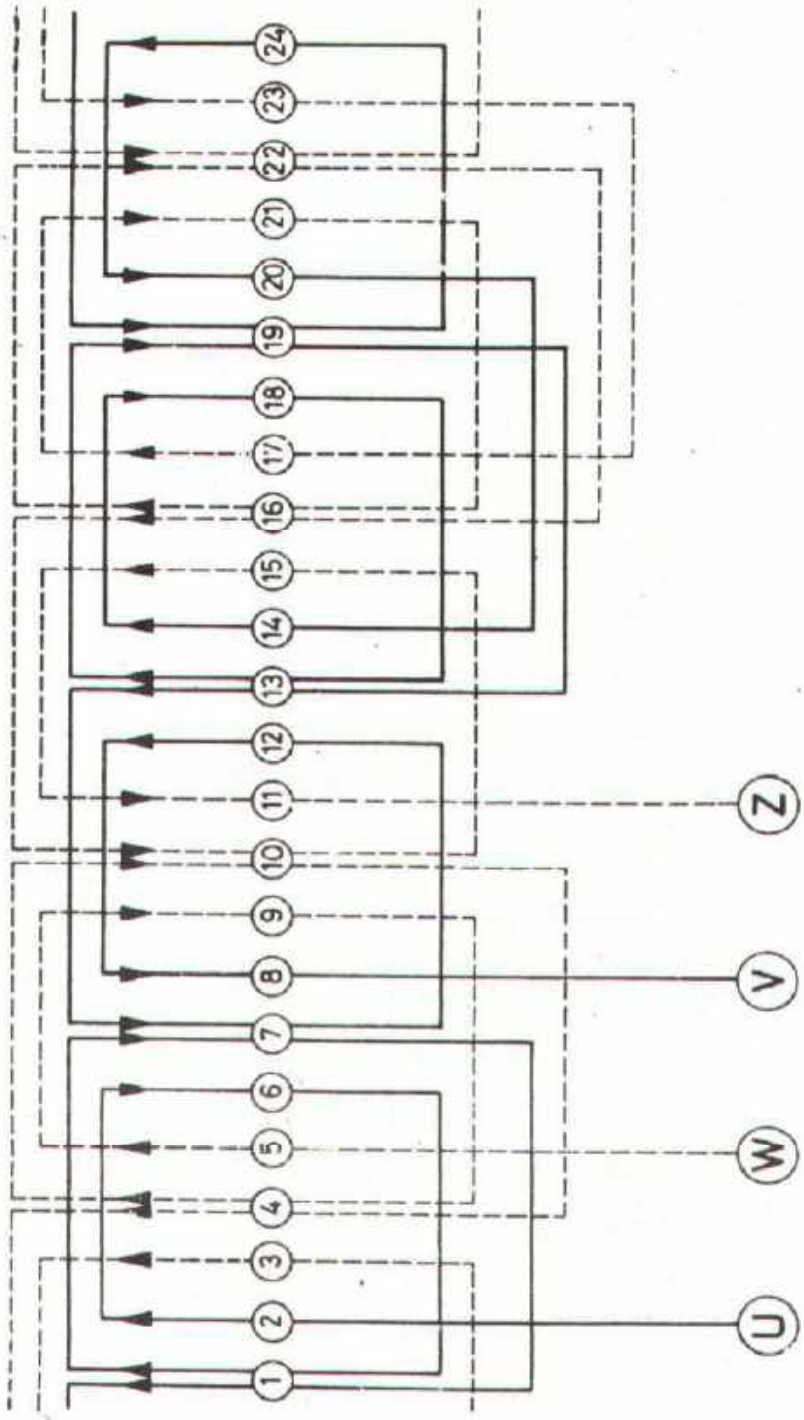
Sample:

Motor power 0.3 kW Voltage 220 V

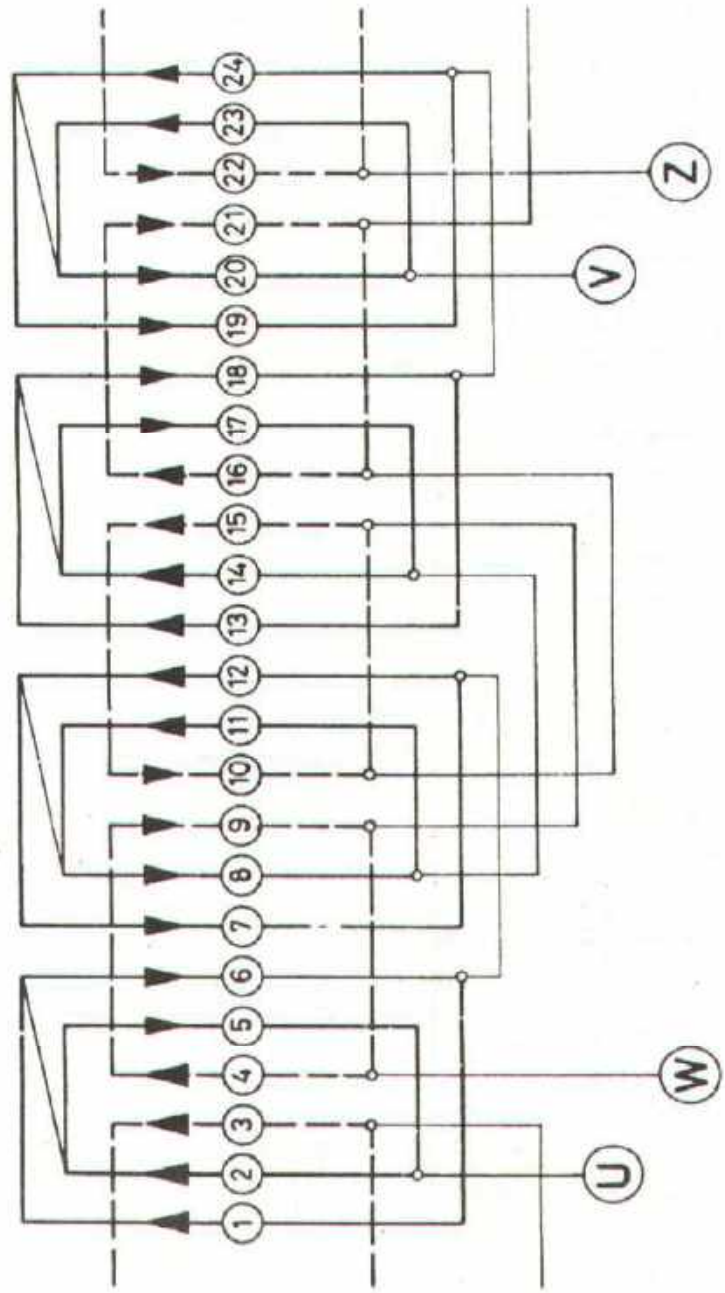
Capacity = 0.3 x 80 = 24µF



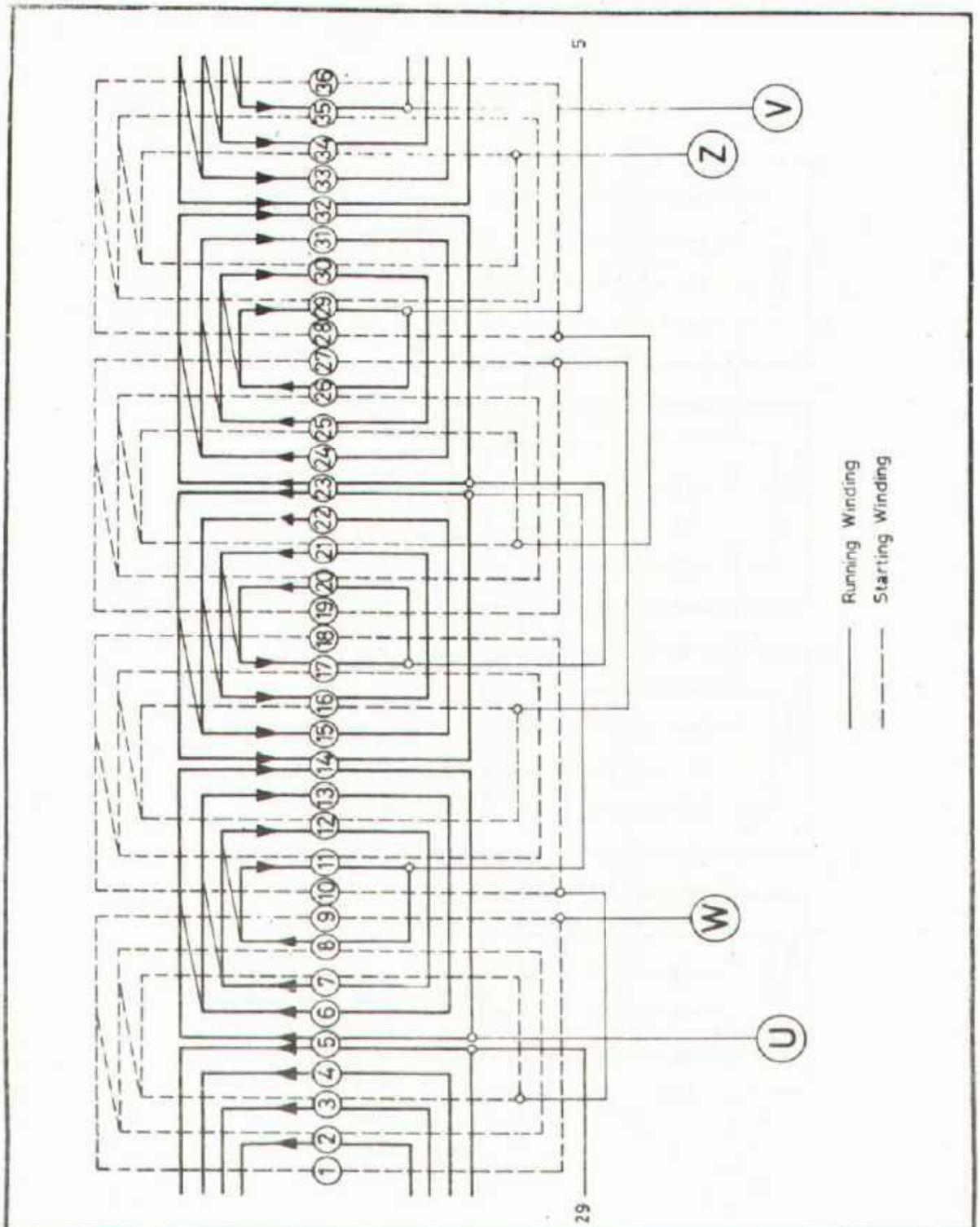

| Trade Training | SINGLE PHASE WINDING<br>18 SLOTS 4 POLES | EP 2.3/4.15.7/16<br>Single-phase motor |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ARMATURE WINDER |




| Trade Training | SINGLE PHASE WINDING<br>24 SLOTS 4 POLES | EP 2.3/4.15.7/17<br>Single-phase motor |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ARMATURE WINDER |




| Trade Training | SINGLE PHASE WINDING<br>24 SLOTS 4 POLES | EP 2.3/4.15.7/18<br>Single-phase motor |
|---|---|---|
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | ARMATURE WINDER |

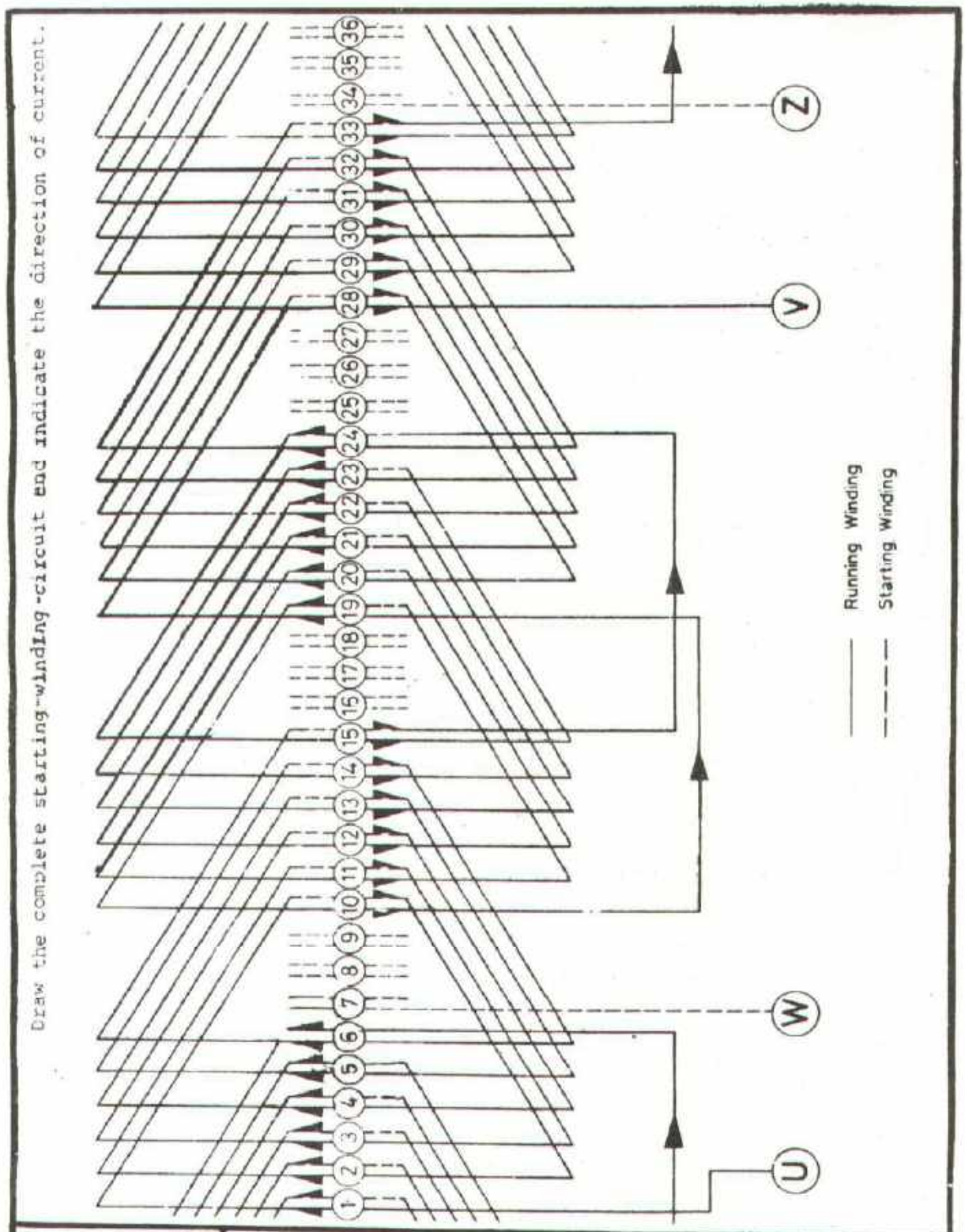



| Trade Training | SINGLE PHASE WINDING<br>36 SLOTS 4 POLES | EP 2.3/4.15.7/19<br>Single-phase motor |
|---|---|---|

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

ARMATURE WINDER




| Trade Training | DOUBLE LAYER WINDING<br>36 SLOTS 4 POLES | EP 2.3/4.15.7/20<br>Single-phase motor |
|---|---|---|

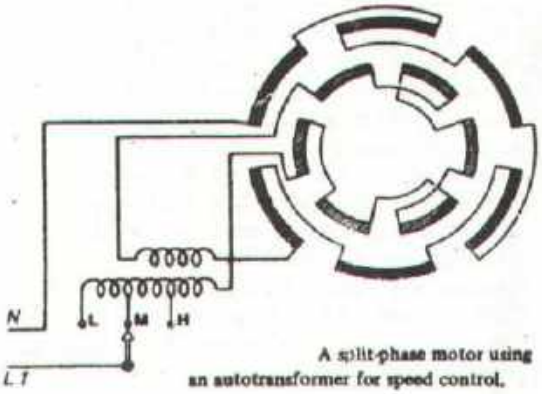
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

GERMAN TECHNICAL TRAINING PROGRAMME

ARMATURE WINDER

## SPLIT - PHASE FAN MOTORS

Split-phase motors driving ceiling fans are wound like ordinary split-phase motors but many do not have a centrifugal switch. A special type of autotransformer is used to change the speed and also to produce phase displaced current in the starting winding. The primary of the transformer is tapped for different speeds and is connected in series with the main winding. The starting winding is connected across the transformer secondary. These motors are usually wound for six poles. The wiring diagram for this type of motor you will find as an example for rewinding in an extra exercise sheet.




A split-phase motor using an autotransformer for speed control.

Another type is the capacitor type. This contains a capacitor of approximately 2 µF in the starting winding circuit. To increase the effective capacity and consequently the starting torque of this motor, the capacitor is connected across an autotransformer. The taps on the transformer permit a choice of various speeds.

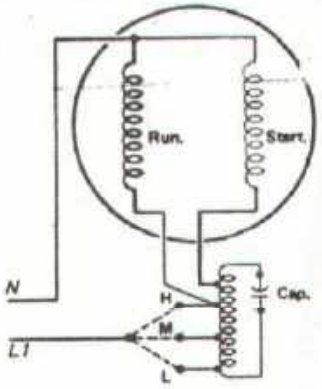
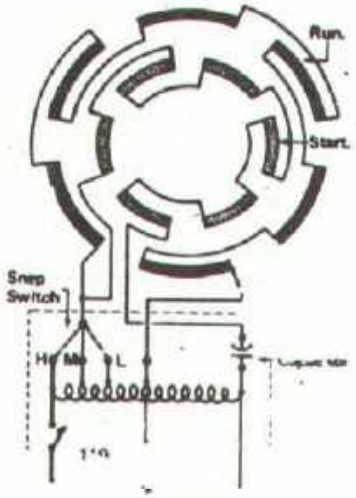


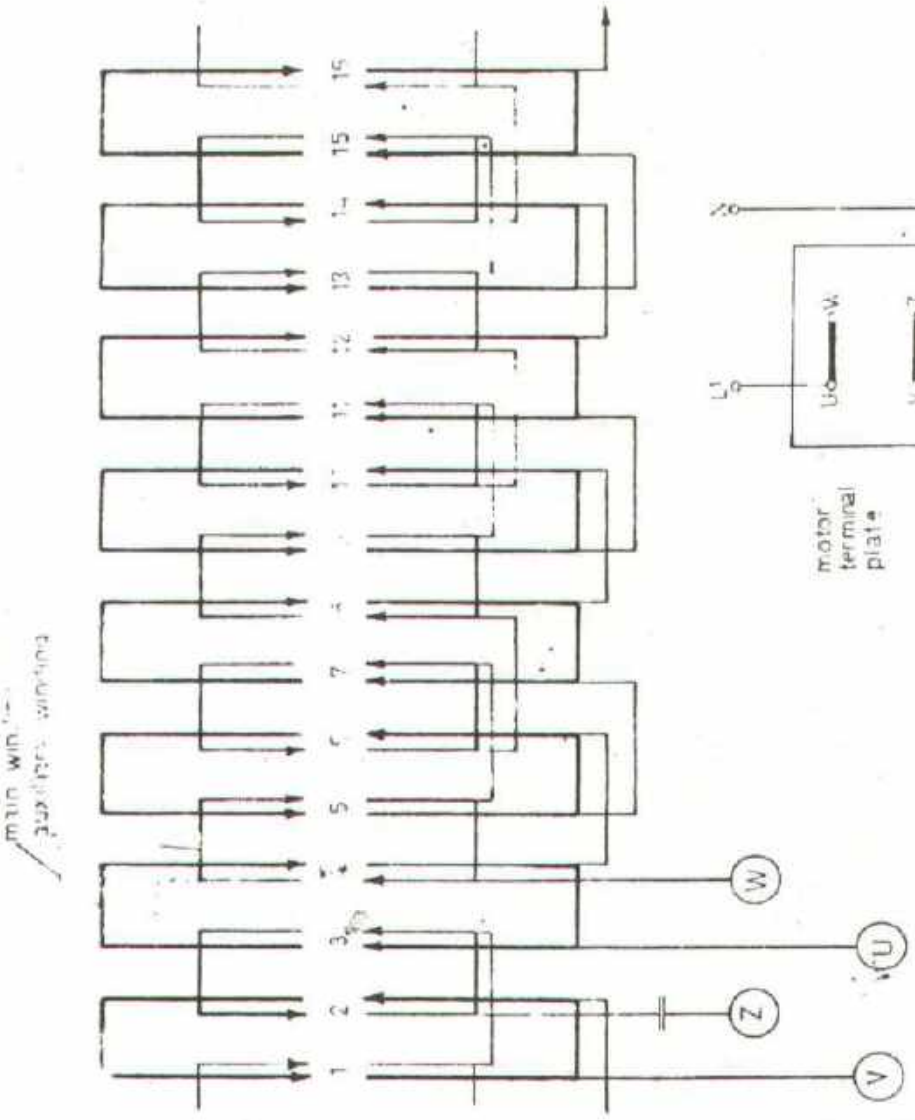

Diagram of a capacitor motor used for fan service.

Another type of fan motor is usually connected to an autotransformer for speed variation and is controlled from a snap switch connected to the autotransformer unit, as shown in the figure. The motors are generally of the single-value, permanent-split capacitor type. To decrease the speed of this type of motor, the voltage in the running and starting windings is lowered by means of the autotransformer. The lower the impressed voltage is, the slower the motor will run.

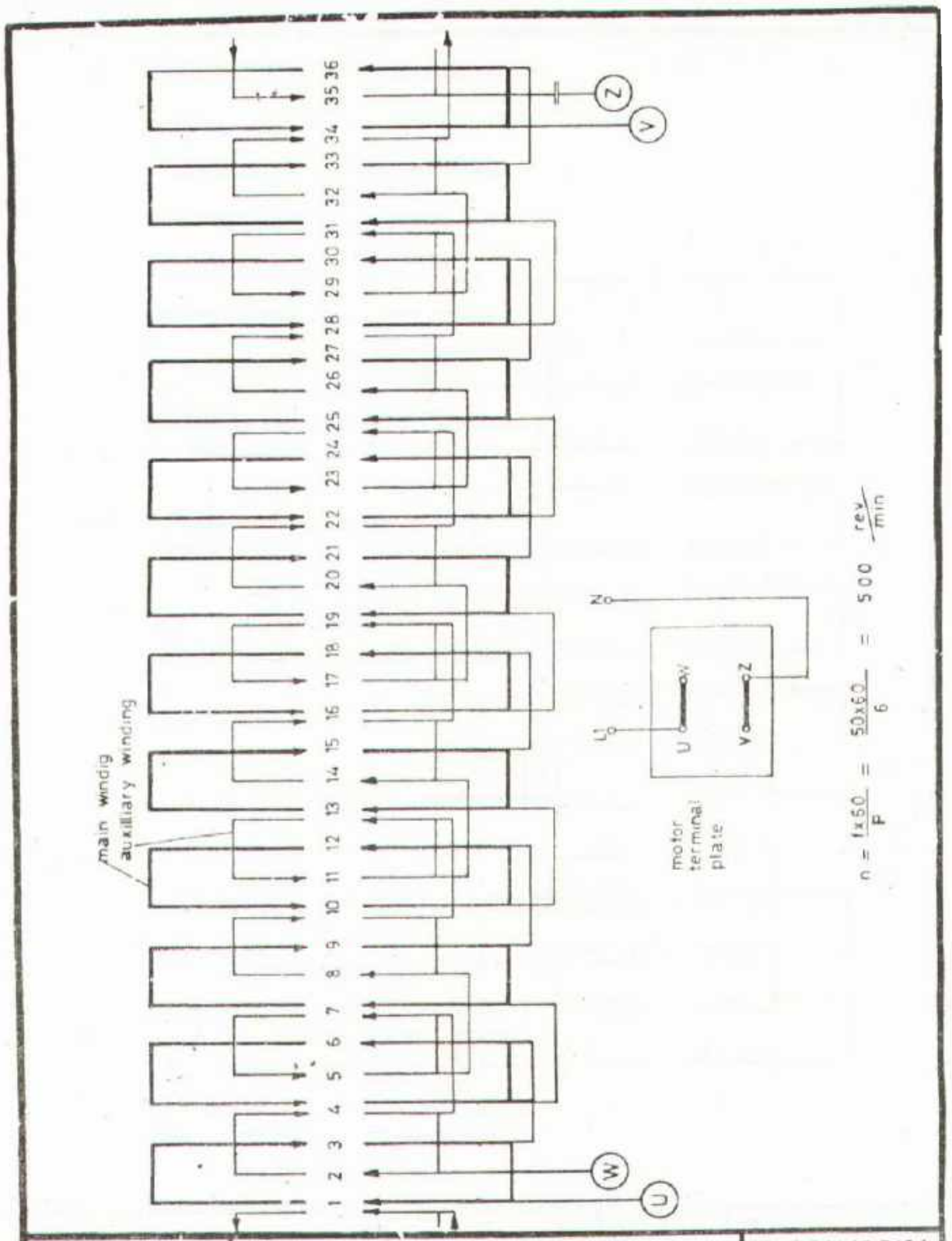



Unit-heater three speed motor. The speed is varied by impressing various voltages from an autotransformer to the running and starting windings.

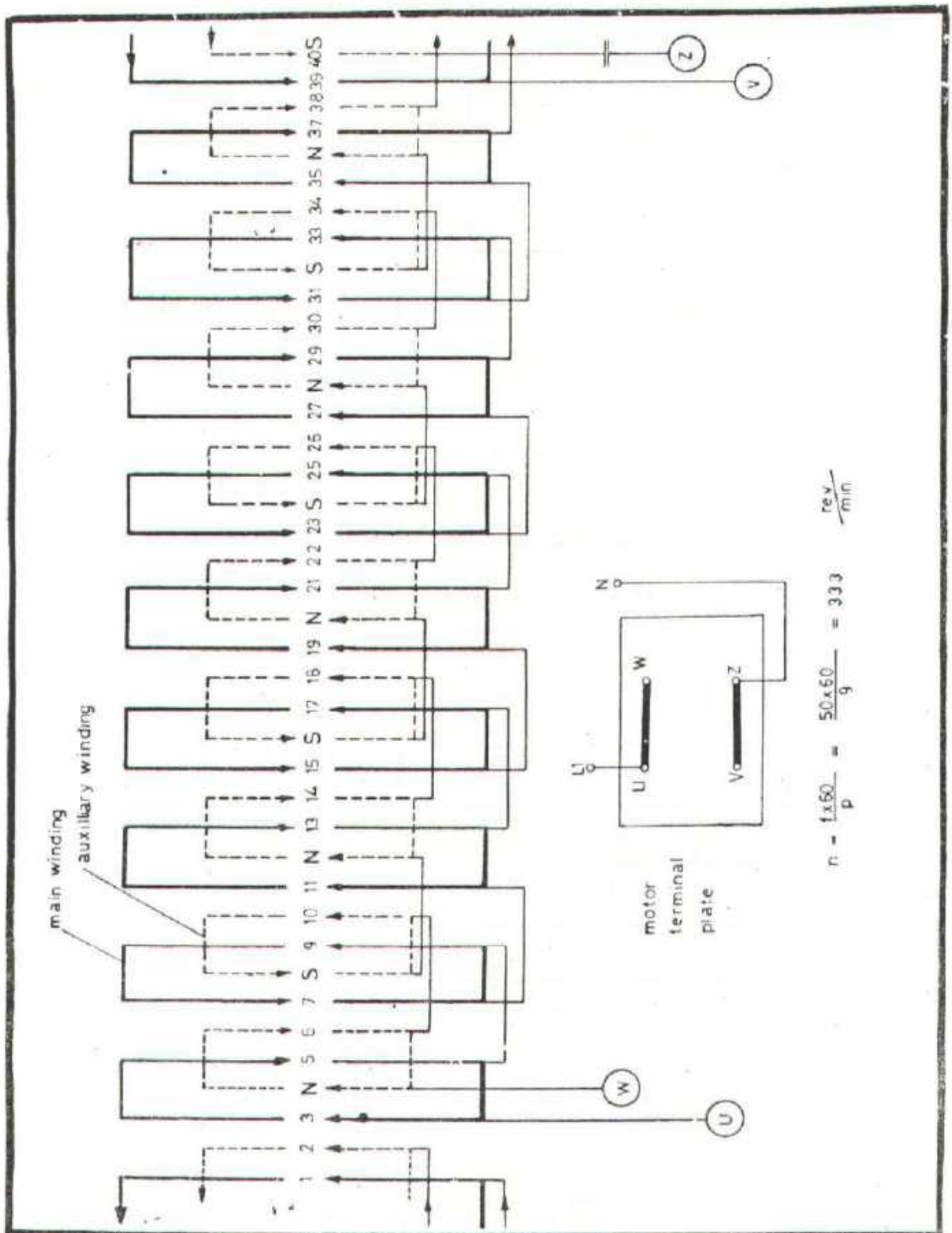
Different manufacturers use different methods for varying the speed. On some motors only the running-winding voltage is varied while the voltage in the starting winding is held constant. On other motors the running winding consists of two sections connected in series across 230 V for high speed. If low speed is desired, the two sections are connected to 115 volts through an autotransformer.



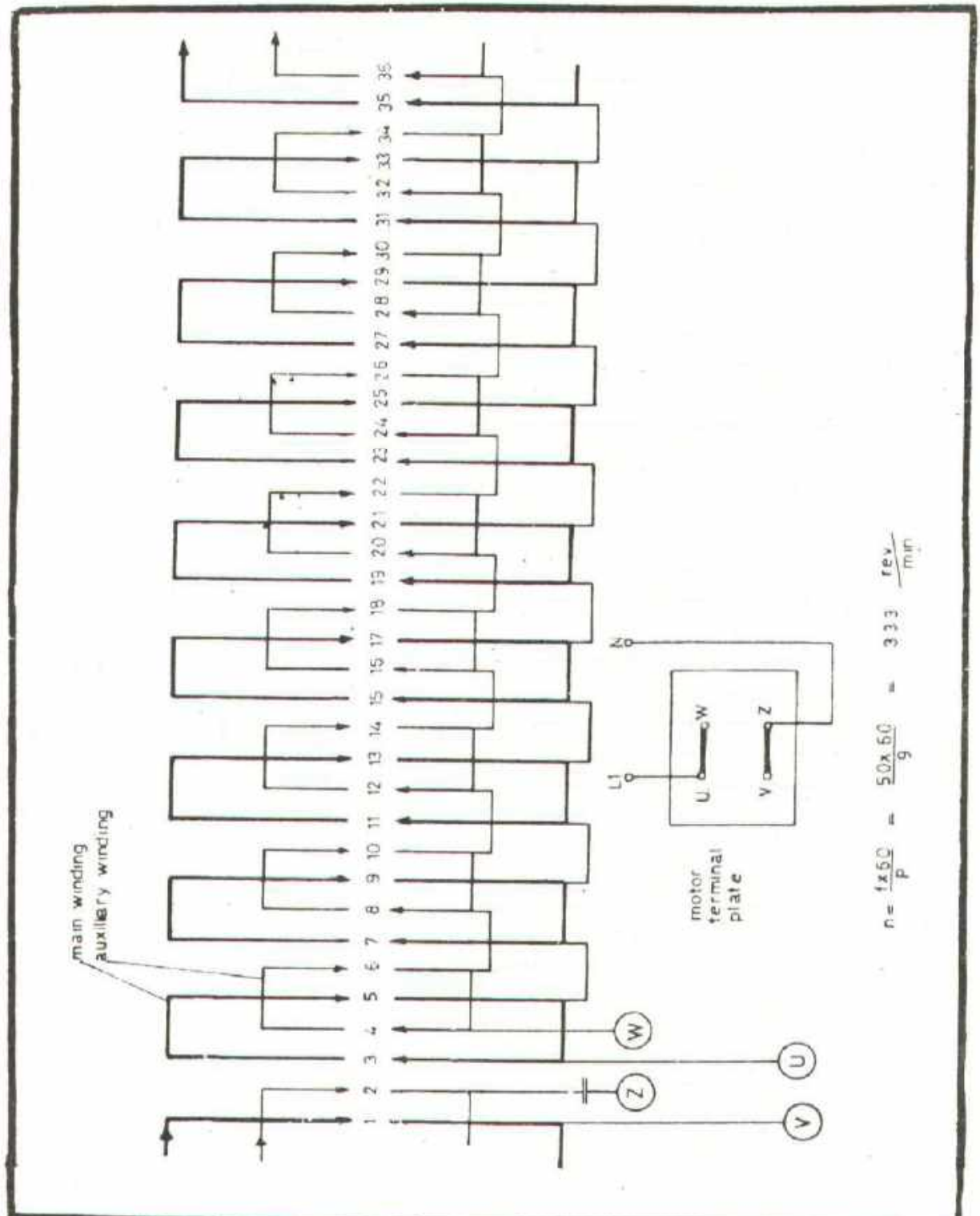

| | | |
|---|---|---|
| Trade Traning | SINGLE-PHASE FAN WINDING CAPACITOR TYPE | EP 2.3/4.15.7/23 |
| | | Single Phase Motor |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING | | Electriain |
| PAK GERMAN TECHNICAL TRAINING PROGRAMME | | General |




| | | |
|---|---|---|
| Trade Traning | SINGLE-PHASE FAN WINDING CAPACITOR TYPE<br>36 SLOTS 12 POLES | EP 2.3/4.15.7/24<br>Single phase Motor |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK GERMAN TECHNICAL TRAINING PROGRAMME | | Electrician General |

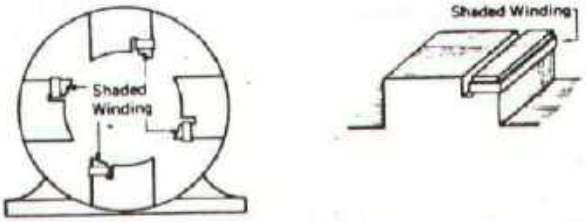



| | | |
|---|---|---|
| Trade Traning | SINGLE-PHASE FAN WINDING CAPACITOR TYPE 40 SLOTS 18 POLES | EP 2 3/4 15 7/25 Single Phase Motor |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK GERMAN TECHNICAL TRAINING PROGRAMME | | Electrician General |




| | | |
|---|---|---|
| Trade Traning | SINGLE-PHASE FAN WINDING CAPACITOR TYPE<br>36 SLOTS 18 POLES | EP 2.3/4.15.7/26<br>Single Phase Motor |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK-GERMAN TECHNICAL TRAINING PROGRAMME | | Electrician<br>General |

## SHADED - POLE FAN - MOTORS

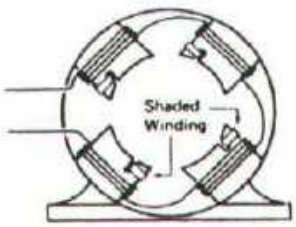



A four-pole, shaded-pole motor showing the field poles and shading windings.

The shaded-pole motor is a single phase AC-motor. It is used for appliances requiring very low starting torque, such as fans and blowers. A typical shaded-pole motor is illustrated in the figure above.
The poles are provided with a slot near one end in which a solid copper coil of one turn, called the shading coil, is placed. In fan motors this is the stator. The rotor is that of a squirrel-cage type, such as are used in split-phase and poly-phase motors.
On split-phase and capacitor motors, a starting winding is required. A shaded-pole motor also requires a starting winding, but in this case it usually consists of just one closed turn of heavy copper wire embedded in one side of each stator pole (see figure above).

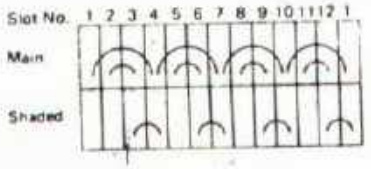
In rewinding of field coils, be sure to put back the same number of turns of the same size of wire with the same insulation. Also, be certain that the new coils are of the same size as the old ones, otherwise difficulty may be created in slipping them over the old poles. It is good practice to put insulating paper on the corners or around the core to prevent the coil from grounding.

A diagram of a 4-pole shaded-pole type motor is shown in the figure.




A four-pole, shaded-pole motor with the field poles connected in series for alternate polarity.

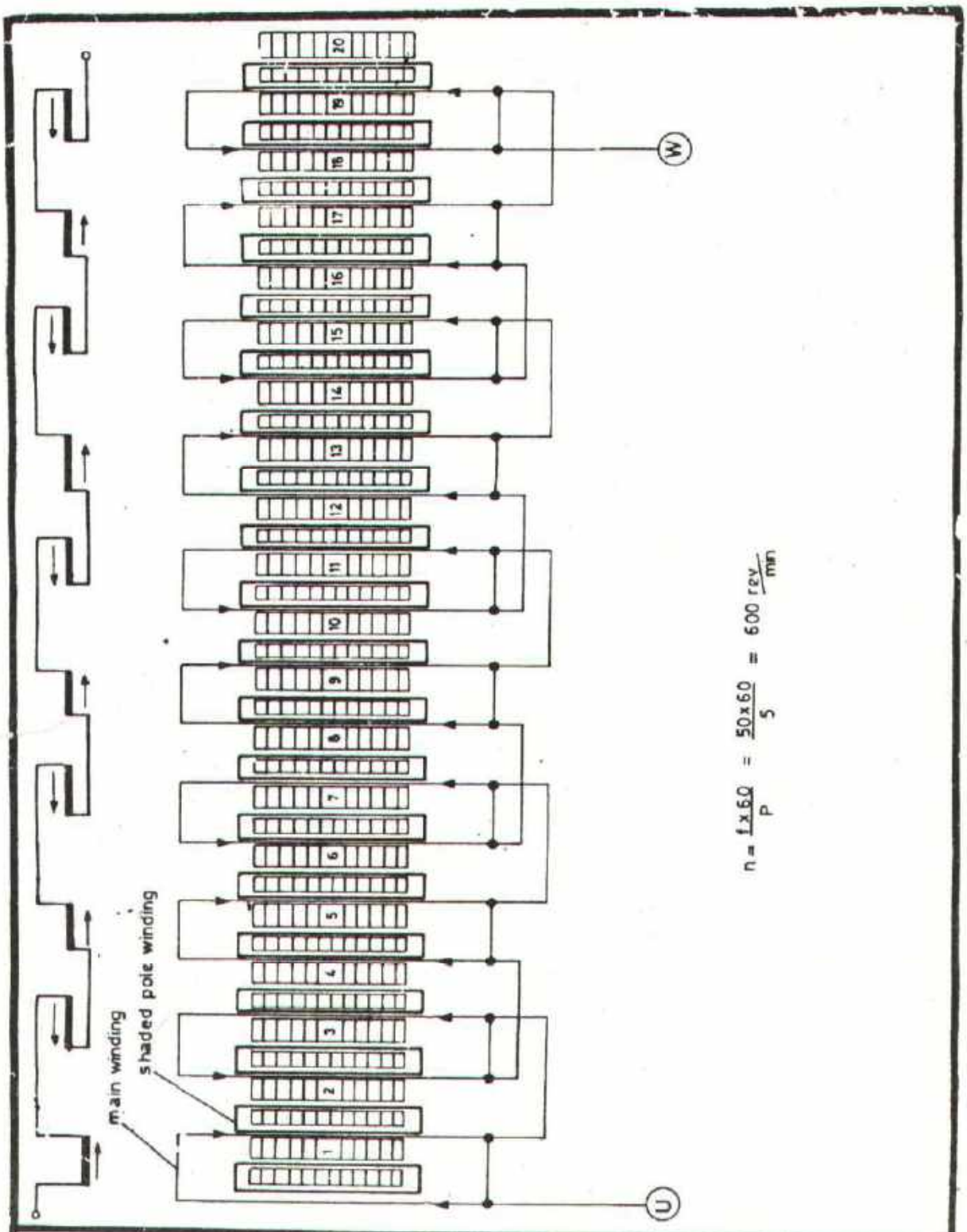
The recording of the windings of a four-pole, 12-slot shaded-pole motor is shown in the figure.




The speed of the shaded-pole motor is varied by inserting a choke coil in series with the main winding as shown in the figure.

Taps on the choke coil provide the different speeds.


**Shaded-pole fan motor with speed control varied by means of a choke coil.**




| | | |
|---|---|---|
| Trade Traning | SHADED POLE FAN MOTOR<br>20 SLOTS 10 POLES | EP 2.3/4.15.7/29<br>Single Phase Motor |
| DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING<br>PAK GERMAN TECHNICAL TRAINING PROGRAMME | | Electrician<br>Genreral |