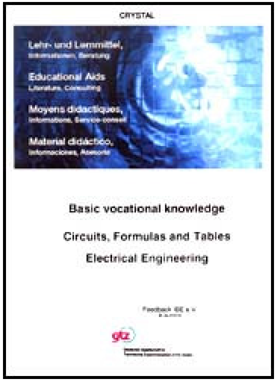


Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

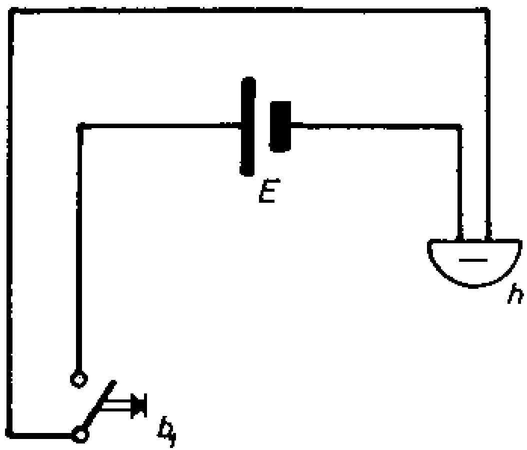
2. Bell Circuits

The reference letters and numbers in the illustrations of bell circuits have the following meanings:

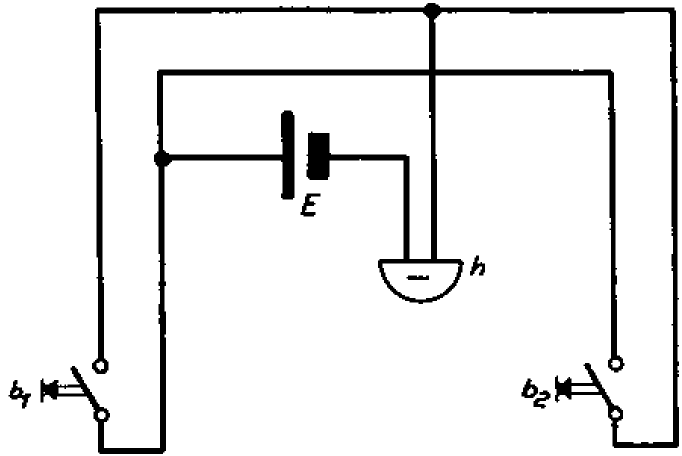
a	switch	E	voltage source
b	control switch	f	transducer
c	contactor	g	measuring instrument
d	auxiliary contactor, relay	h	visual and audio alarm

e protective device Tr transformer

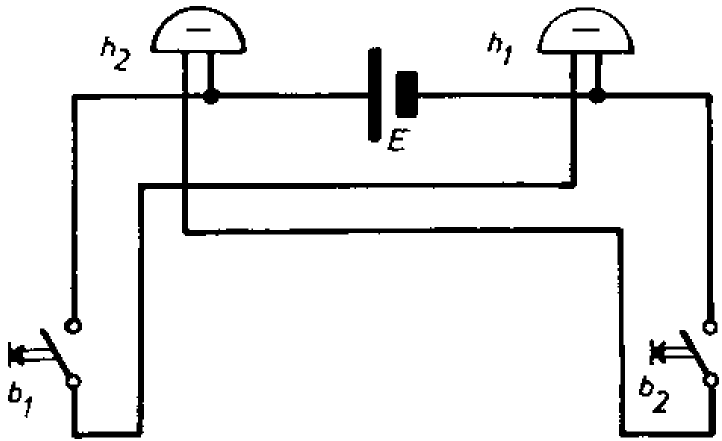
2.1. Direct-current Bell



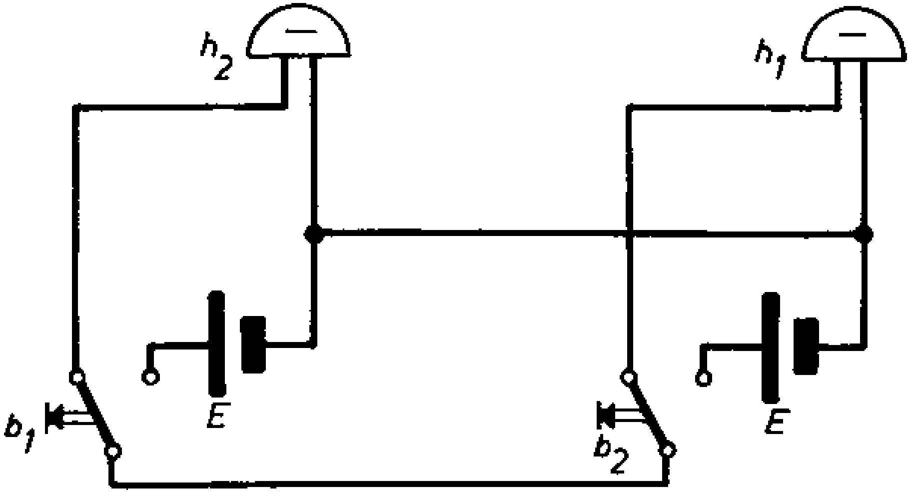
Direct-current bell to be actuated from one place



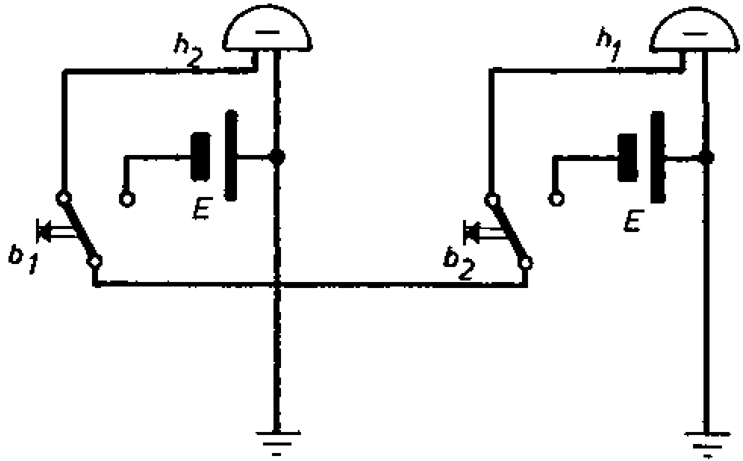
Direct-current bell to be actuated from two places



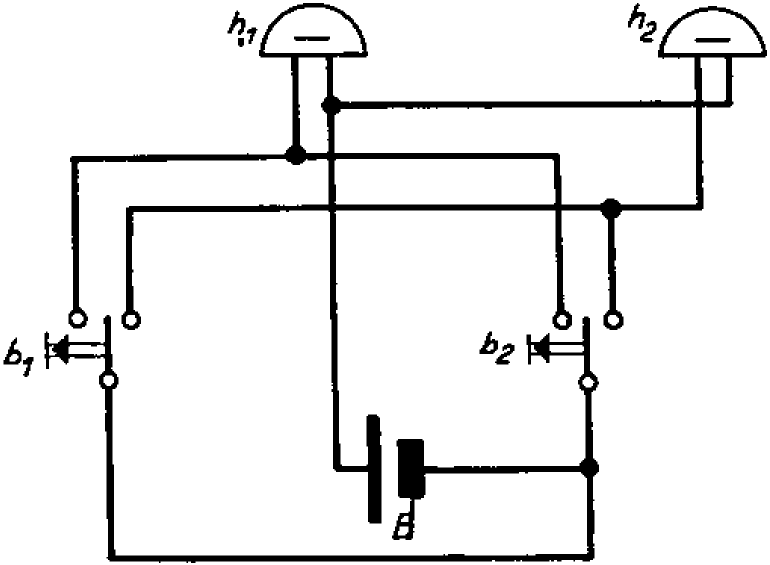
Bell installation for reciprocal calls



Sell installation for reciprocal calls with key change-over switch

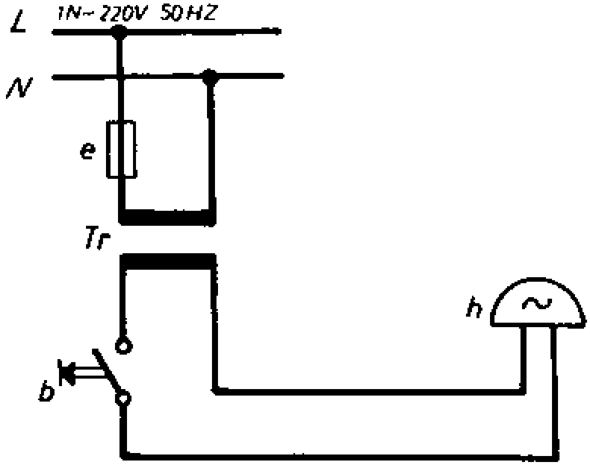


Bell installation for reciprocal calls with switch-on push-button, line-saving

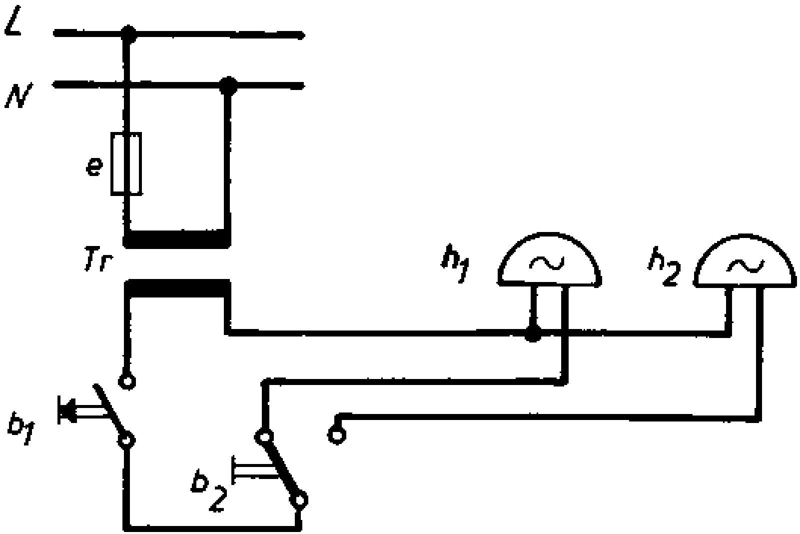


Bell installation for reciprocal calls, line-saving

2.2. Alternating-current Bell

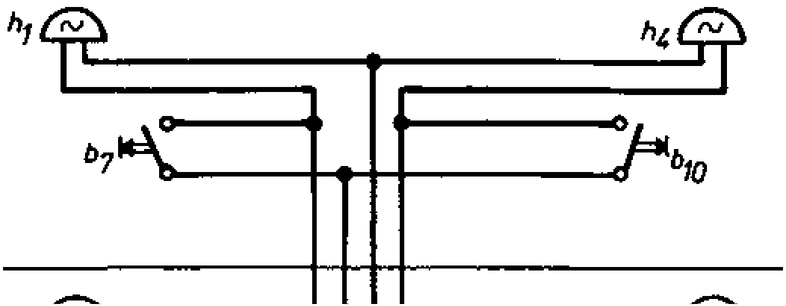


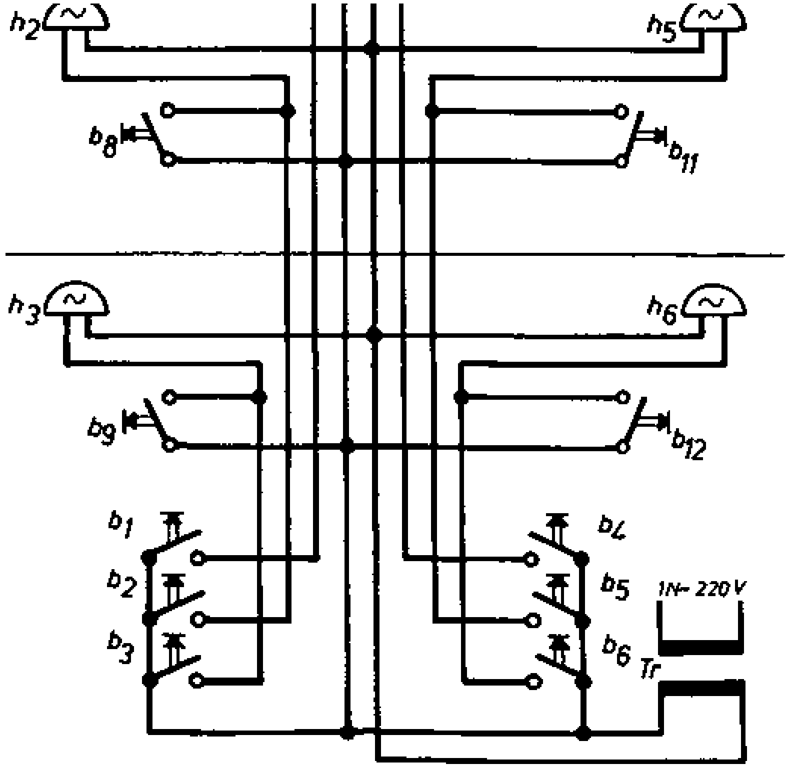
Alternating-current bell with bell transformer, simple circuit



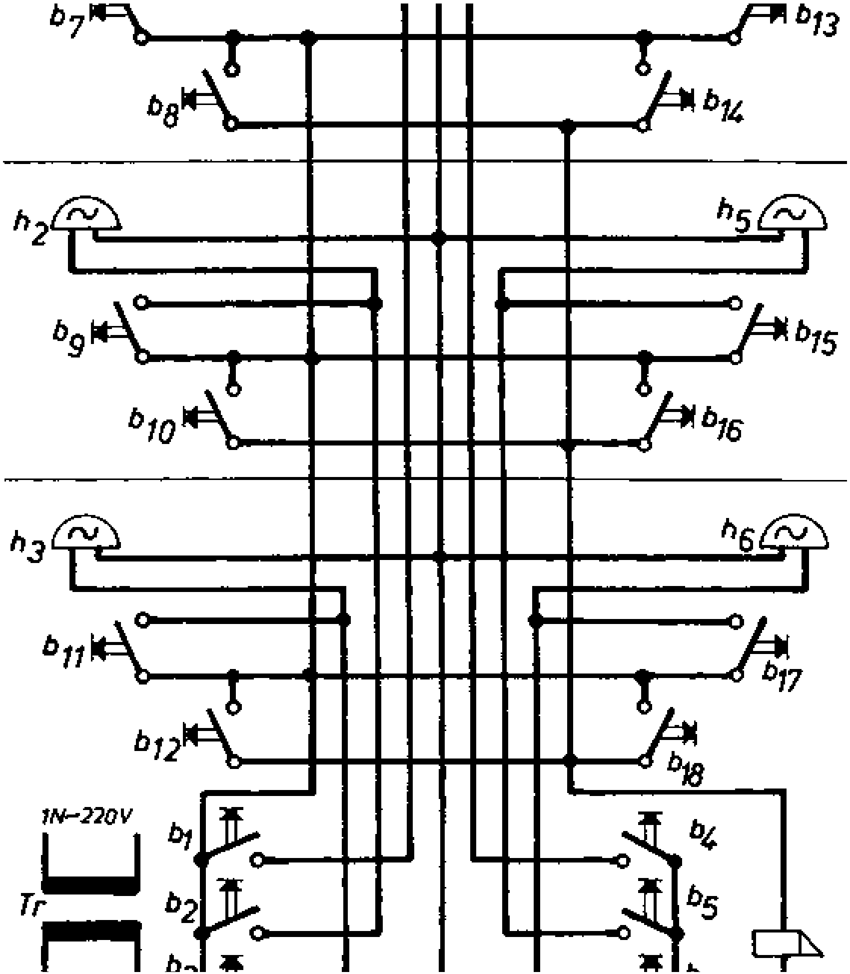
Bell installation with change-over switch

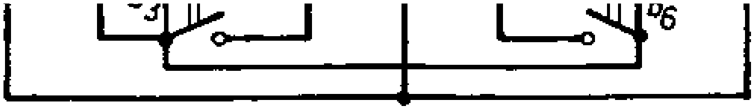
2.3. House Bell Installation





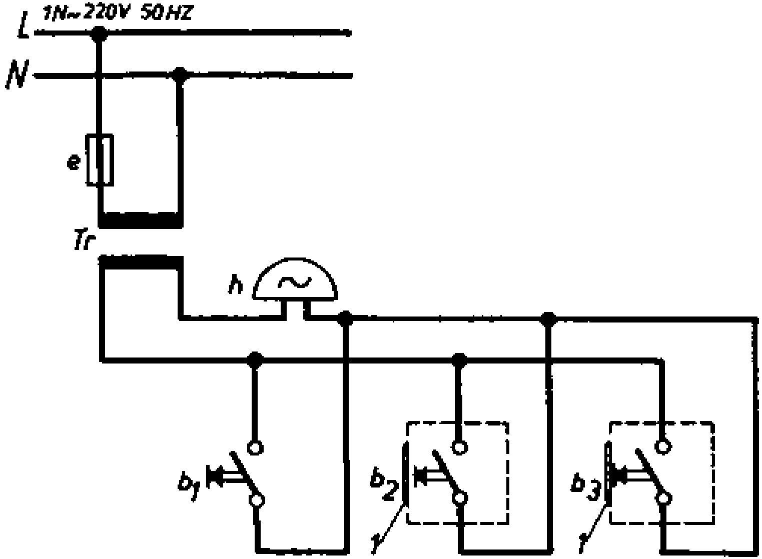
Circuit of a house bell installation


b7
b13
b8
b14
h2
h5
b9
b15
b10
b16
h3
h6
b11
b17
b12
b18
1N~220V
Tr
b1
b4
b2
b5

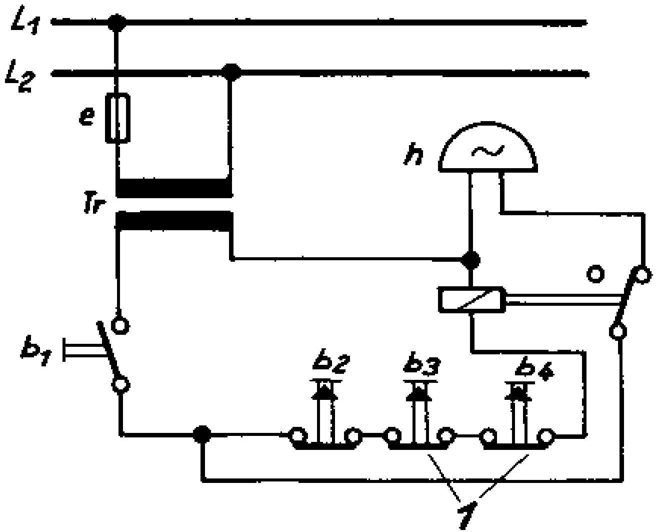


Circuit of a house bell installation with electric door operator

2.4. Alarm Systems



Circuit of an alarm system with normally open contacts b_1 test key, 1 glass panel



Circuit of an alarm system with normally closed contacts b_2 test key, 1 glass panel

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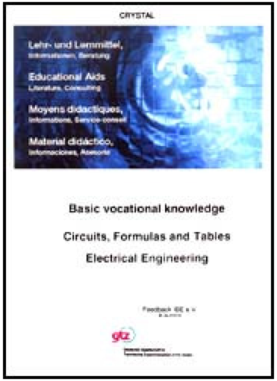
Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

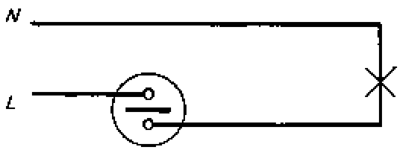
3. Basic Circuits of Illumination Engineering



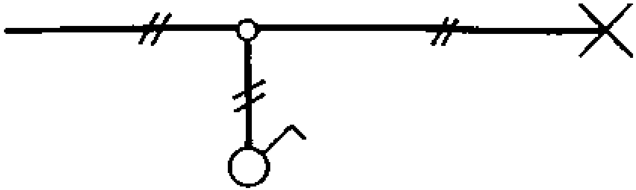
Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

3. Basic Circuits of Illumination Engineering

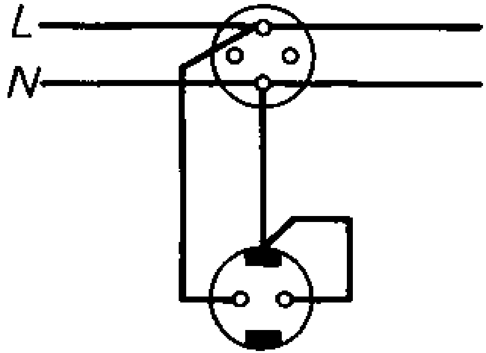
3.1. Circuit-breaking Arrangements



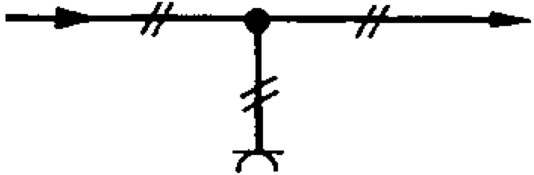
cut-out, schematic diagram (all-pole)



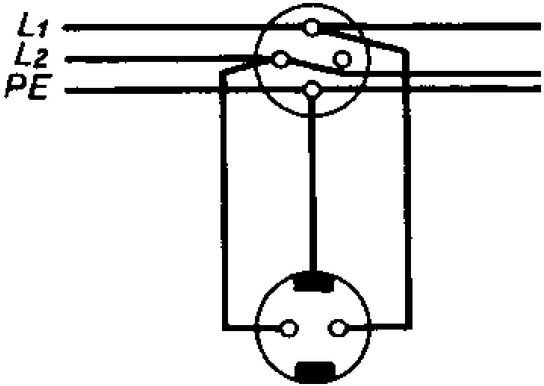
cut-out, schematic diagram (single-pole)



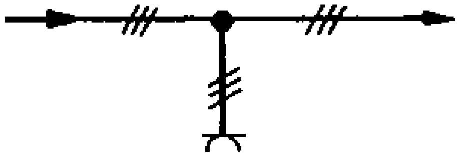
plug socket with protective contact (all-pole)



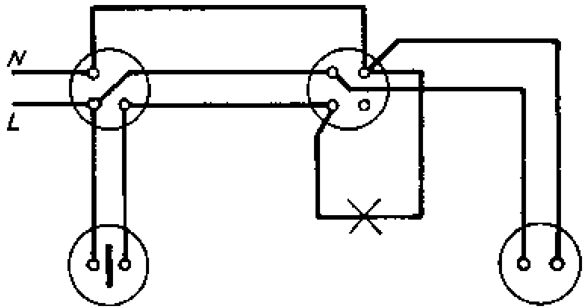
plug socket with protective contact (single-pole)



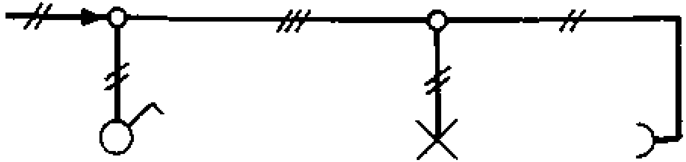
plug socket with protective contact and separate protective conductor (all-pole)



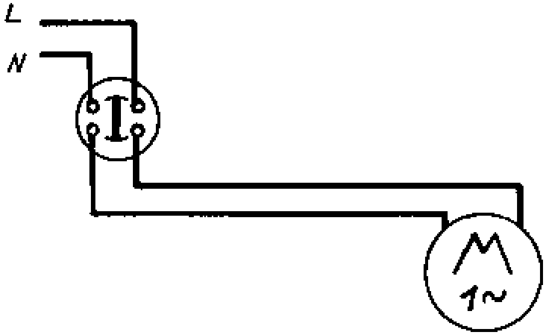
plug socket with protective contact and separate protective conductor (single-pole)



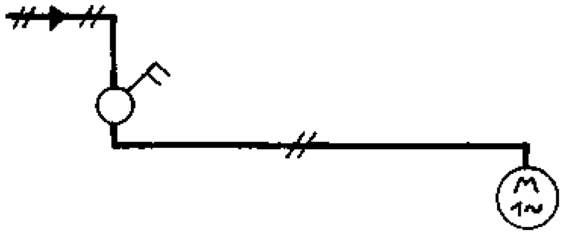
Cut-cuts with plug socket (all-pole)



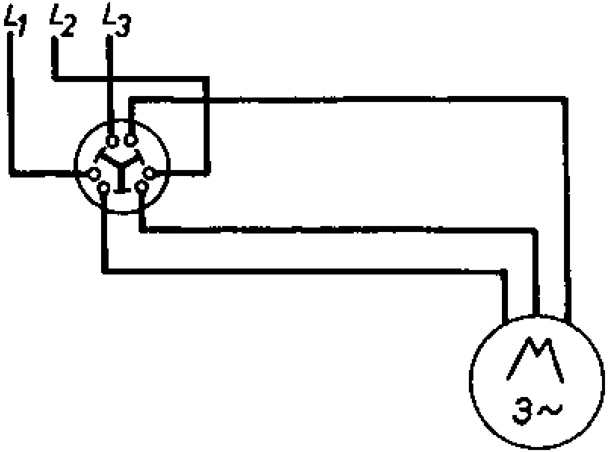
Cut-cuts with plug socket (single-pole)



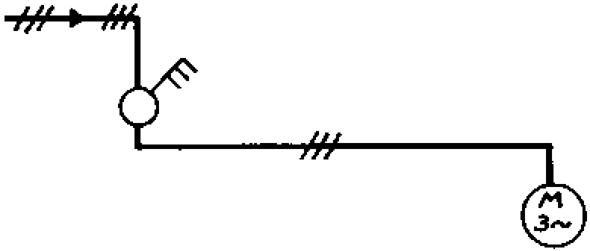
two-pole cut-out (all-pole)



two-pole cut-out (single-pole)

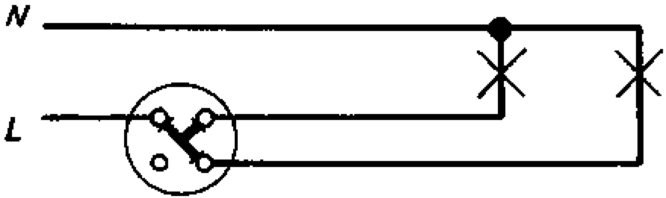


three-pole cut-out (all-pole)

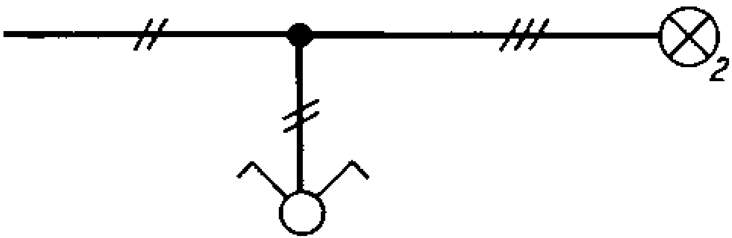


three-pole cut-out (single-pole)

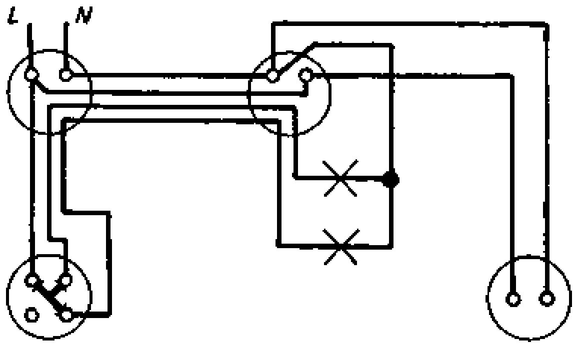
3.2. Series Circuits



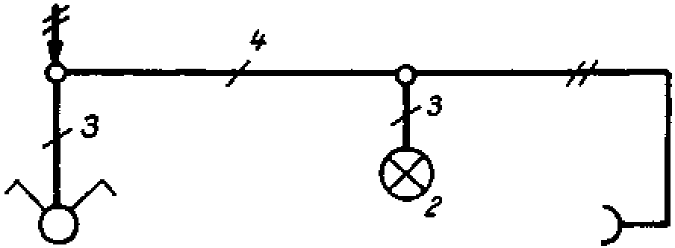
multi-circuit switch -also know as series switch-, schematic diagram (all-pole)



multi-circuit switch -also know as series switch-, schematic diagram (single-pole)

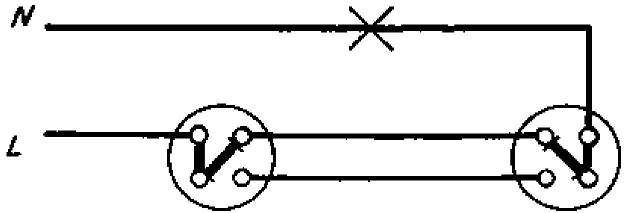


series switch with plug socket (all-pole)

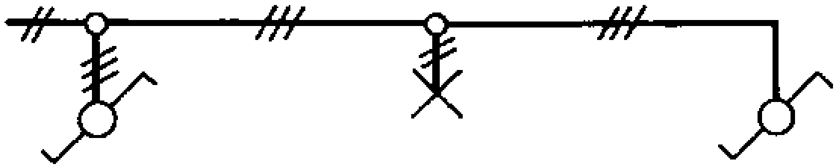


series switch with plug socket (single-pole)

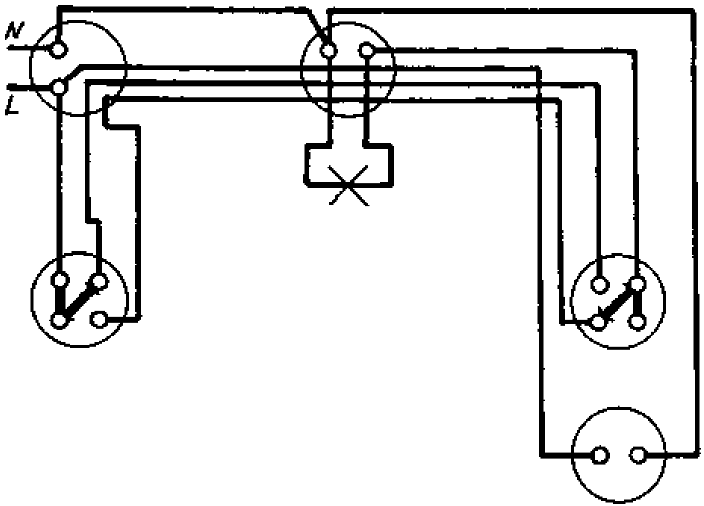
3.3. Two-way Switching Circuits



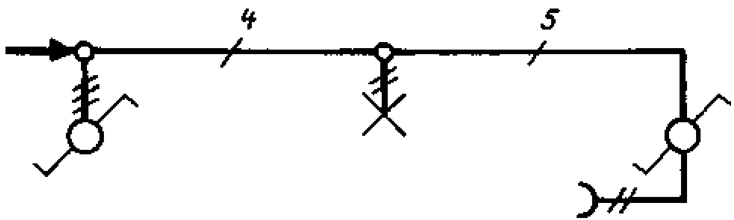
two-way switch, schematic diagram (all-pole)



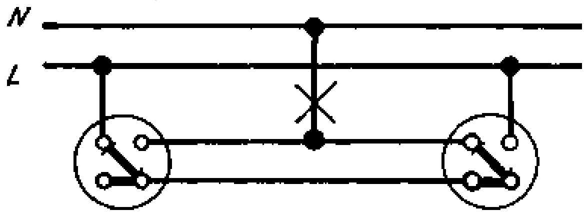
two-way switch, schematic diagram (single-pole)



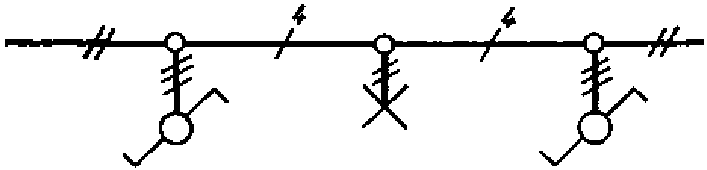
two-way switch with plug socket (all-pole)



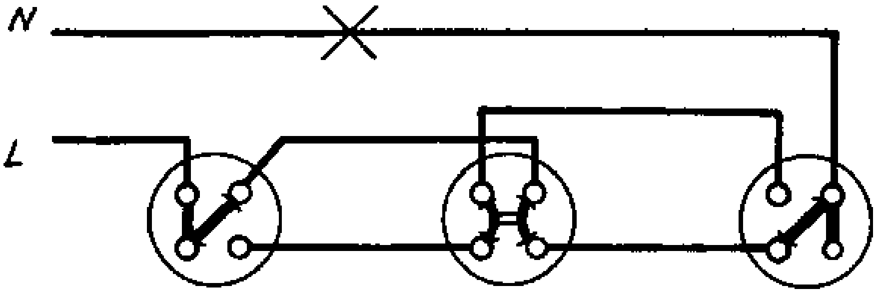
two-way switch with plug socket (single-pole)



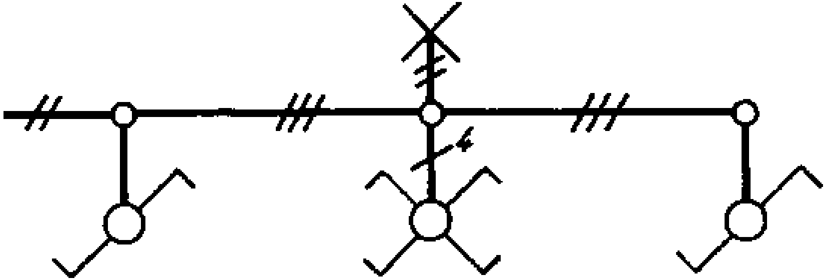
two-way switch, economy circuit, schematic diagram (all-pole)



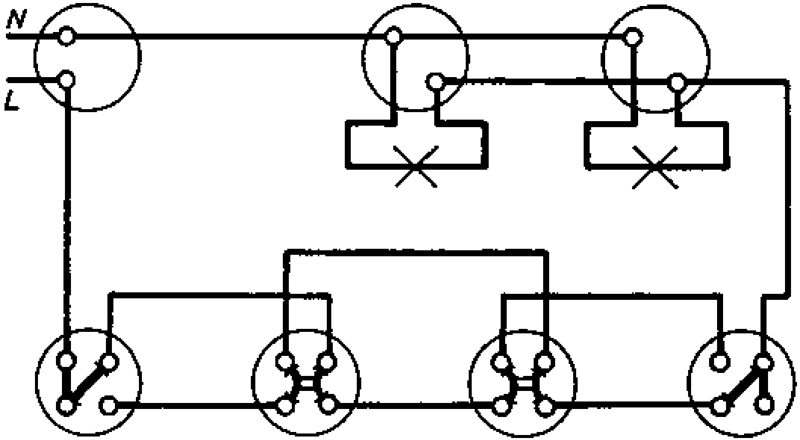
two-way switch, economy circuit, schematic diagram (single-pole)



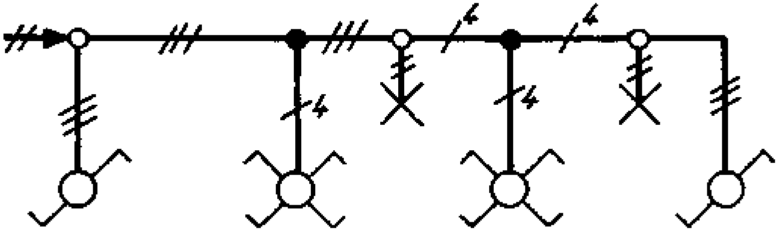
two-way switch with four-way switch, schematic diagram (all-pole)



two-way switch with four-way switch, schematic diagram (single-pole)

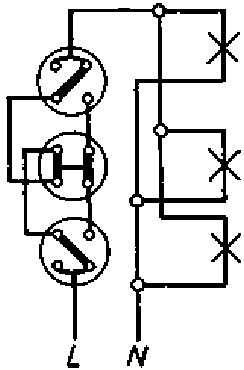


two-way switch with four-way switch (all-pole)

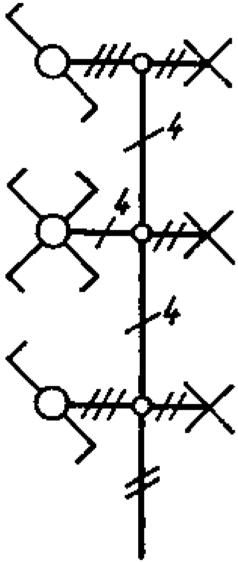


two-way switch with four-way switch (single-pole)

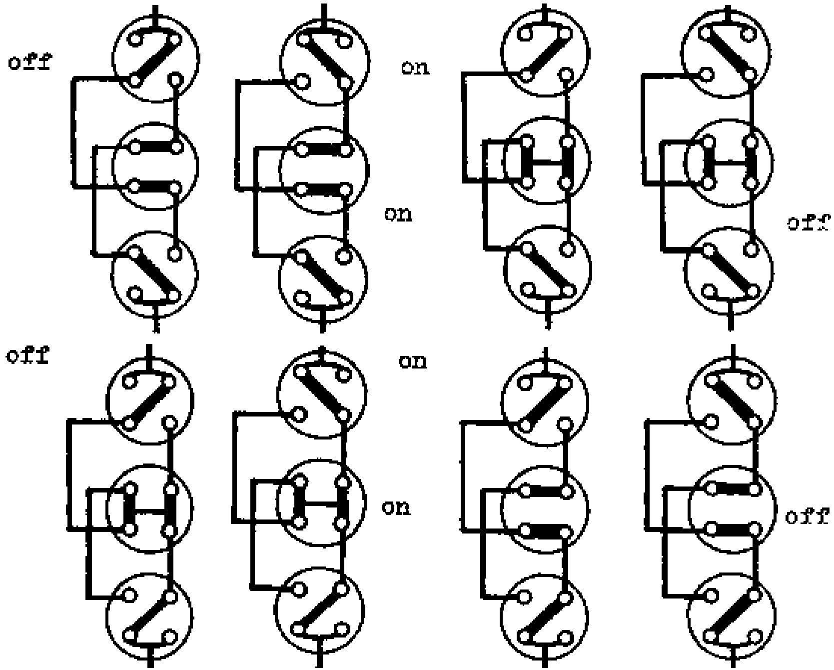
3.4. Staircase Lighting Circuits



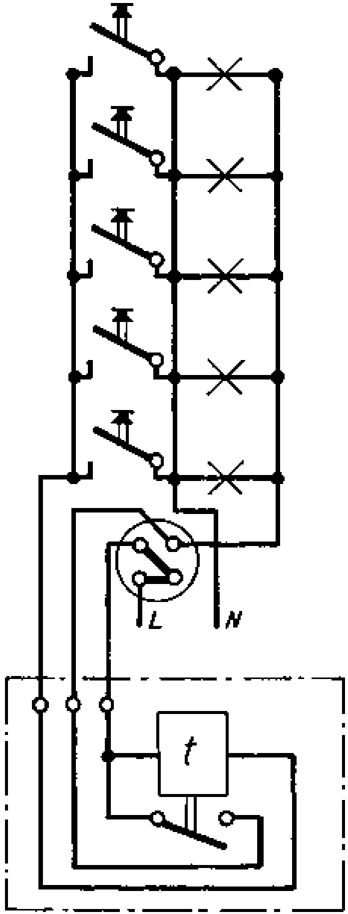
staircase lighting circuit with four-way switch (all-pole)



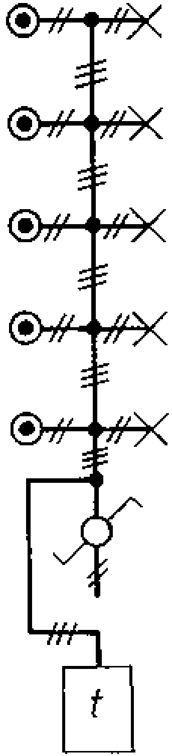
staircase lighting circuit with four-way switch (single-pole)



staircase lighting circuit with four-way switch (switch positions)



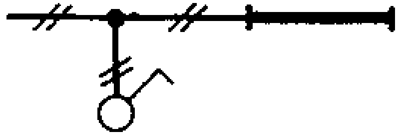
staircase circuit with automatic unit (all-pole)



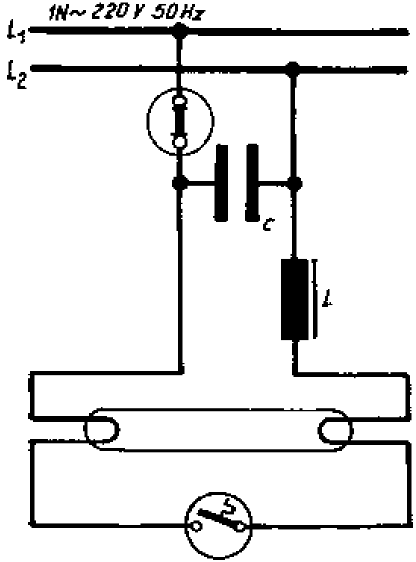
staircase circuit with automatic unit (single-pole)

t = automatic staircase lighting switch unit

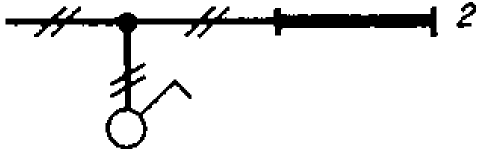
3.5. Fluorescent Lamp Circuits



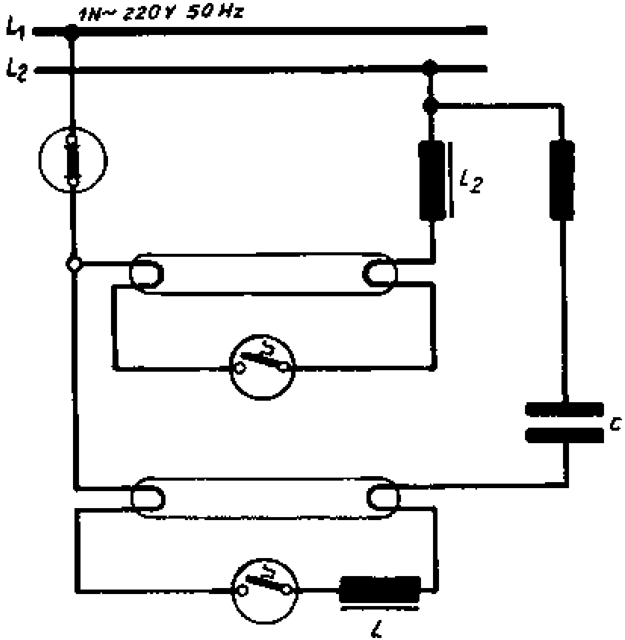
fluorescent lamp at single-phase mains (single-pole)



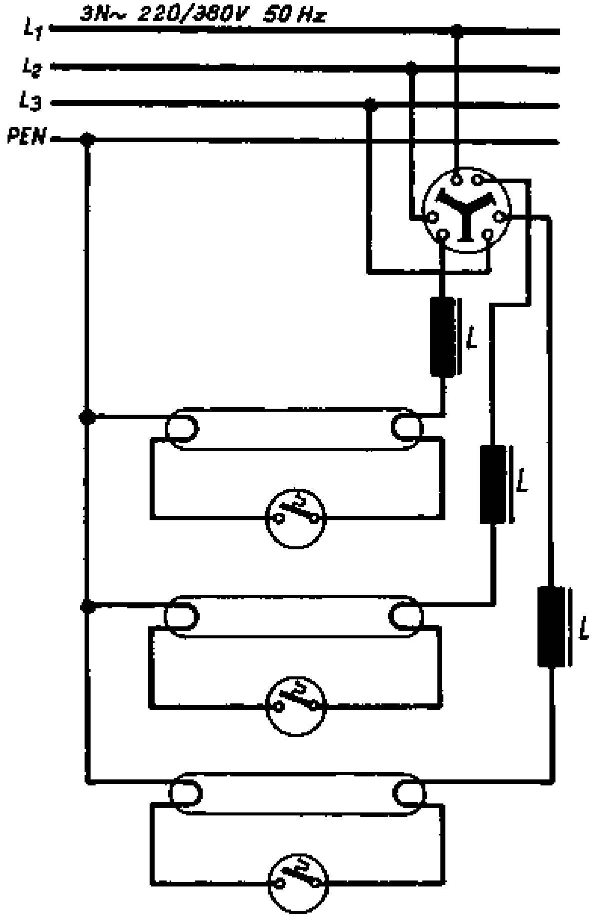
fluorescent lamp at single-phase mains (all-pole)



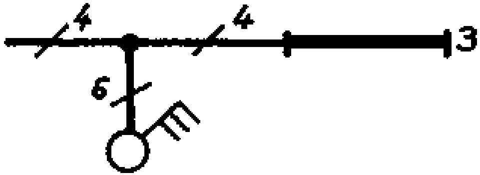
fluorescent lamp in lead-lag connection (single-pole)



fluorescent lamp in lead-lag connection (all-pole)



fluorescent lamp at three-phase mains (all-pole)



fluorescent lamp at three-phase mains (single-pole)

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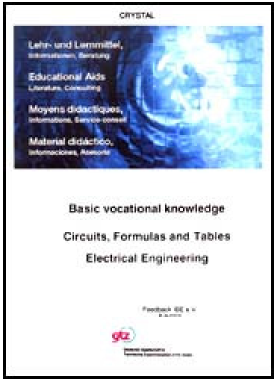


4.3.2. Three-phase Transformers

Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

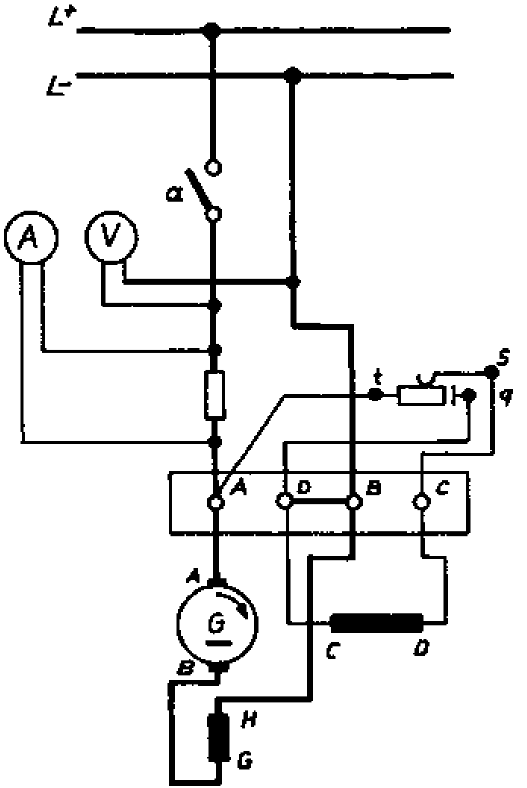
4. Electrical Machines

Designation of electrical conductors

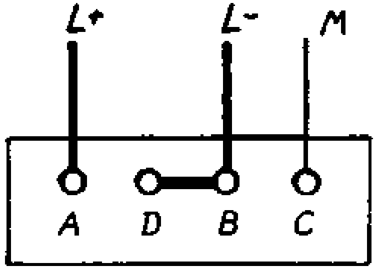
Alternating current	
any external conductor	L
1st external conductor	L1
2nd external conductor	L2
3rd external conductor	L3
neutral conductor without the function of a protective conductor	N
Direct current	
any external conductor	L
positive external conductor	L+
negative external conductor	L-
central conductor without the function of a protective conductor	M

4.1. Direct-current Machines

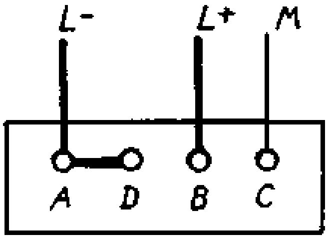
4.1.1. Direct-current Generators



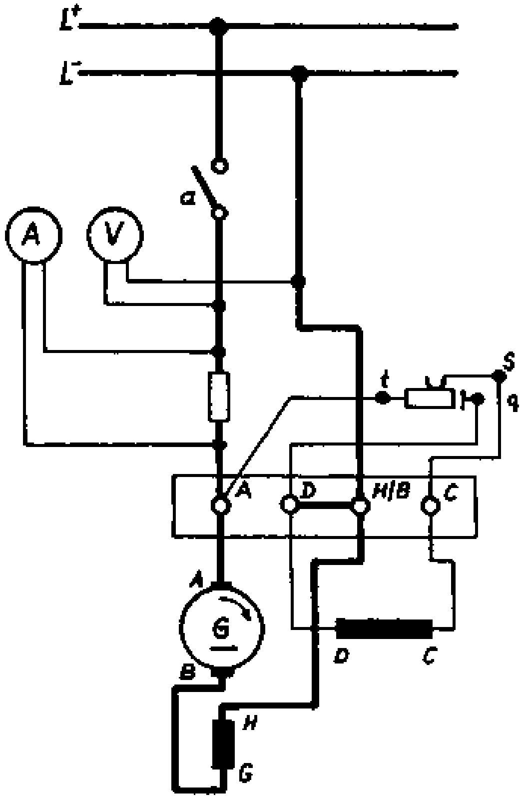
d.c. shunt-wound generator without commutating poles (clockwise sense of rotation)



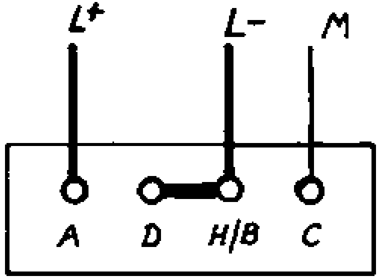
terminal boards (clockwise sense of rotation)



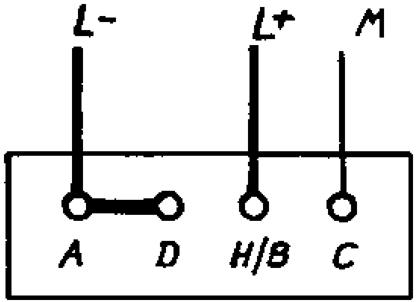
terminal boards (anti-clockwise sense of rotation)



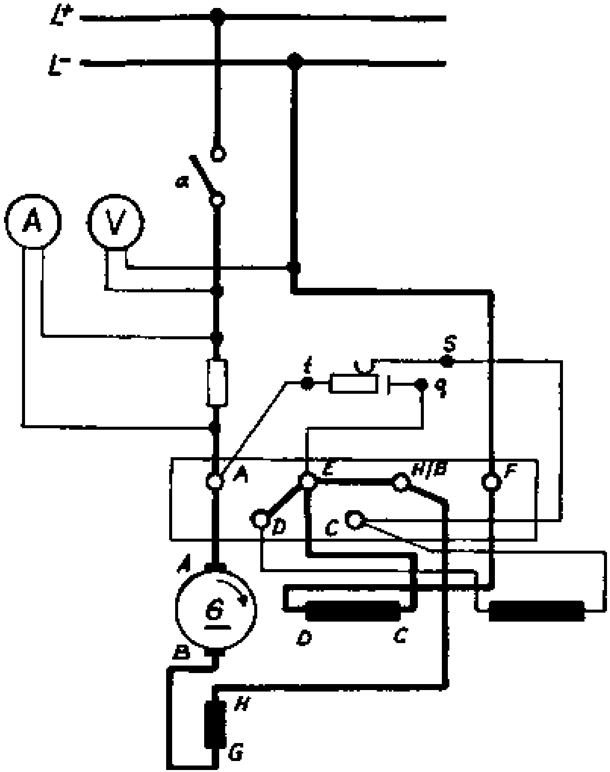
d.c. shunt-wound generator with commutating poles (clockwise sense of rotation)



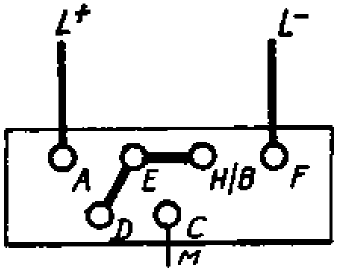
The commutating poles are clamped inside the generator terminal boards with commutating poles (clockwise sense of rotation)



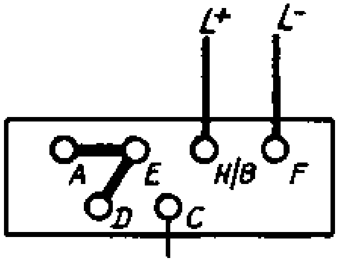
The commutating poles are clamped inside the generator terminal boards with commutating poles (anti-clockwise sense of rotation)



d.c. compound-wound generator with commutating poles (clockwise sense of rotation)

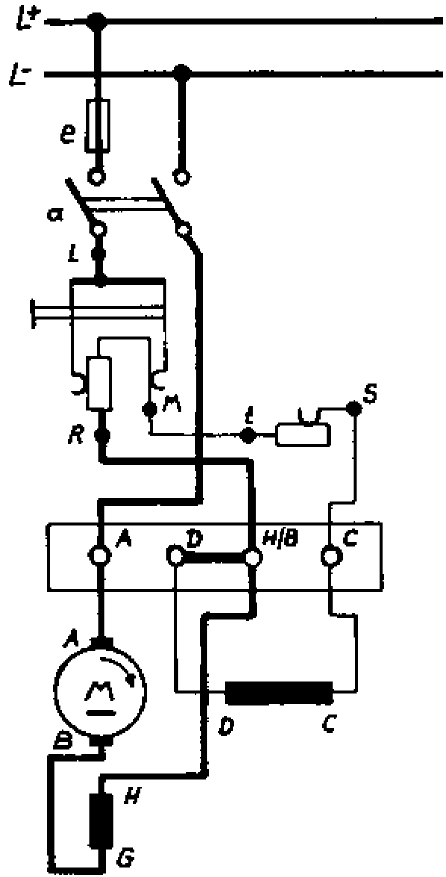


terminal boards (clockwise sense of rotation)

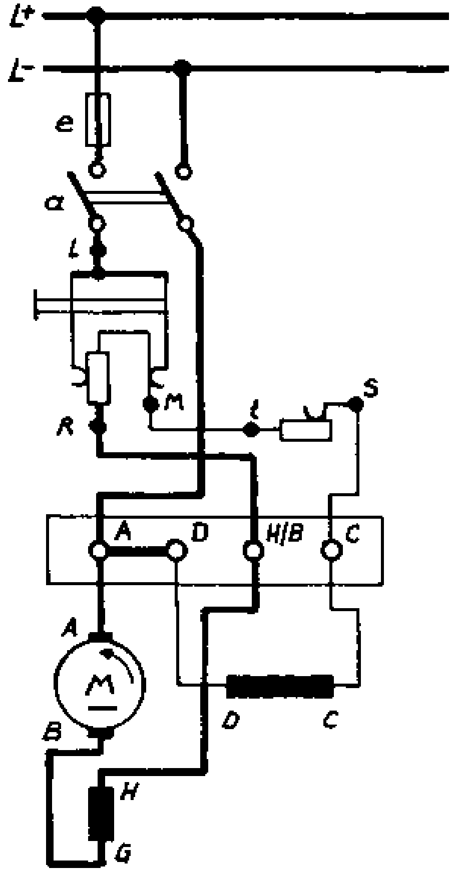


terminal boards (anti-clockwise sense of rotation)

4.1.2. Direct-current Motors

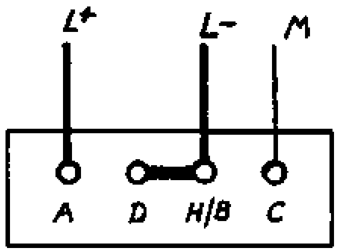


d.c. shout-wound motor with commutating poles and starter (clockwise sense of rotation)

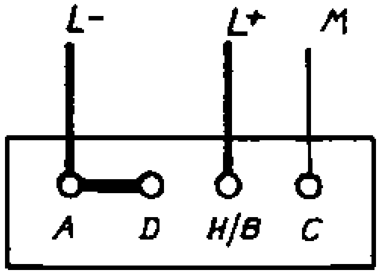


d.c. shout-wound motor with commutating poles and starter (anti-clockwise sense of rotation)

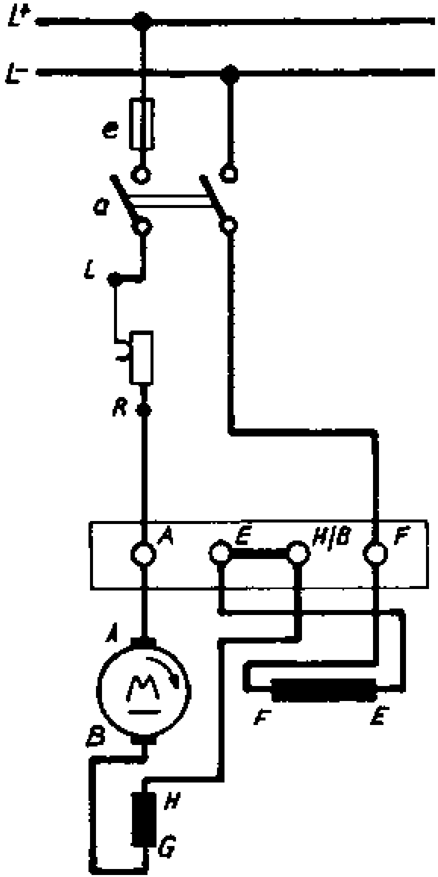
The commutating poles are clamped inside the motor



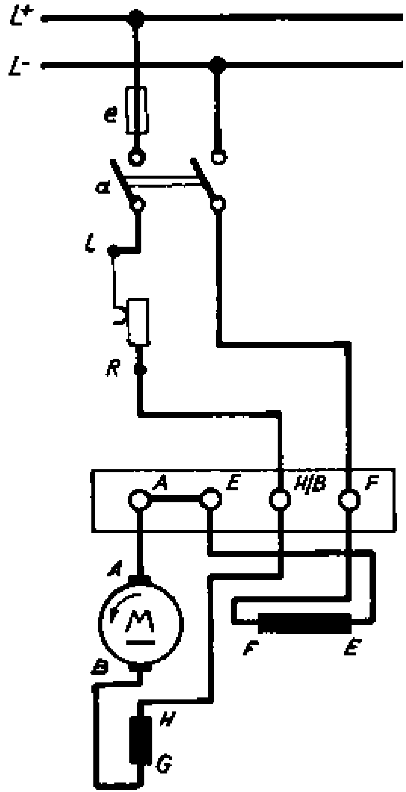
terminal boards (A)



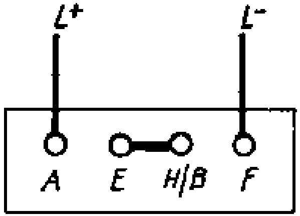
terminal boards (B)



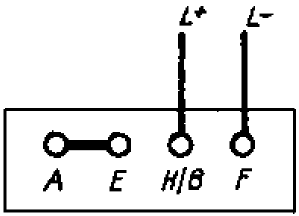
d.c. series motor with commutating poles (clockwise sense of rotation)



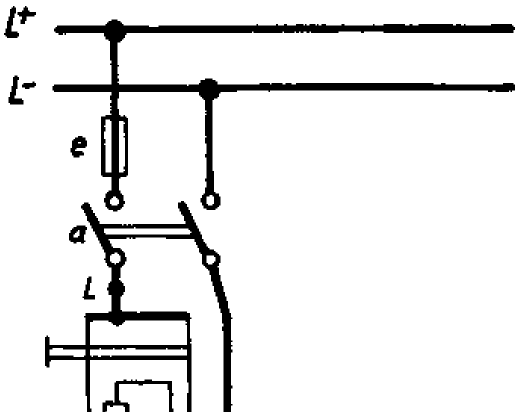
d.c. series motor with commutating poles (anti-clockwise sense of rotation)

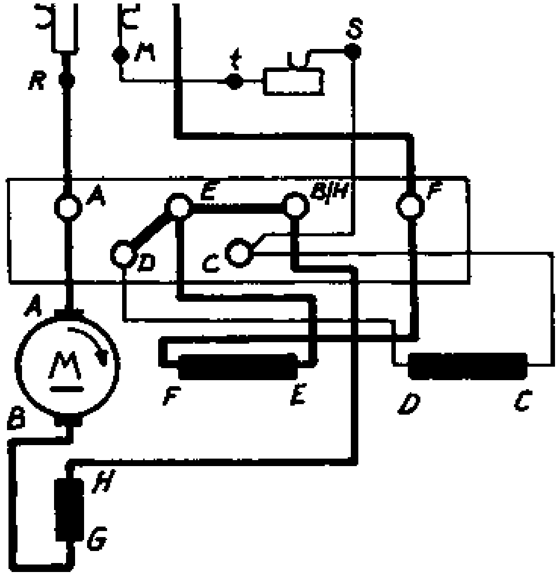


terminal boards (A)

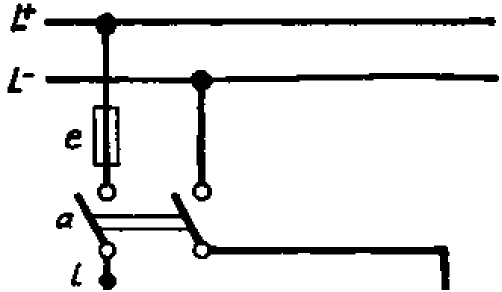


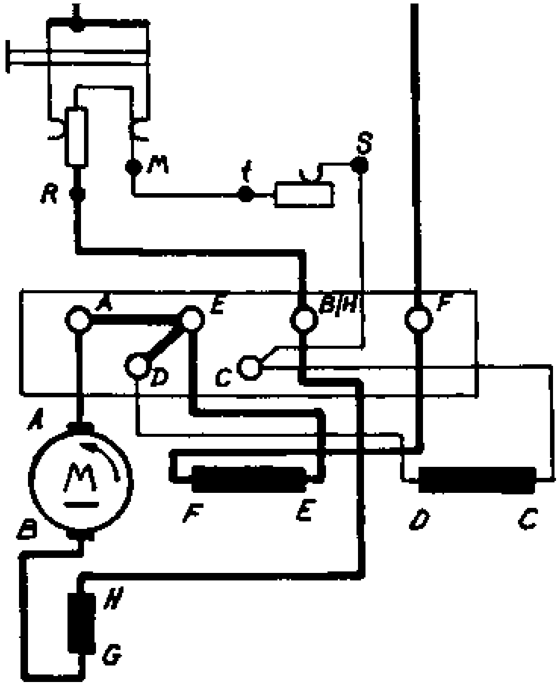
terminal boards (B)



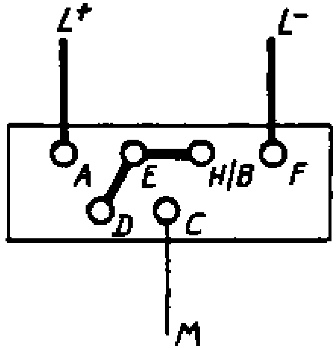


d.c. compound - wound motor with commutating poles (clockwise sense of rotation)

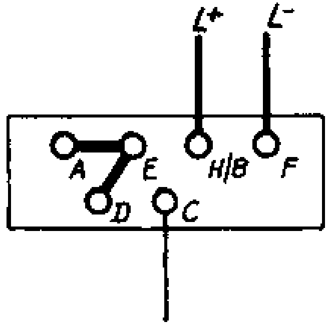




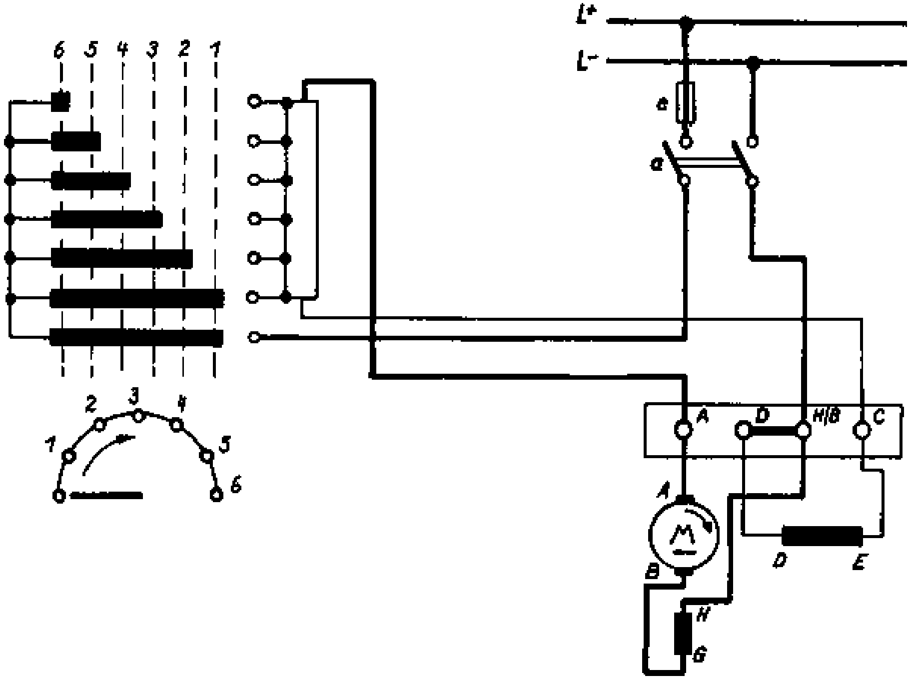
d.c. compound - wound motor with commutating poles (anti-clockwise sense of rotation)



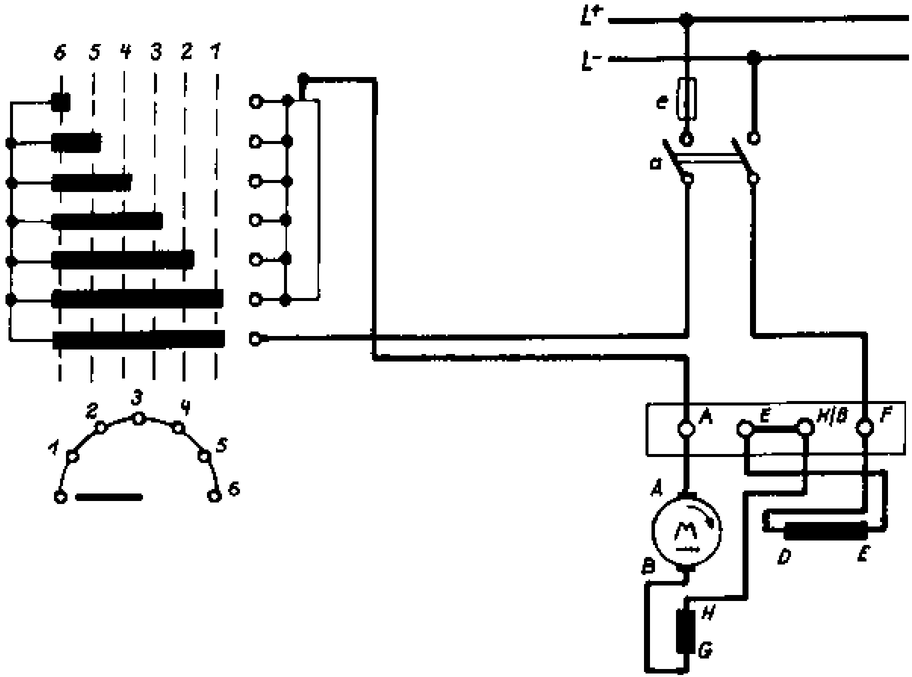
terminal boards (A)



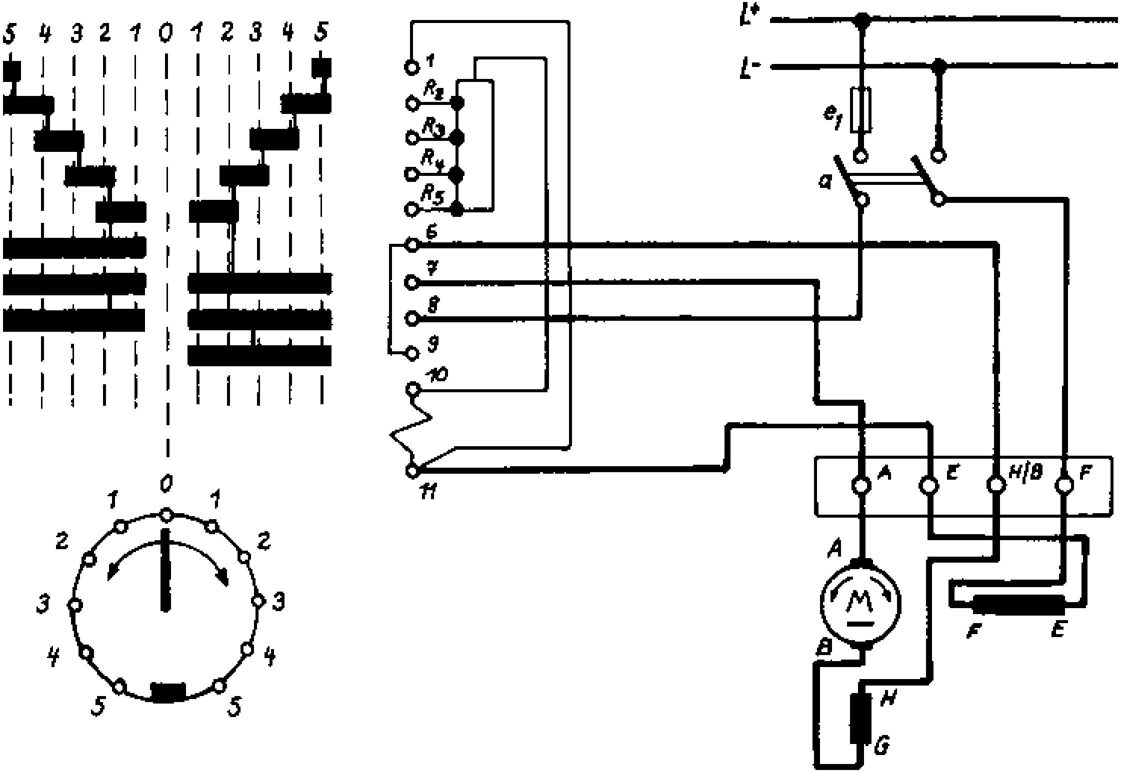
terminal boards (B)



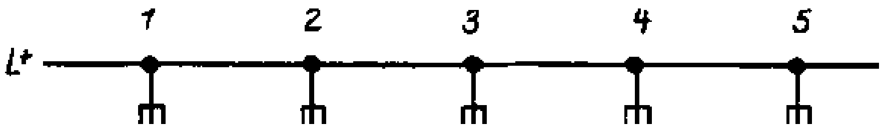
d.c. shunt-wound motor with cylindrical starter (clockwise sense of rotation)

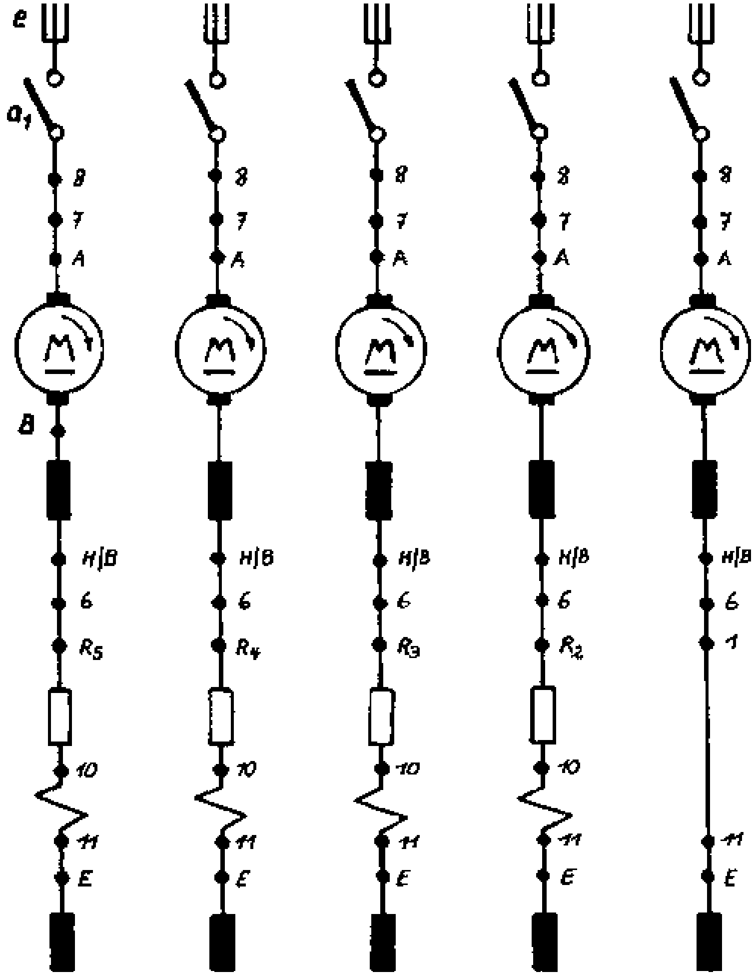


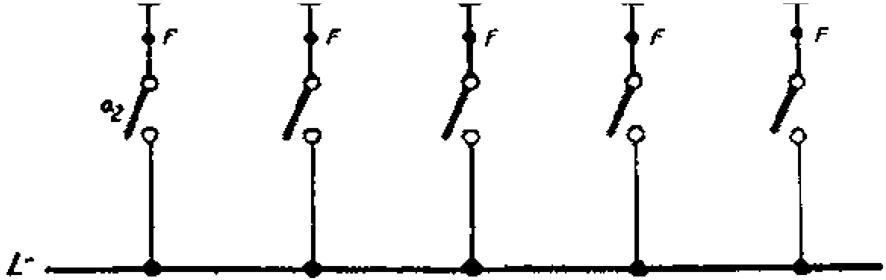
d.c. series motor with cylindrical starter (clockwise sense of rotation)



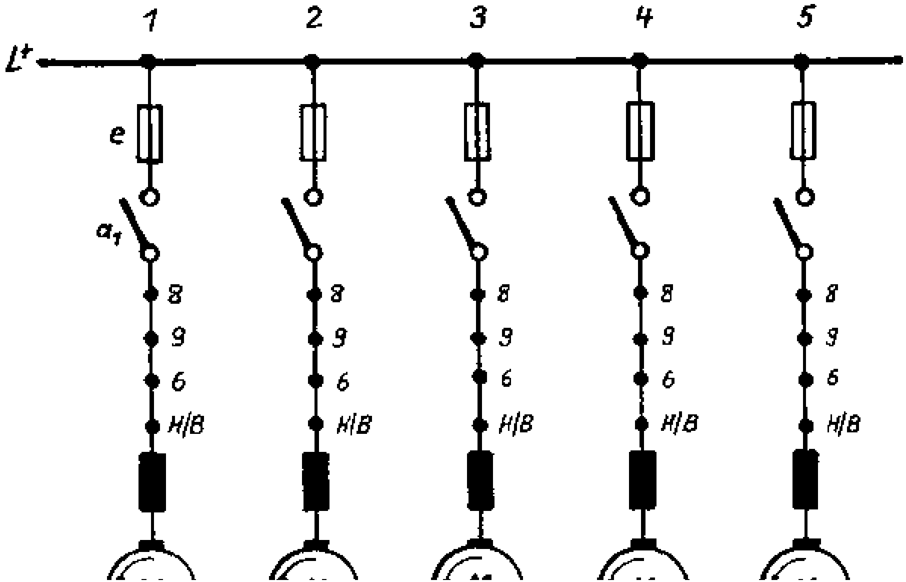
d.c. series motor with reversing starter

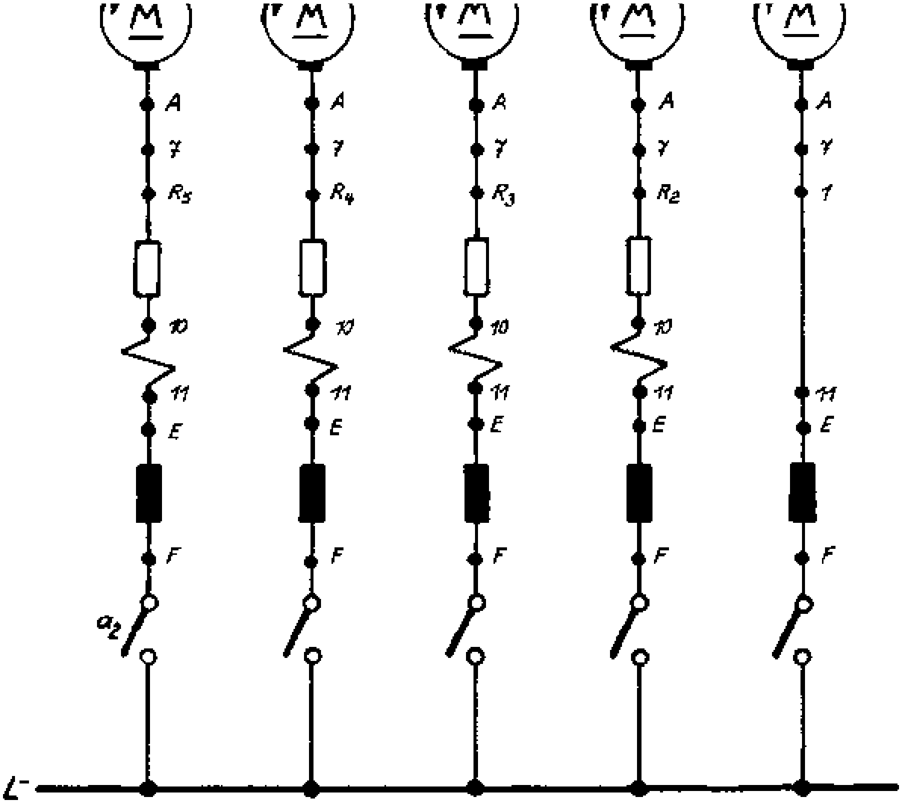



e
Q1
8
7
A
B
H/B
6
R5
R4
R3
R2
1
10
11
E

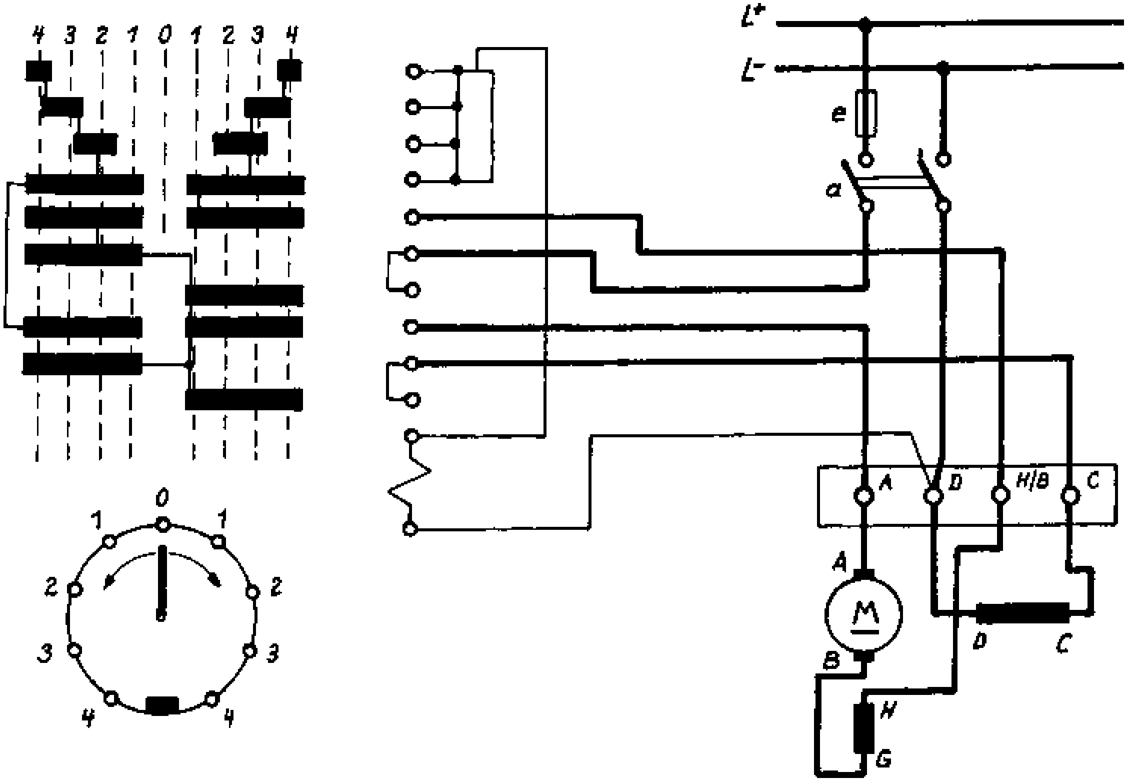


Schematic circuit diagram for reversing starter with d.c. series motor (clockwise sense of rotation)

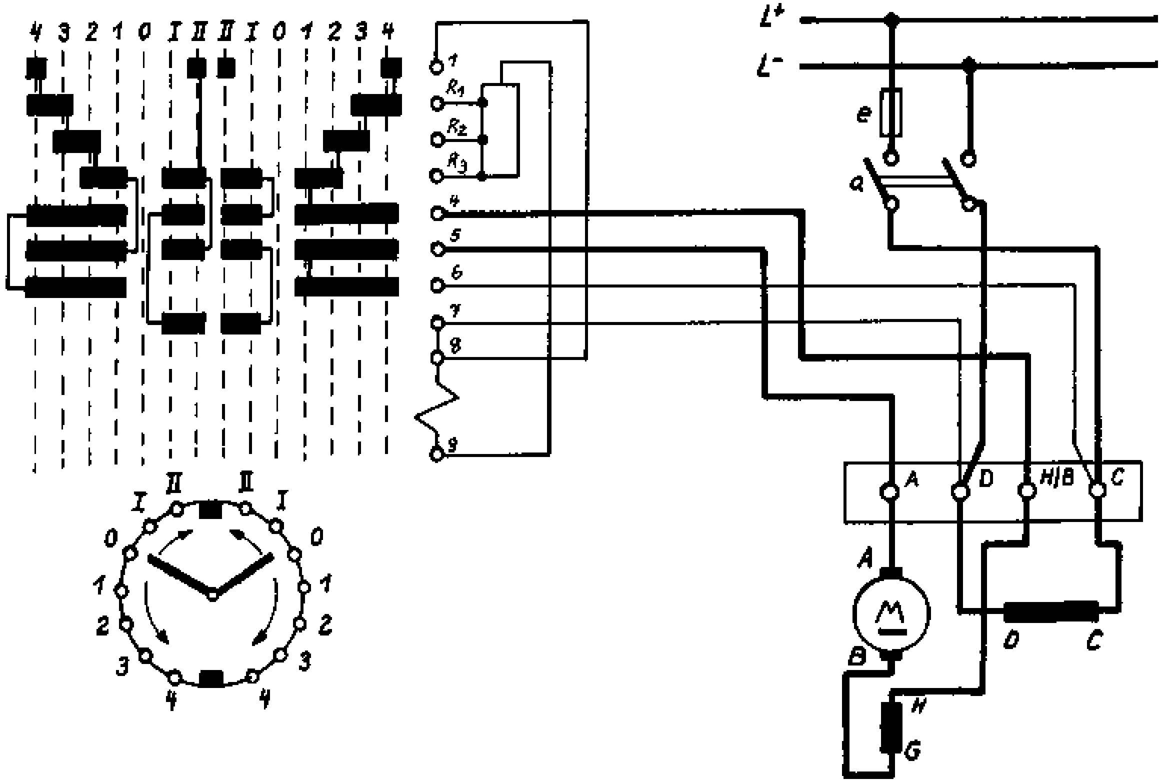




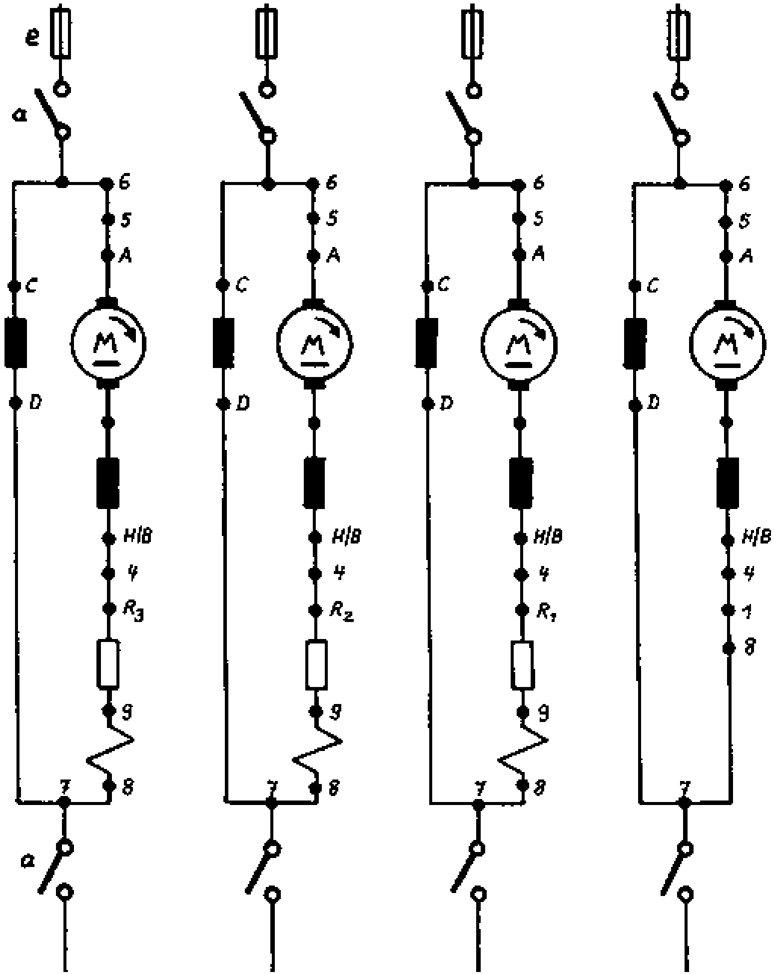
Schematic circuit diagram for reversing starter with d.c. series motor (anti-clockwise sense of rotation)



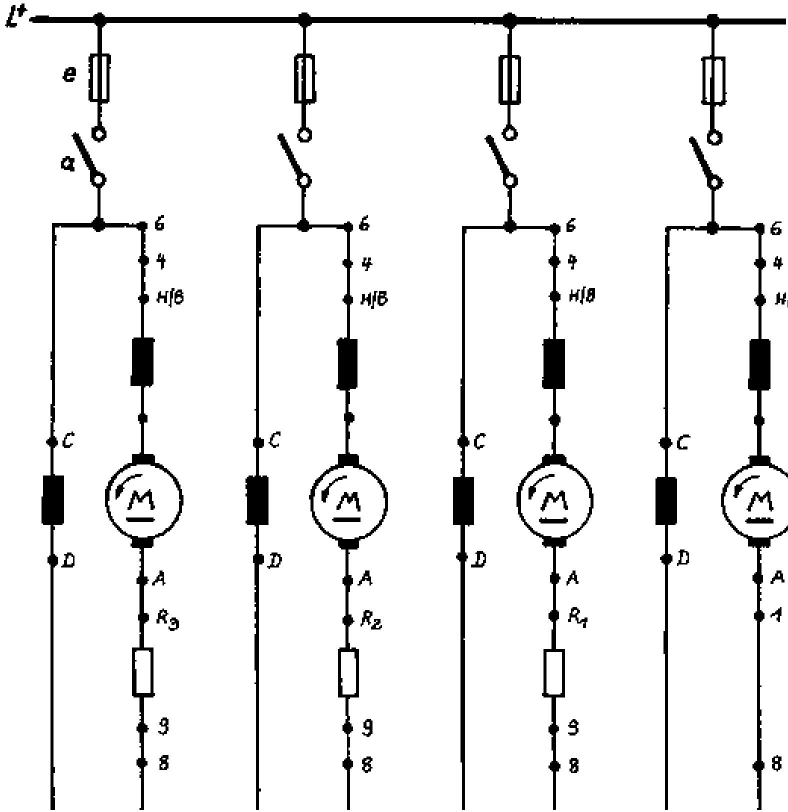
d.c. shunt-wound motor with controller drum for clockwise and anti-clockwise sense of rotation

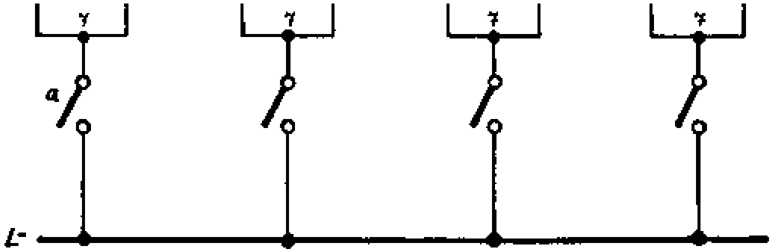


d.c. shunt-wound motor with controller drum for clockwise and anti-clockwise rotation and braking

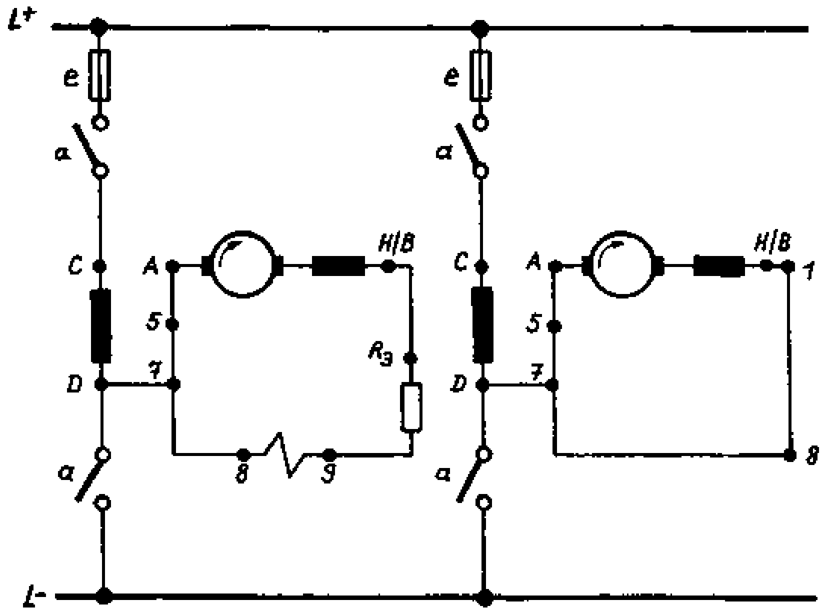

e
a
6
5
A
C
D
M
H/B
4
R3
R2
R1
1
8
9
7
a

Schematic circuit diagram for controller drum with reversing and braking circuit for d.c. shunt-wound motor (clockwise sense of rotation)

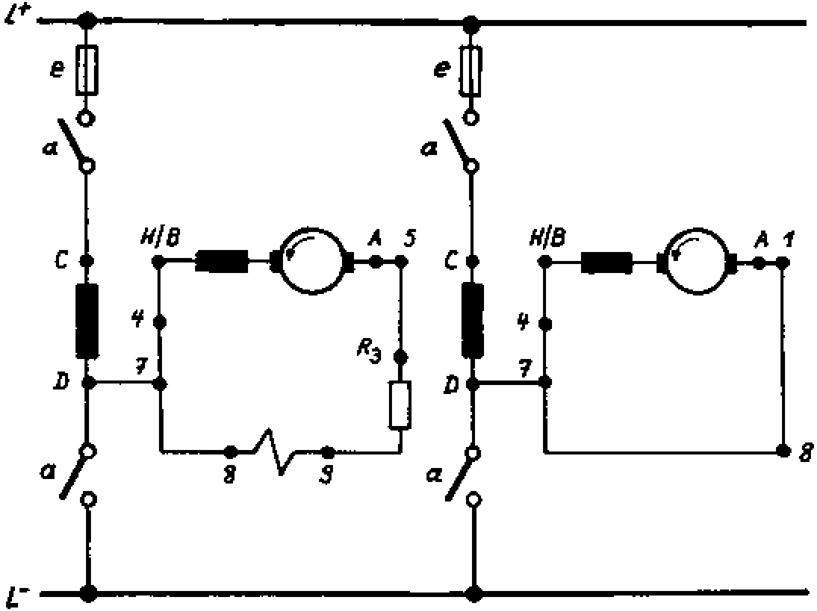




Schematic circuit diagram for controller drum with reversing and braking circuit for d.c. shunt-wound motor (anti-clockwise sense of rotation)



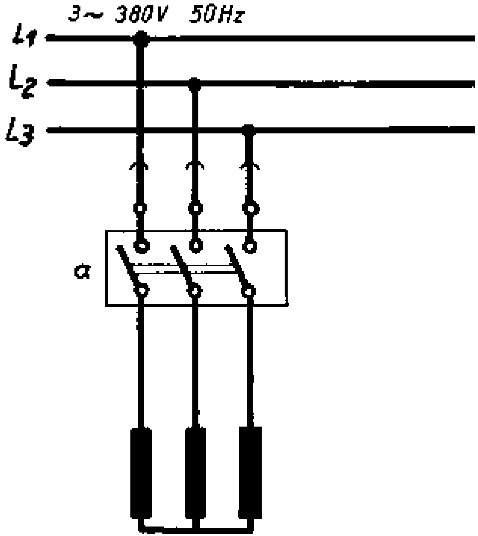
Schematic circuit diagram for controller drum with reversing and braking circuit for d.c. shunt-wound motor (braking right-hand side)



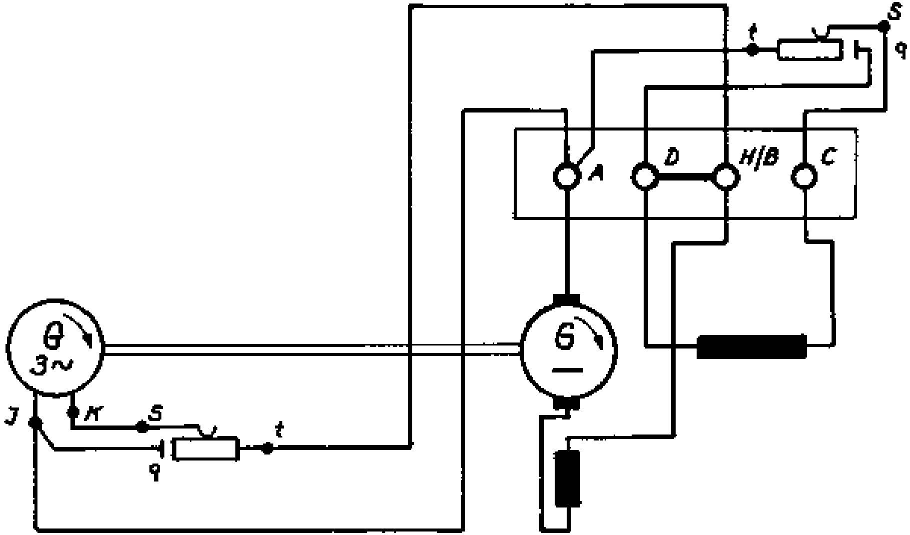
Schematic circuit diagram for controller drum with reversing and braking circuit for d.c. shunt-wound motor (braking left-hand side)

4.2. Three-phase Machines

4.2.1. Three-phase Generators



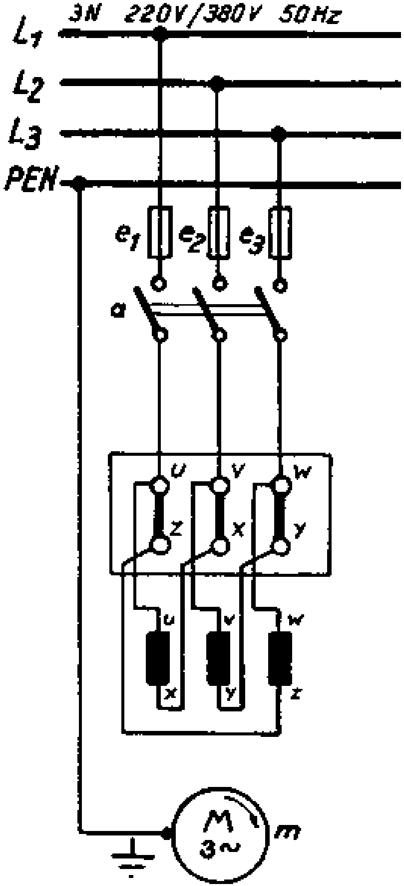
Three-phase generator with exciter (A)



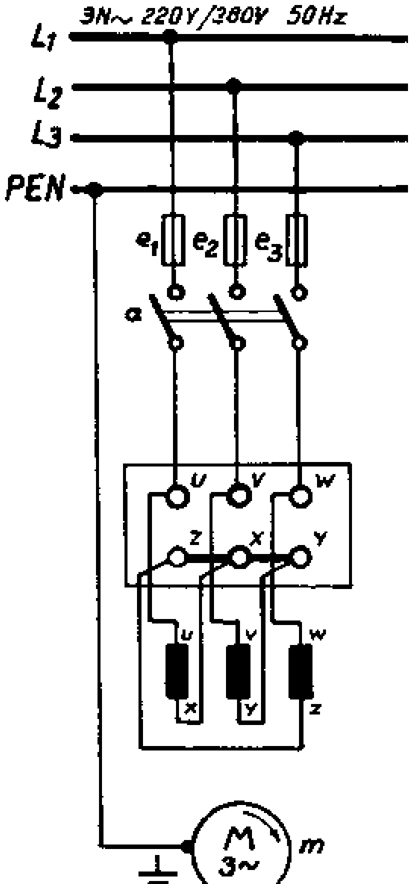
Three-phase generator with exciter (B)

4.2.2. Three-phase Motors

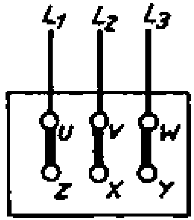
Mains voltage designations	3 N 220V/380V 50 Hz
	1 N 220V 50 Hz



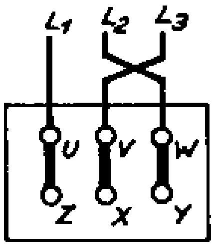
Three-phase motor with star-delta connection (star connection)



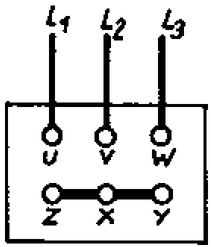
Three-phase motor with star-delta connection (delta connection)



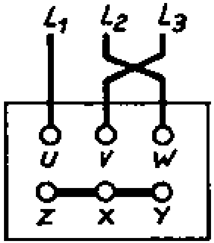
terminal boards (clockwise sense of rotation)



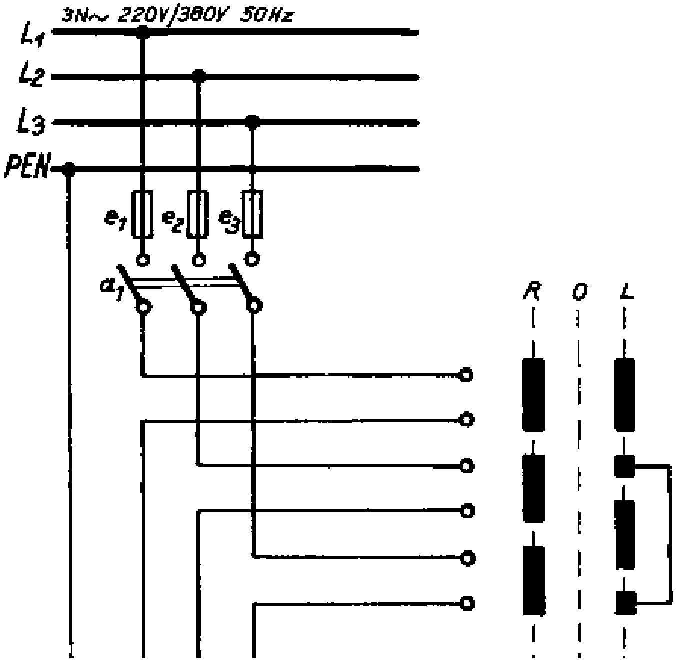
terminal boards (anti-clockwise sense of rotation)

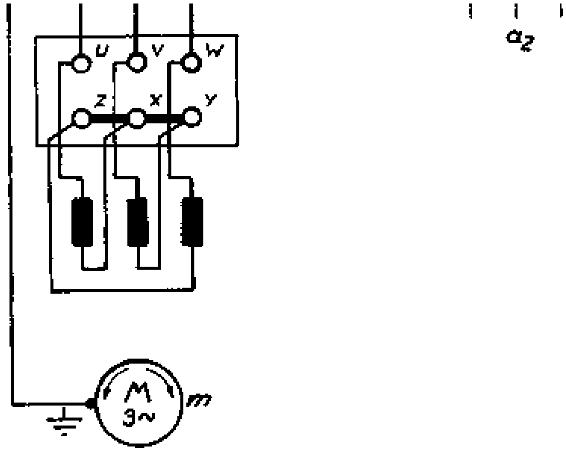


terminal boards (clockwise sense of rotation)

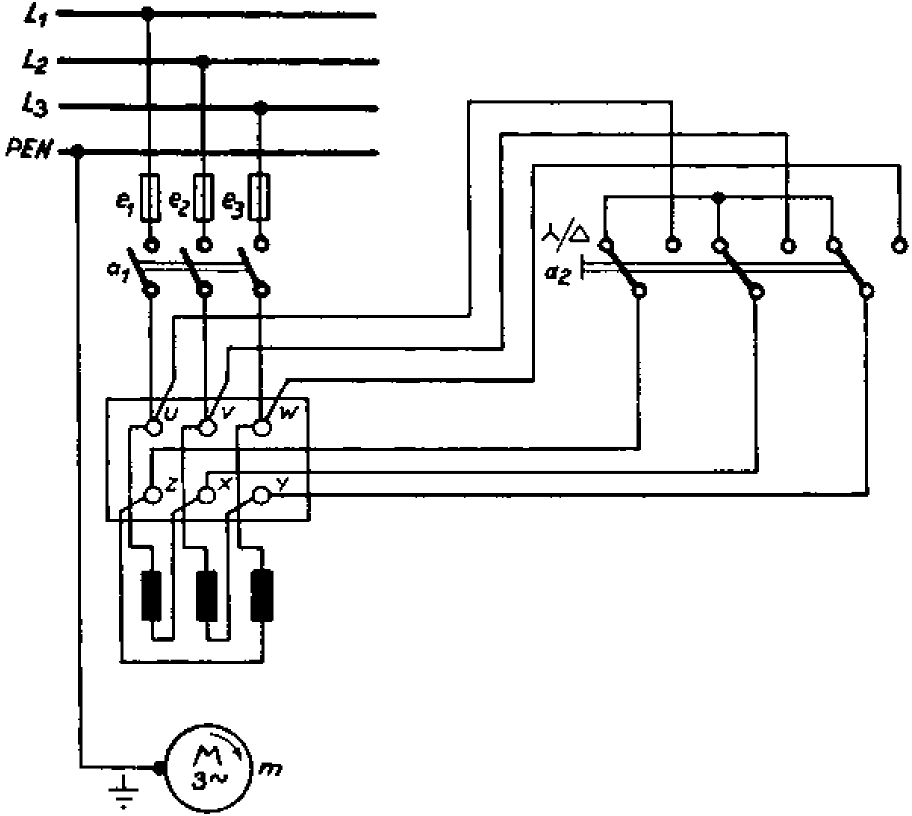


terminal boards (anti-clockwise sense of rotation)

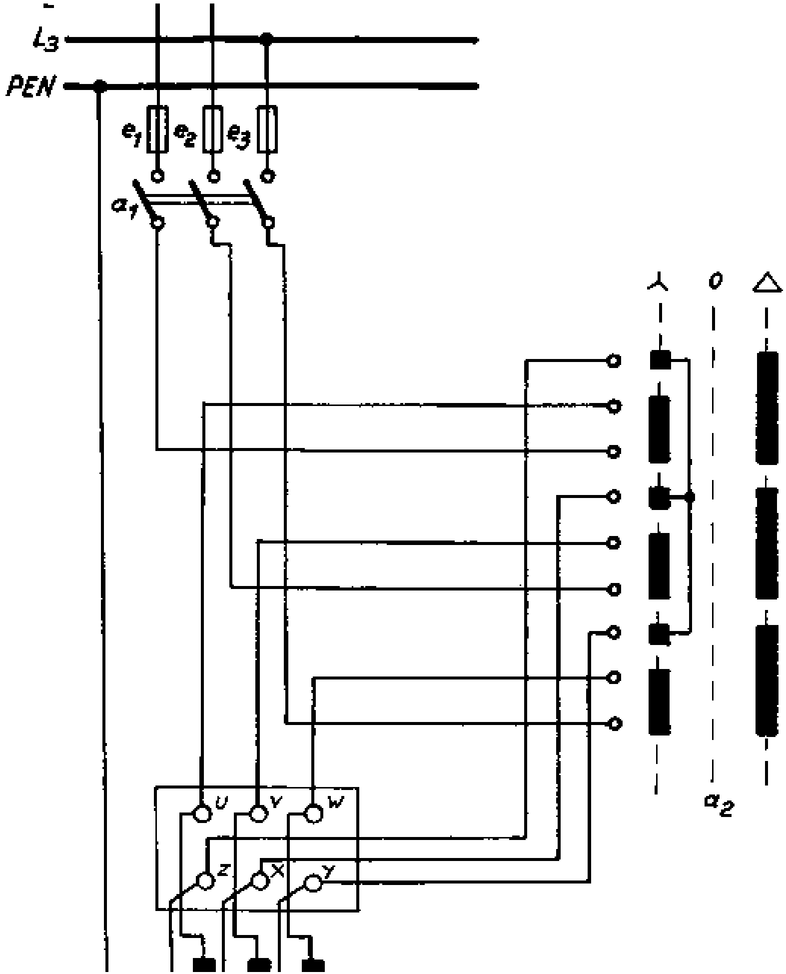


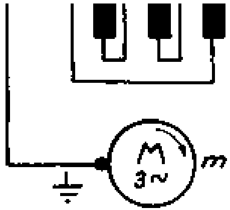


Three-phase motor with drum switch for clockwise and anti-clockwise rotation

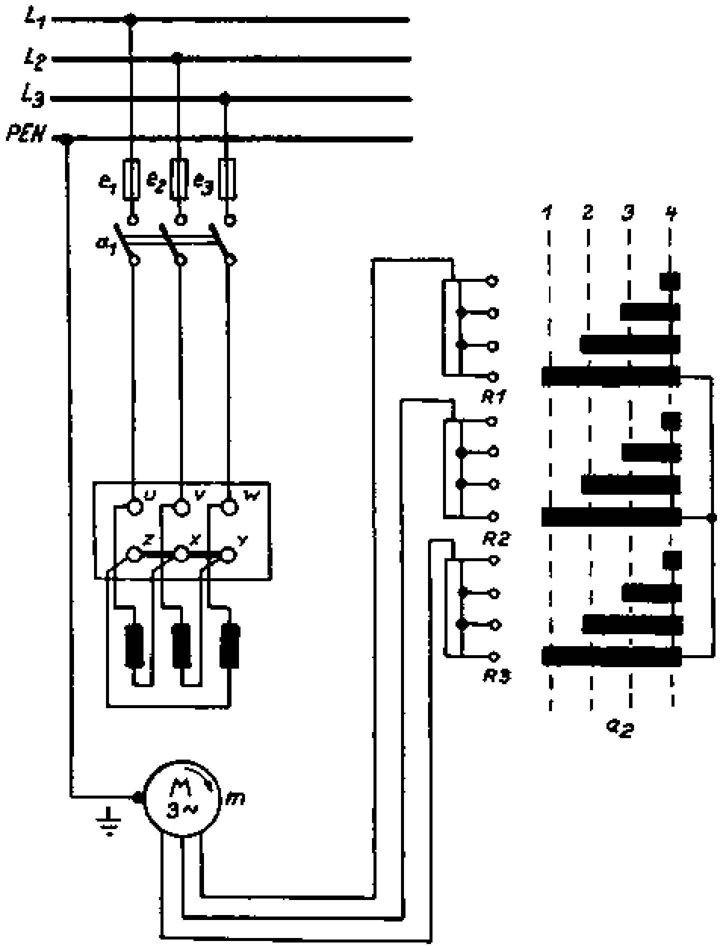


Three-phase motor with lever commutator for star-delta starting

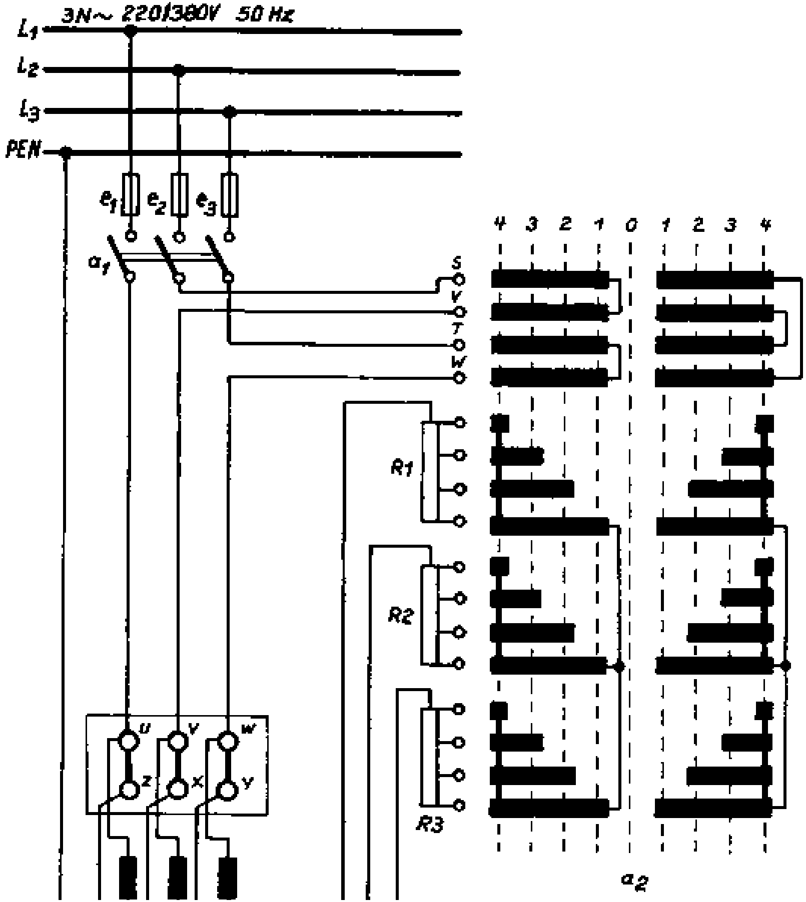

L3
PEN
e1
e2
e3
a1
U
V
W
Z
X
Y
0
a2

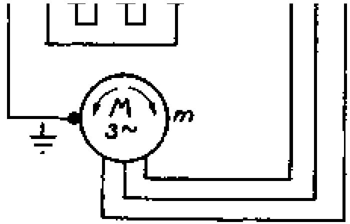


Three-phase motor with dram switch for star-delta starting

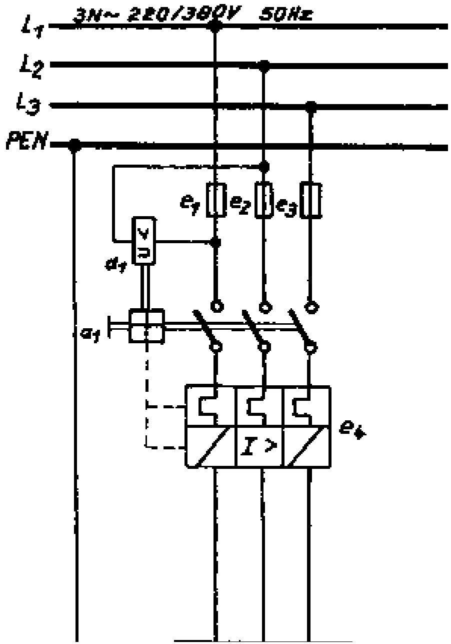

L1
L2
L3
PEN
e1
e2
e3
a1
1
2
3
4
R1
R2
R3
a2
U
V
W
Z
X
Y
M
3~
m

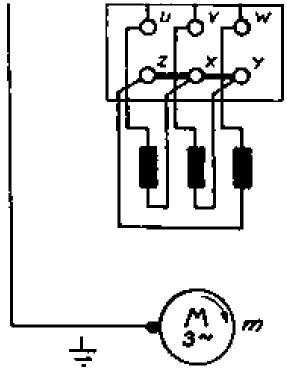
Three-phase motor (slip ring rotor) with rotor starter in star connection



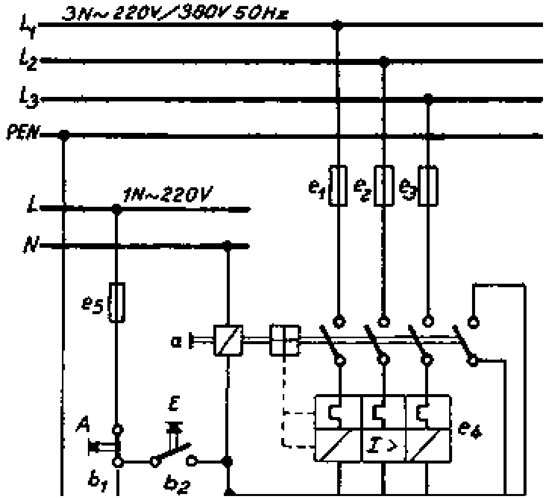


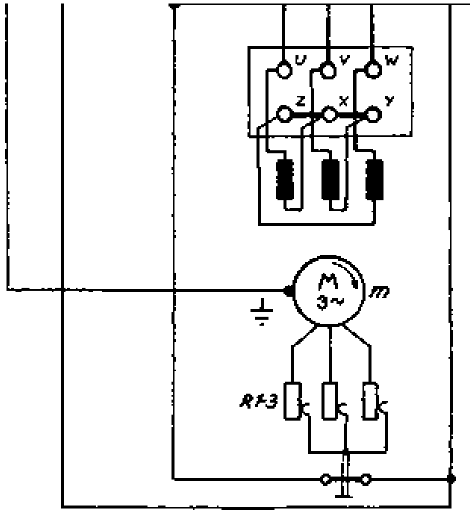
Three-phase motor (slip ring rotor) with rotor starter in delta connection and controller drum for clockwise and anti-clockwise rotation





Three-phase motor with protective motor switch for undervoltage tripping, thermal tripping and magnetic tripping



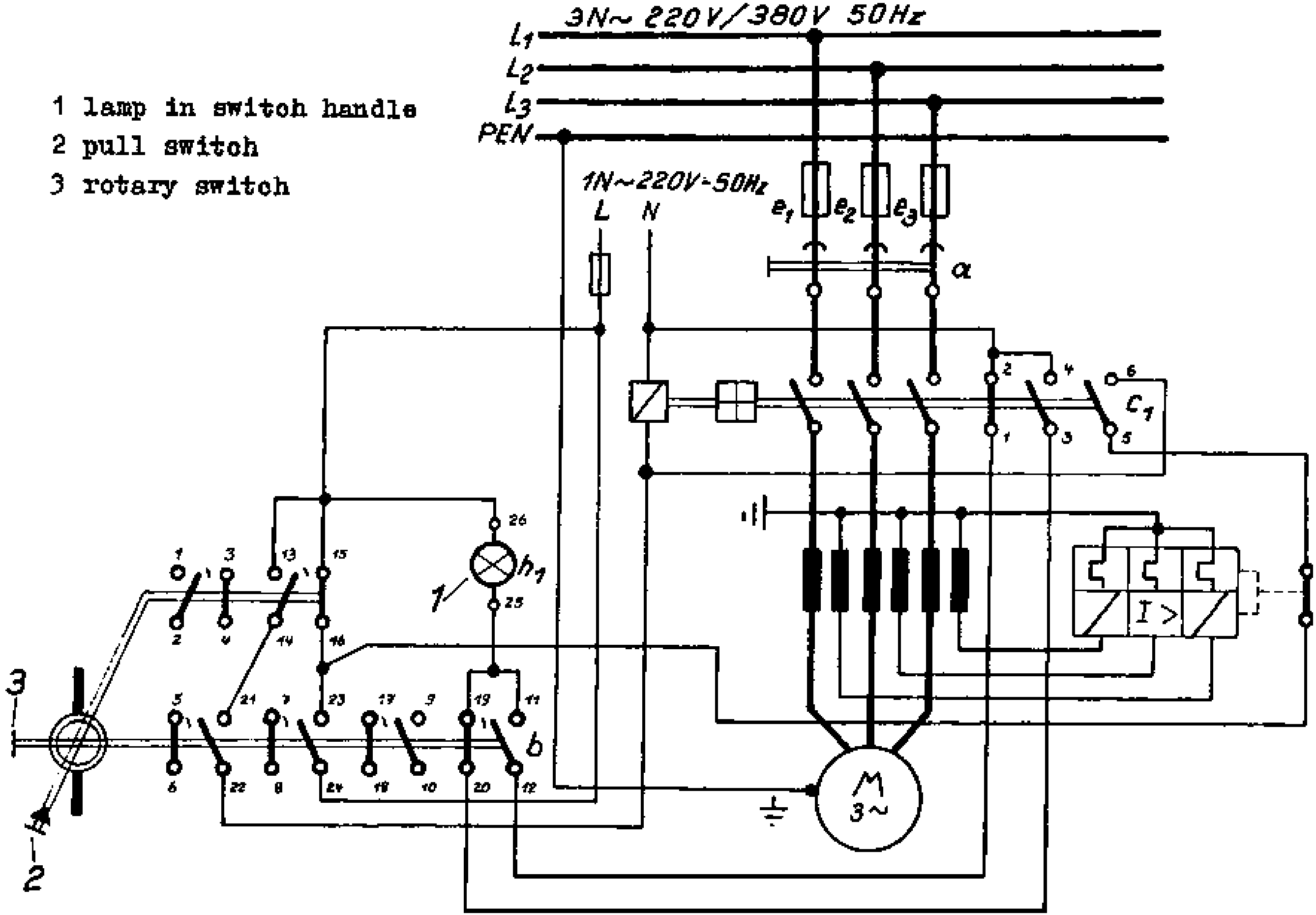


Three-phase motor (slip ring rotor) with rotor starter and protective motor switch for manual and magnetic tripping

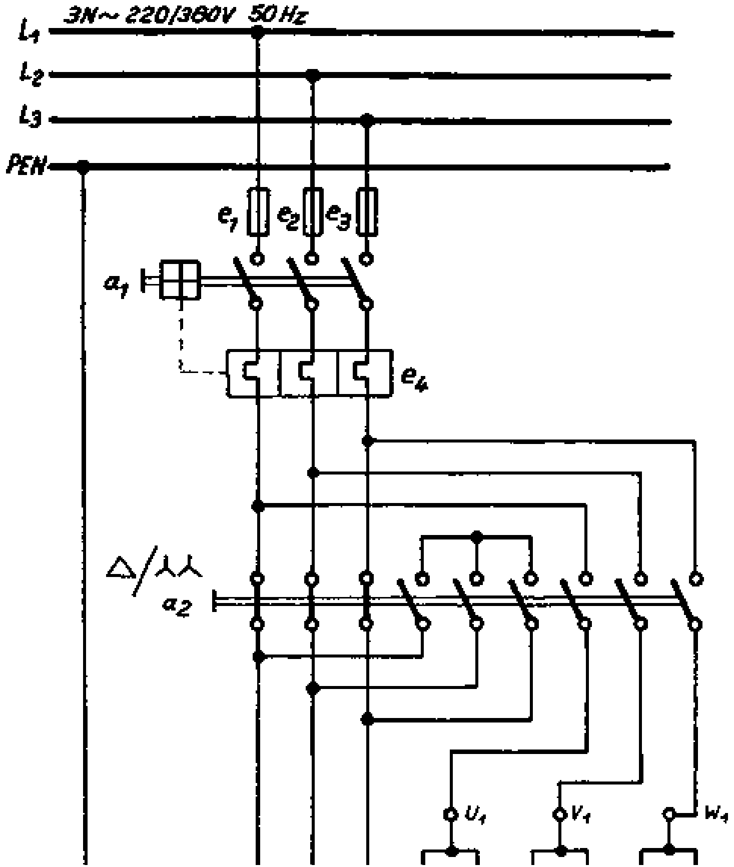
1 lamp in switch handle

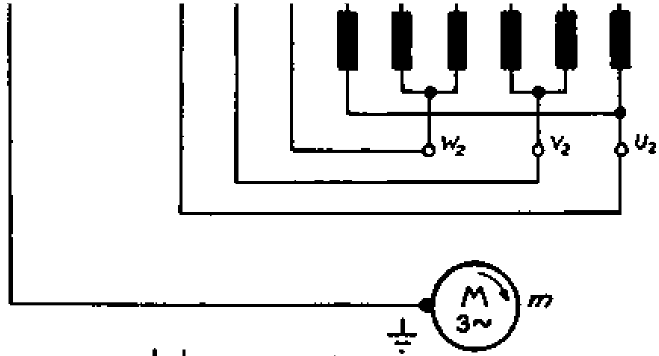
2 pull switch

3 rotary switch



Three-phase motor with control acknowledging switch and protective motor switch

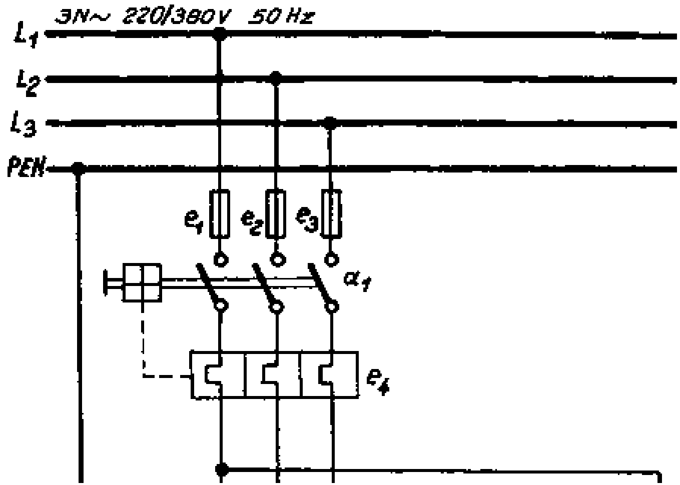


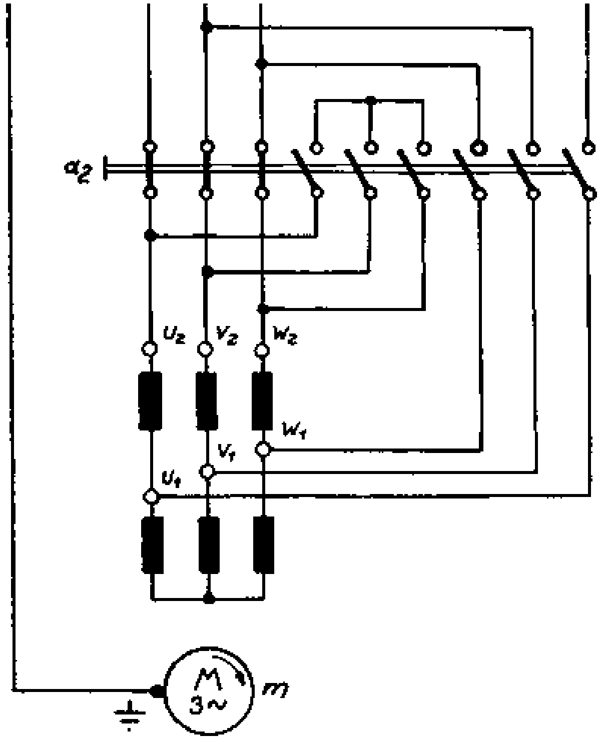


(△ 750 rpm, ⅄⅄1,500 rpm)

the torque remains constant for the two rotational speeds

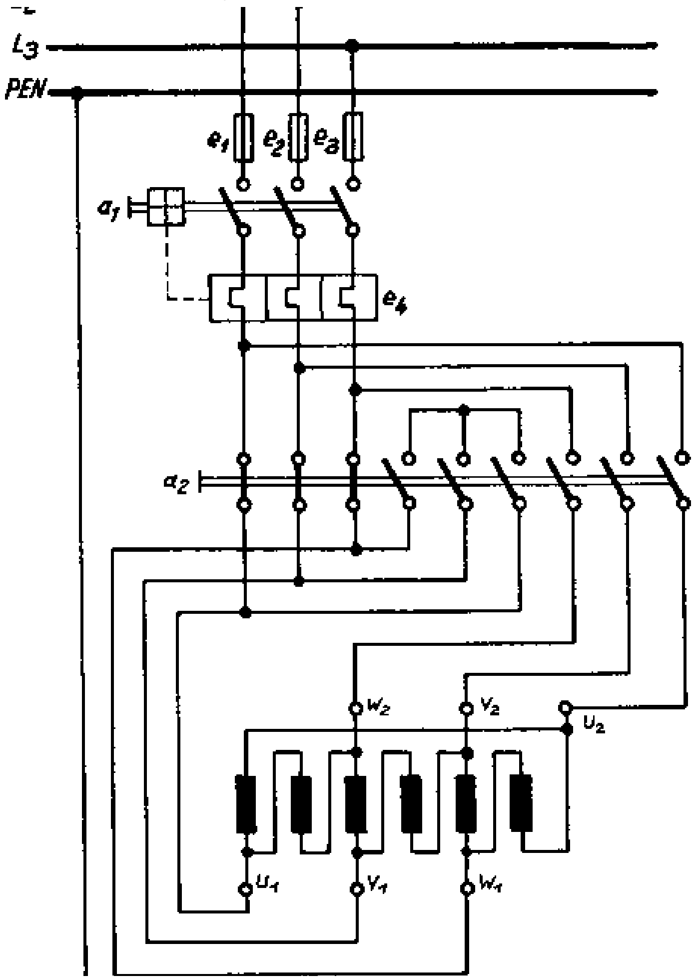
Three - phase motor in Dahlander pole-changing connection

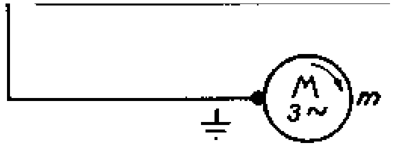




(⅄ 750 rpm, ⅄⅄ 1,500 rpm)
the torque changes almost quadratically

Three-phase motor in "with Dahlander pole-changing connection"

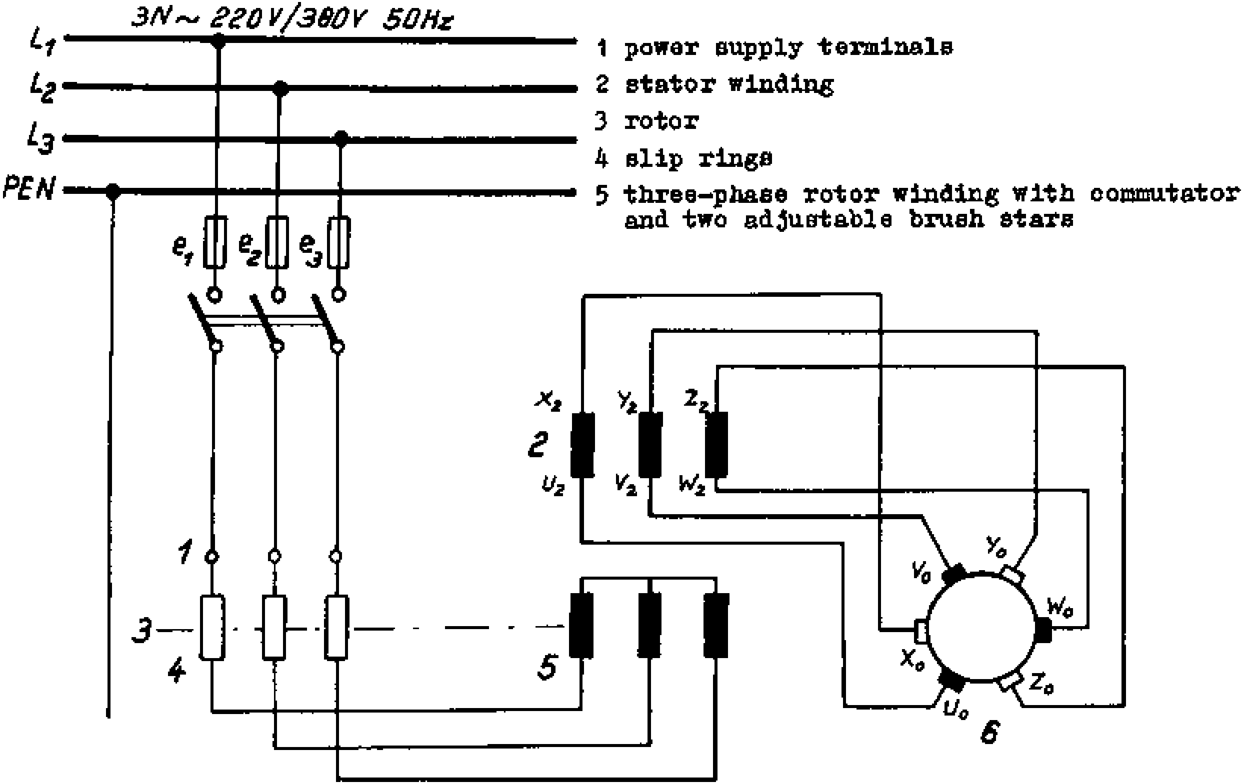

L3
PEN
e1
e2
e3
a1
e4
a2
W2
V2
U2
U1
V1
W1



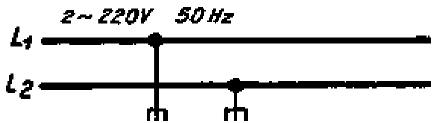
(△ 1,500 rpm, YY 750 rpm)

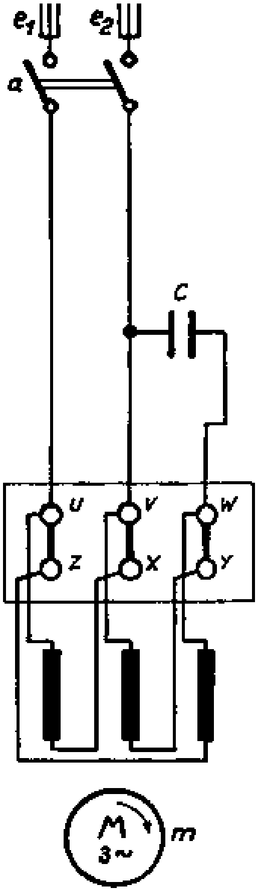
the torque for the two rotational speeds remains practically equal

Three-phase motor in “reverse Dahlander pole-changing connection”

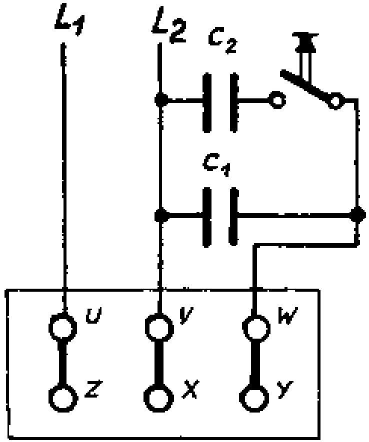


Rotor-fed three-phase shunt-wound commutator motor





Three-phase motor at the single-phase mains (A)



Three-phase motor at the single-phase mains (B)

explanations to the wiring diagram
c_1 operating capacitor, c_2 starting capacitor

Frequently it is necessary to connect three-phase not ors to single-phase mains. In this connection, the following disadvantages must be taken into account. The rated output (see rating plate) will be reduced to 80 % to 65 %.

The rated torque will be reduced to 30 %.

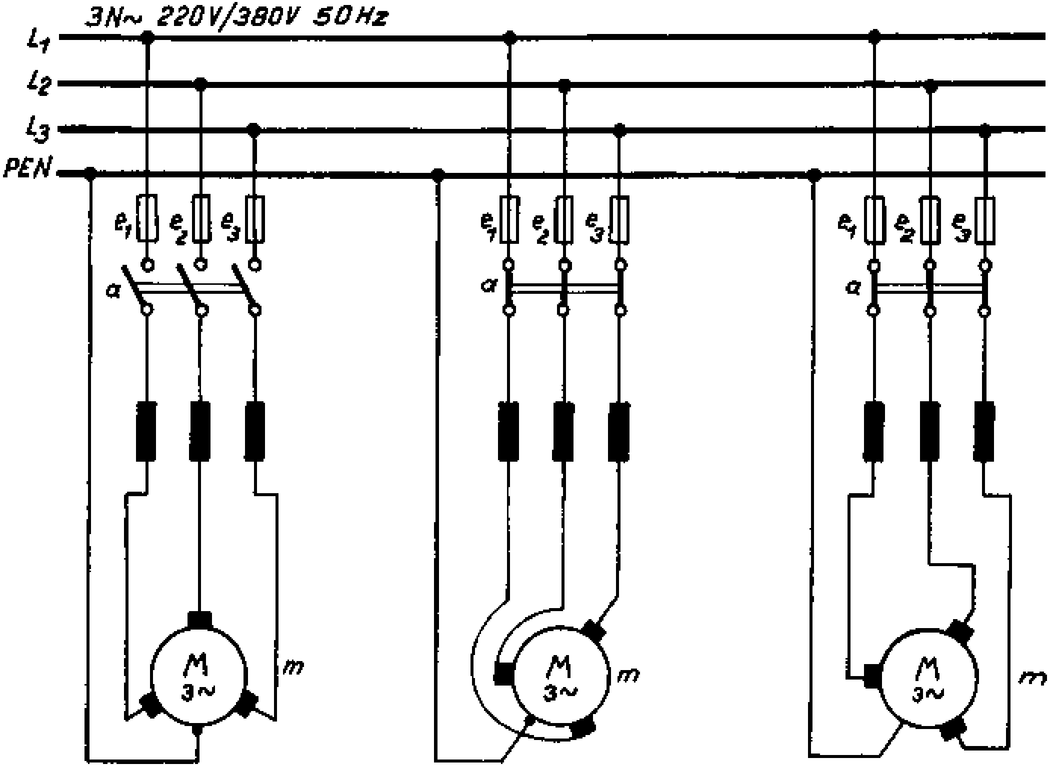
The output or power can be calculated according to the following equation:

$$C = \frac{P.10^9}{U^2.2\pi f}$$

C = capacity of the capacitor in μF
P = power in kW
U = voltage in V
f = frequency

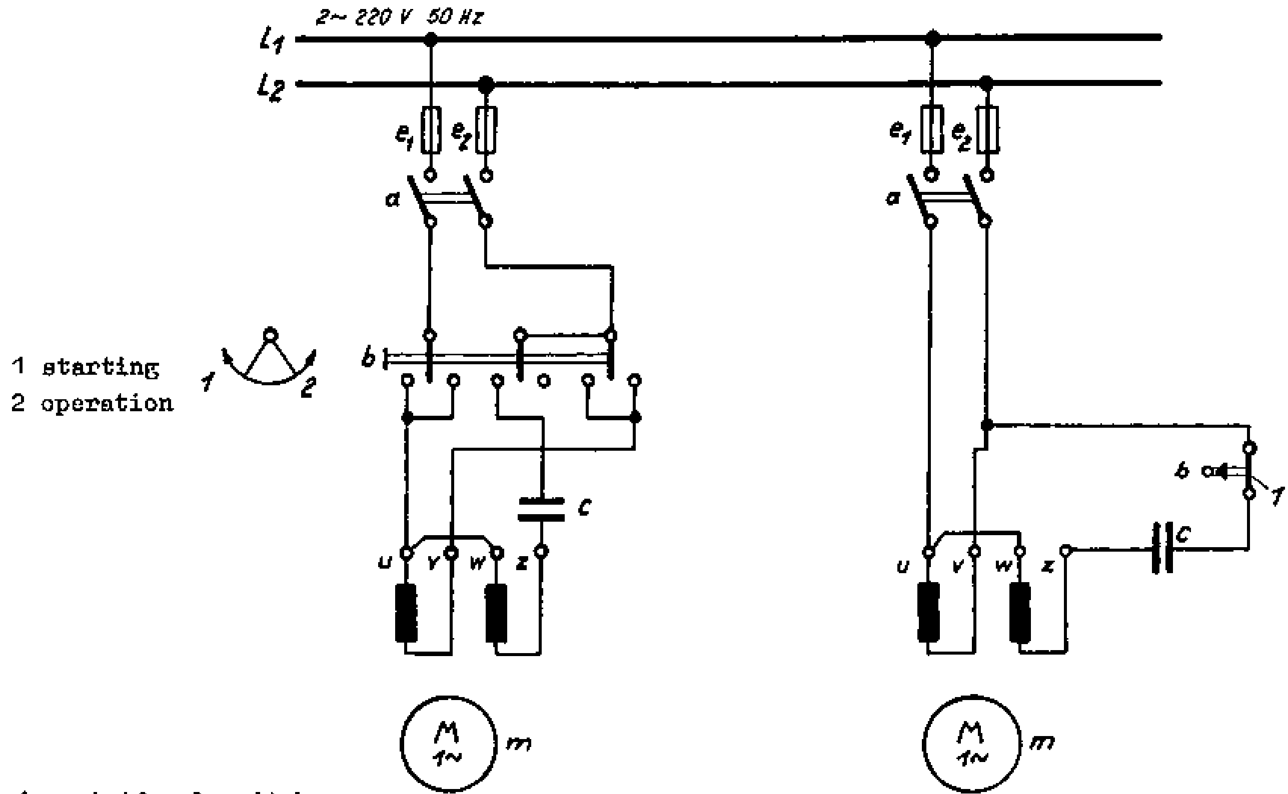
The following approximate values can be assumed when connecting to single-phase alternating current of 220 V:

Power (kW)	Capacity of the Capacitor
0.10	7
1.00	50
2.00	100



Three-phase series commutator motor

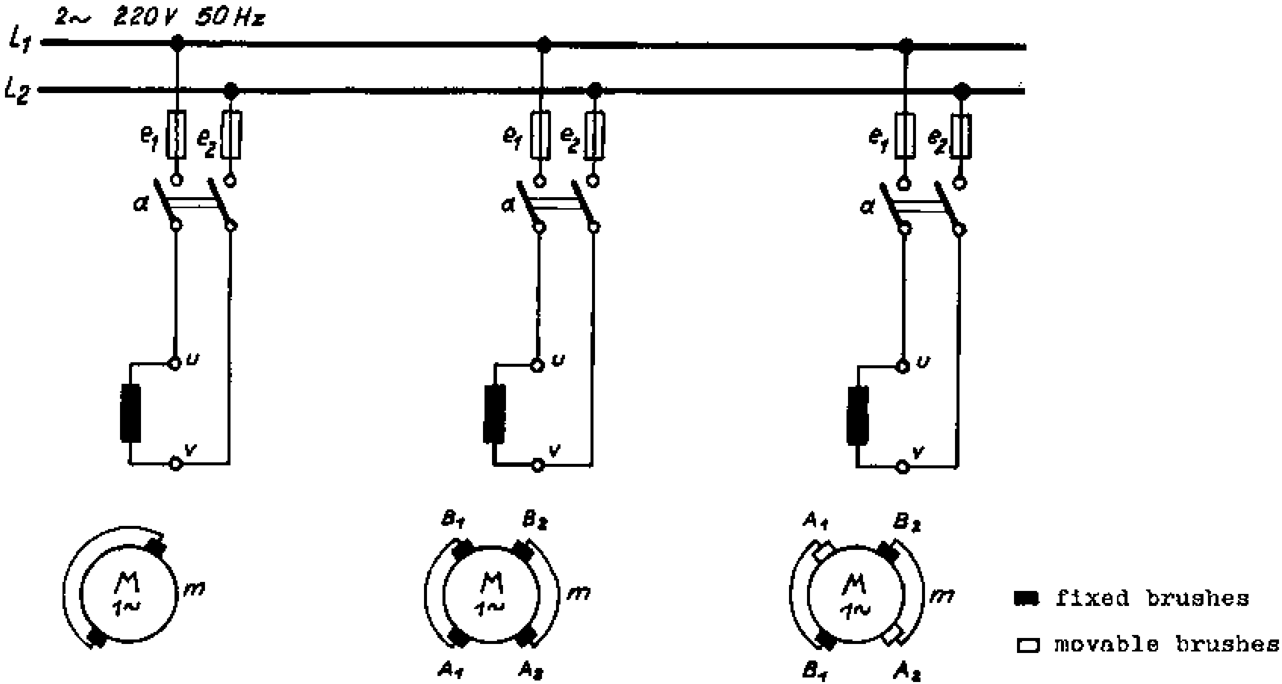
1 OFF position
2 starting, operation
3 braking



1 centrifugal switch

After reaching the rated speed, the centrifugal switch will switch off the auxiliary phase W - Z.

Single-phase capacitor motor with auxiliary phase

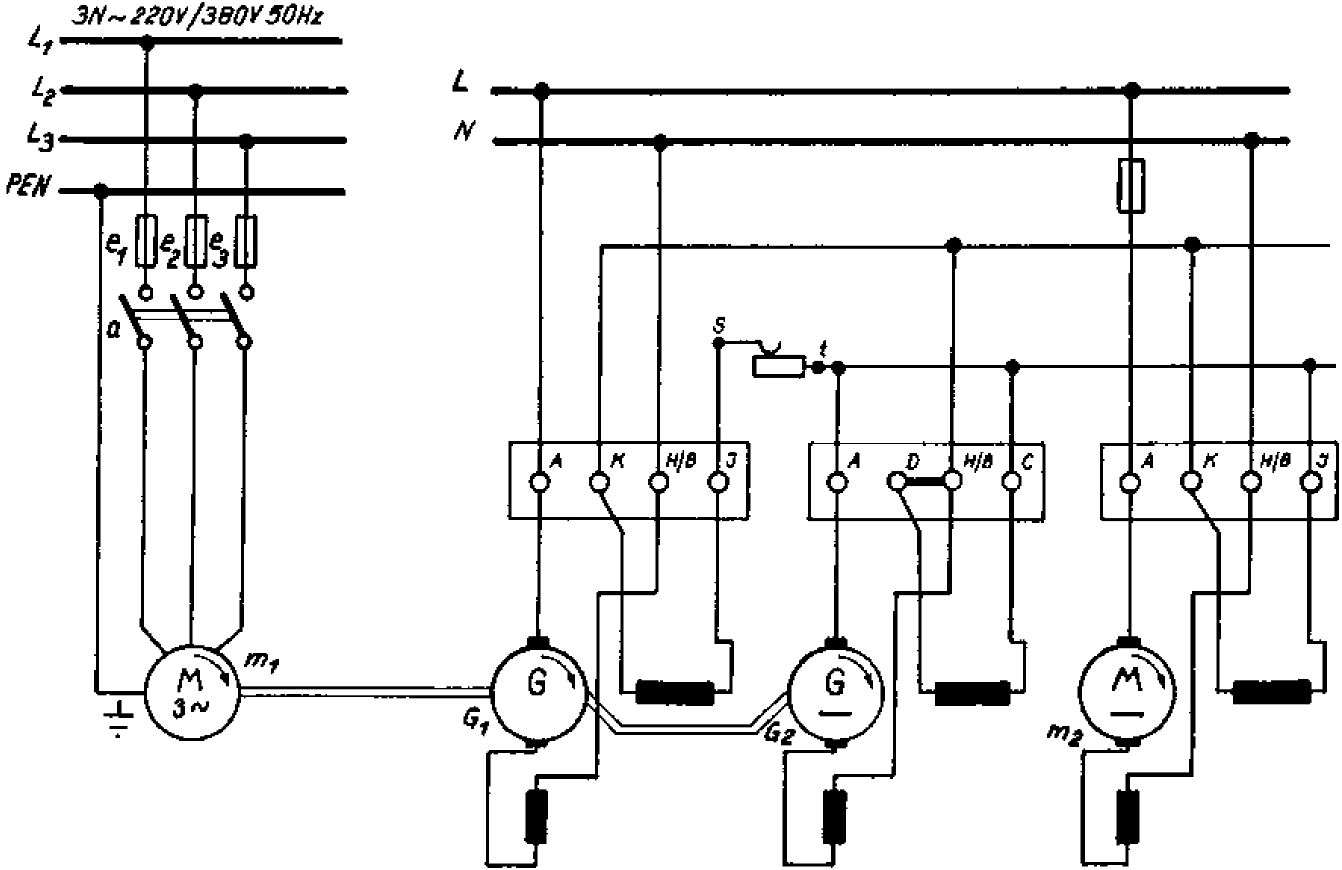


circuit with diameter brushes

circuit with double-frame brushes

circuit of the Deri motor

Repulsion motor



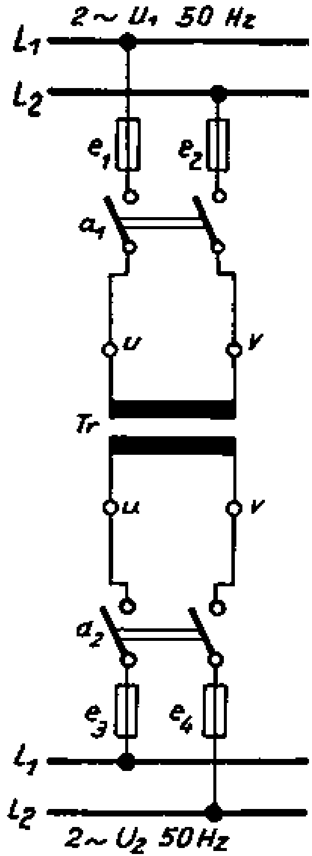
driving motor control generator exciting generator

Ward-Leonard Control low-loss speed adjustment at the direct-current motor

(General wiring diagram)

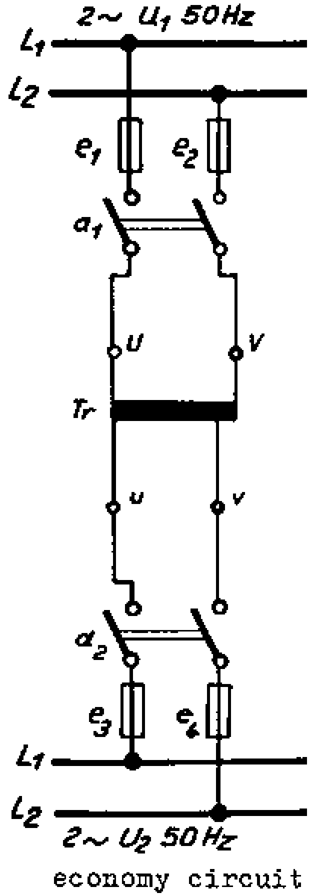
4.3. Transformers

4.3.1. Single-phase Transformers



normal circuit

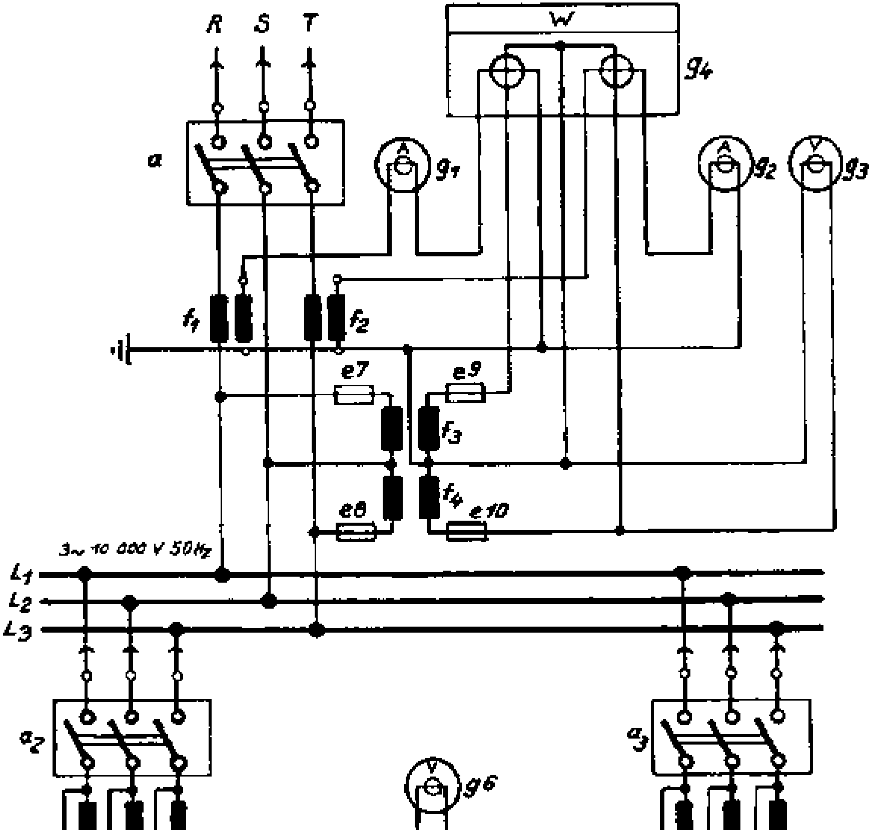
normal circuit

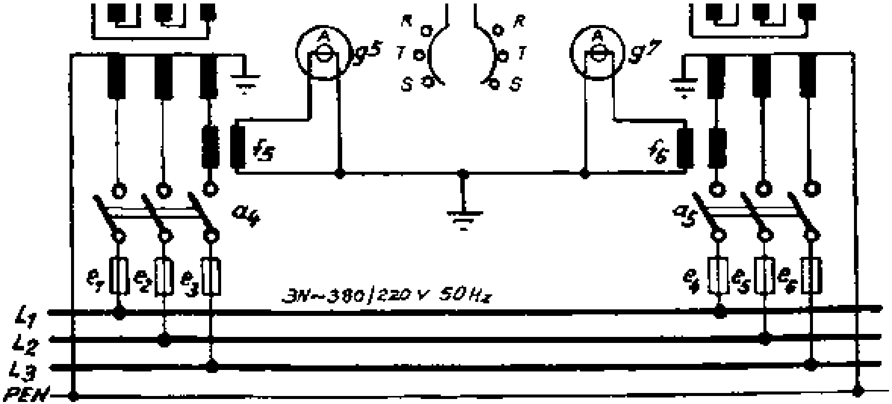


economy circuit

4.3.2. Three-phase Transformers

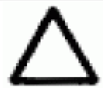
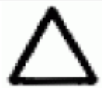
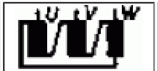
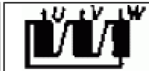
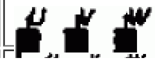
Three-phase transformers in parallel connection

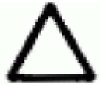
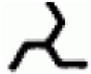
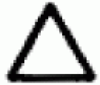
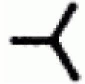
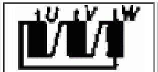
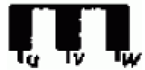
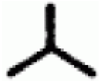
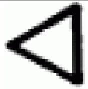
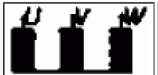
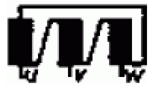
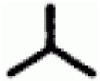
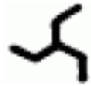
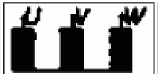
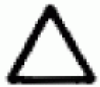
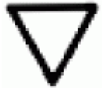
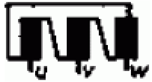
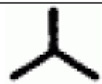
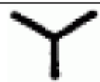
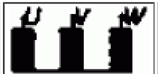
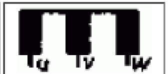
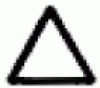
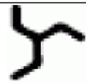
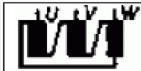
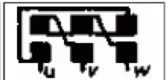
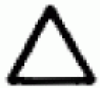
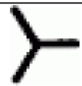
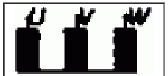
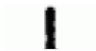
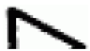


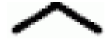
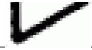
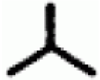
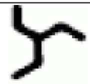
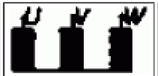
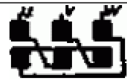
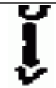
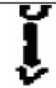
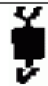


Transformer station with two transformers connected in parallel

Usual groups of connection for transformers

Designation		**Indicator Diagram**		**Circuit Diagram**		
Identification number	**Group of connection**	**High Voltage**	**Lower Voltage**	**High Voltage**	**Lower Voltage**	**Transformation**
Three-phase power transformers						
	Dd 0					$\frac{W_1}{W_2}$
0	*Yy 0*					W_1

	Dz 0					$\frac{2w_1}{3w_2}$
	Dy 5					$\frac{w_1}{\sqrt{3}\,w_2}$
5	*Yd 5*					$\frac{\sqrt{3}\,w_1}{w_2}$
	Yz 5					$\frac{2\,w_1}{\sqrt{3}\,w_2}$
	Dd 6					$\frac{w_1}{w_2}$
6	*Yy 6*					$\frac{w_1}{w_2}$
	Dz 6					$\frac{2w_1}{3w_2}$
	Dy 11					$\frac{w_1}{\sqrt{3}\,w_2}$
11	*Yd 11*					$\sqrt{3}\,w_1$

						$\frac{}{w_2}$
	Yz 11					$\frac{2\,w_1}{\sqrt{3}\,w_2}$
Single-phase power transformers						
						$\frac{w_1}{w_2}$

Explanations for the table

The table shows the commonly used circuits according to the relevant Standard of the International Electrotechnical Commission (I E C). When multiplying the identification number by 30°, the phase shift of the high voltage side with respect to the lower voltage side is obtained.

Dd 6 means:

D = high voltage side delta connection
d = lower voltage side delta connection

The lower voltage is shifted with respect to the high voltage by 6 x 30° = 180°.

Due to these different circuits, different operational behaviour is attained.

The ratio of transformation is calculated as follows:

$$ü = \frac{w_1}{w_2} = \frac{U_1}{U_2}$$

$$\frac{U_1}{U_2} = \frac{I_2}{I_1}$$

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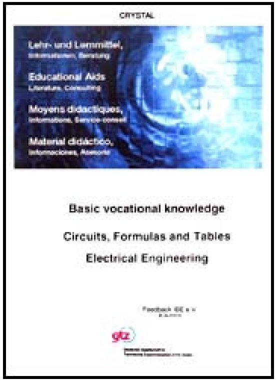


Impulse Relay

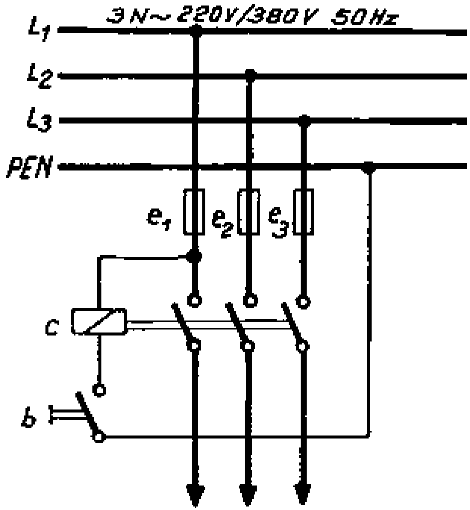
Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

5. Contactor Circuits

5.1. Types of Excitation of the Control

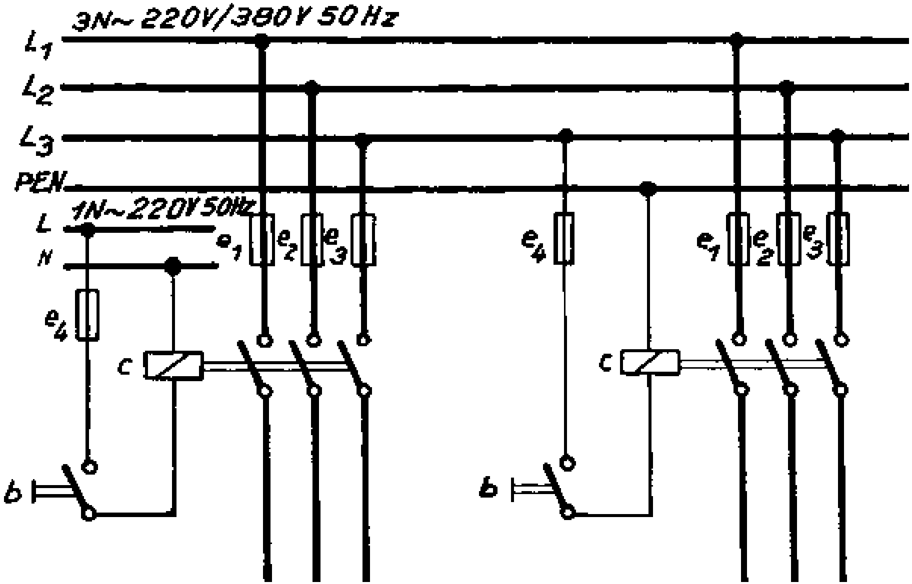
Self-excitation

Advantage: no-voltage characteristic



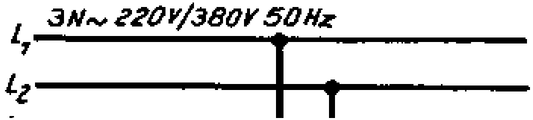
Figure

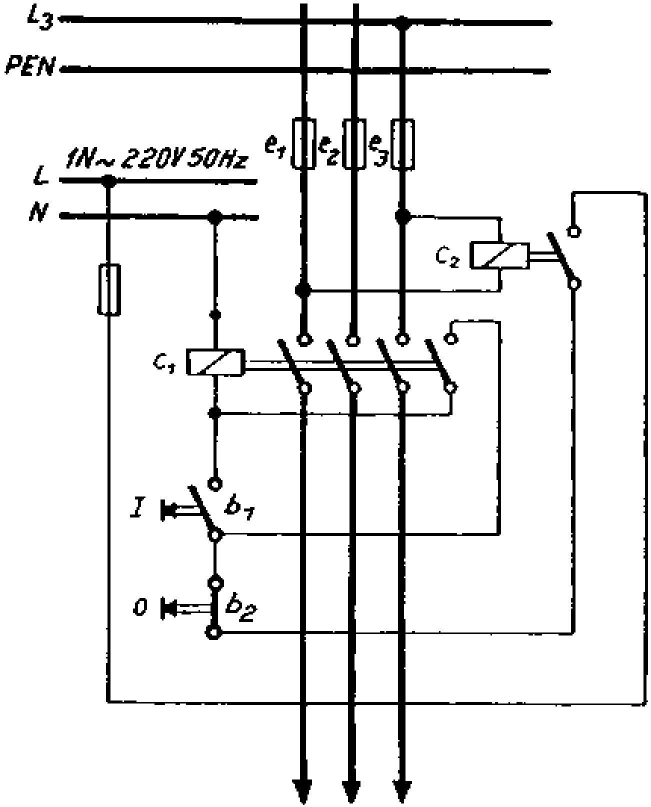
Separate excitation



Figure

The contactor circuits are provided with permanent contact making





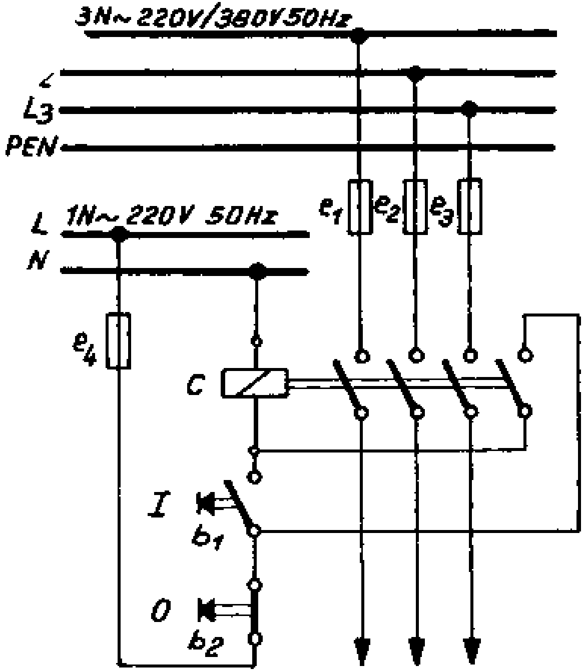
C_1 main contactor, C_2 control current locking contactor (when voltage is applied to C_2, the maker of the contactor is closed)

I ON key, 0 OFF key

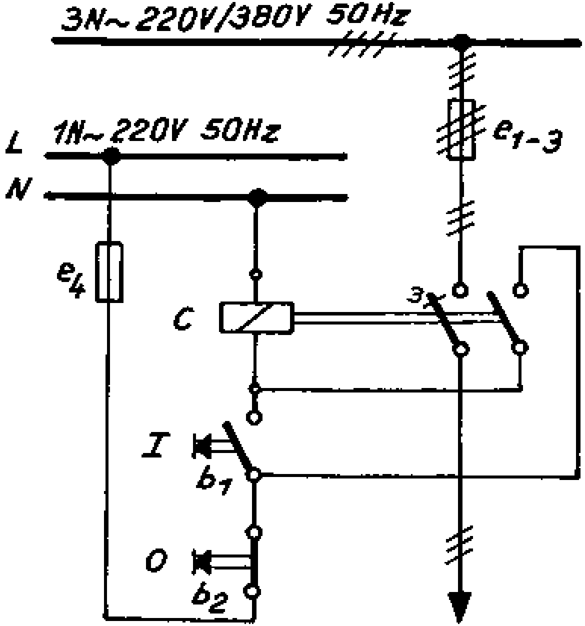
Control current locking

Advantage: By means of the control current locking contactor, no-voltage characteristic is attained in separately excited contactor circuits.

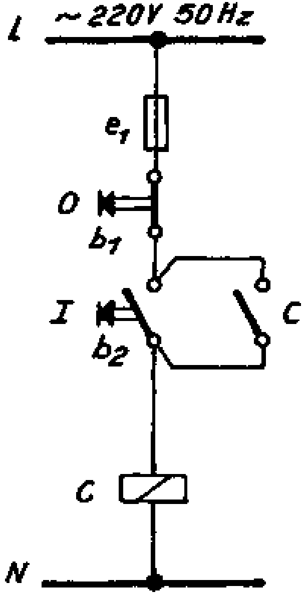
5.2. Possibilities of Representing Contactor Circuits



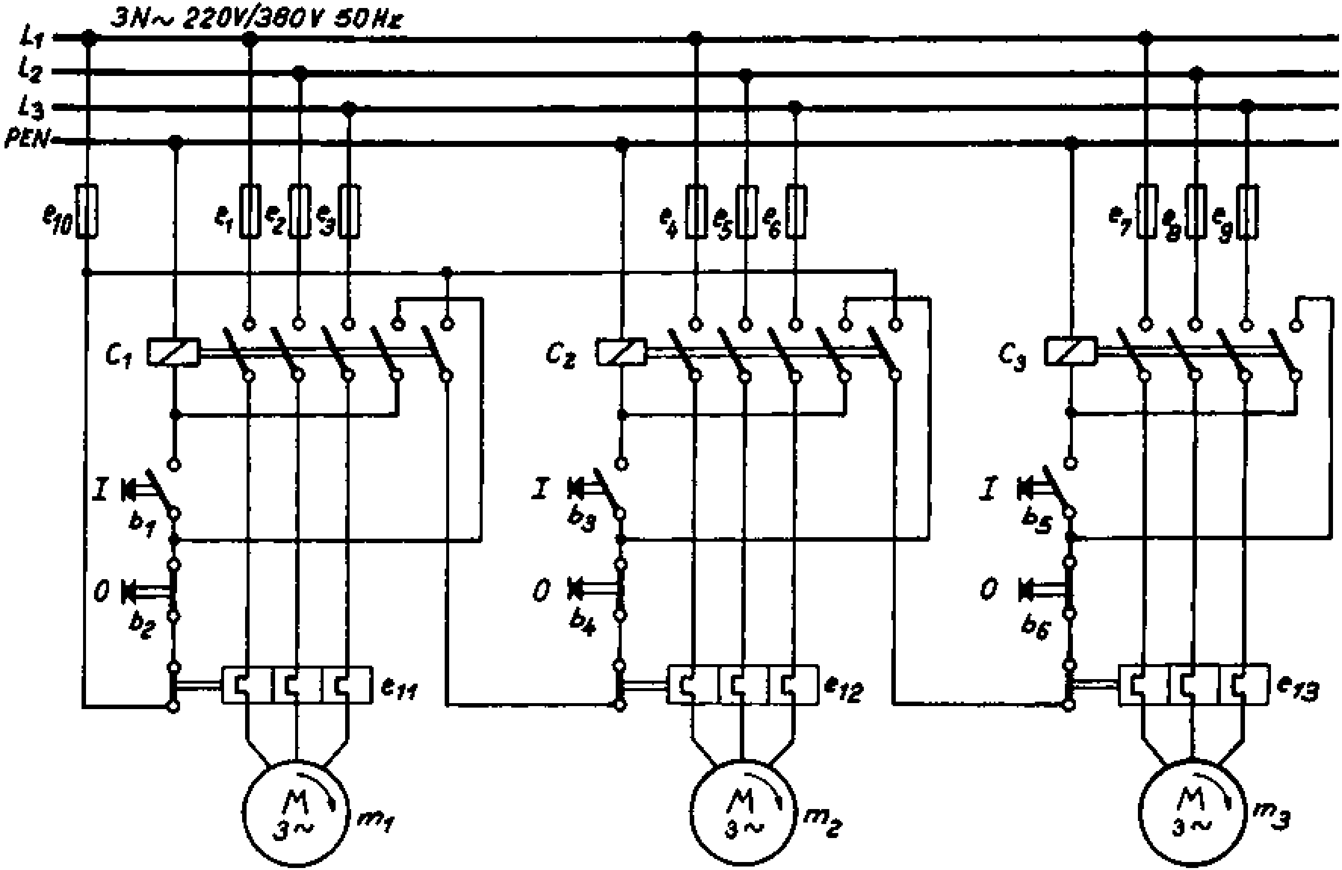
pulse contact making functional diagram



mixed representation - main circuit (single-pole); control circuit (all-pole)

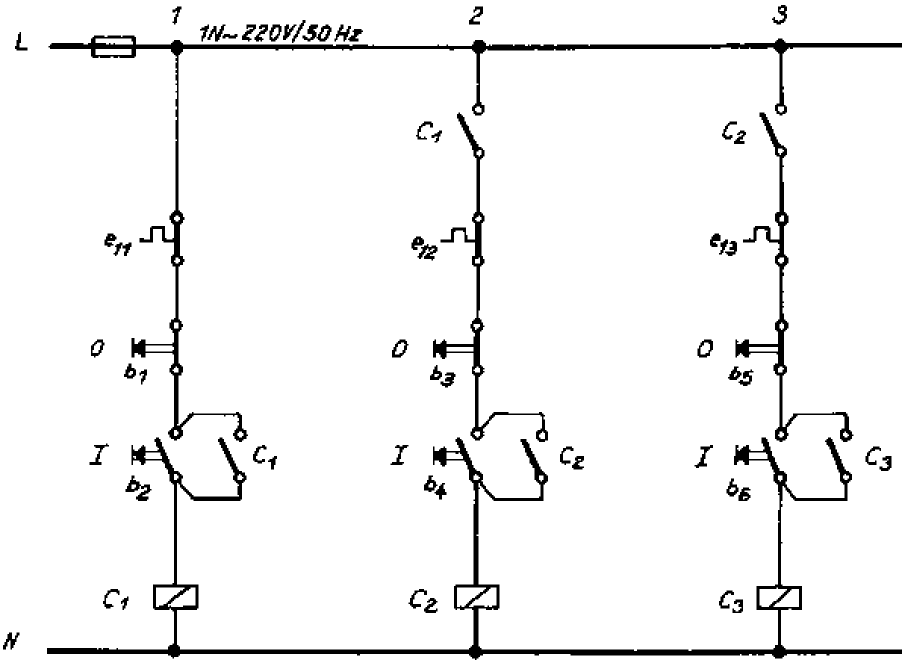


control circuit - shown in the form of a circuit diagram



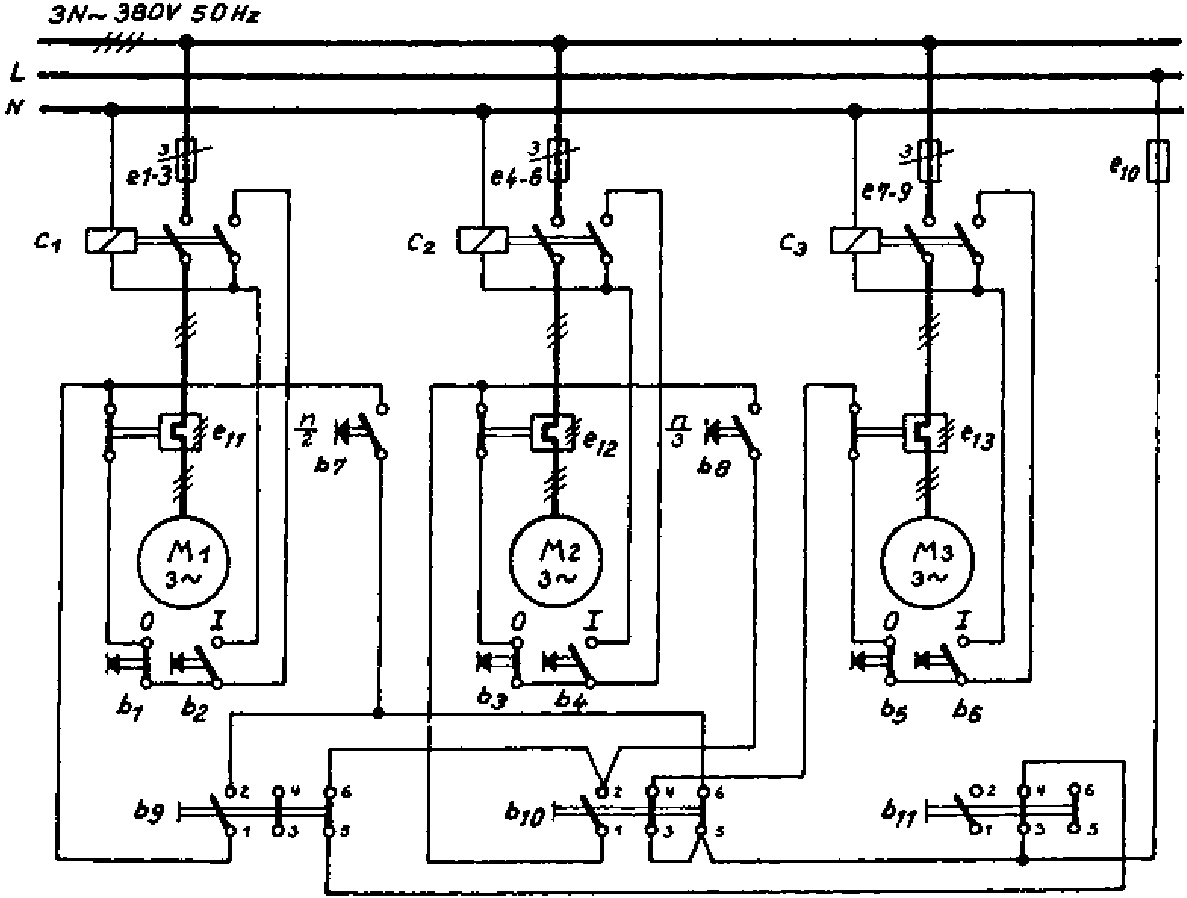
sequential circuit functional diagram

sequential circuit - functional diagram



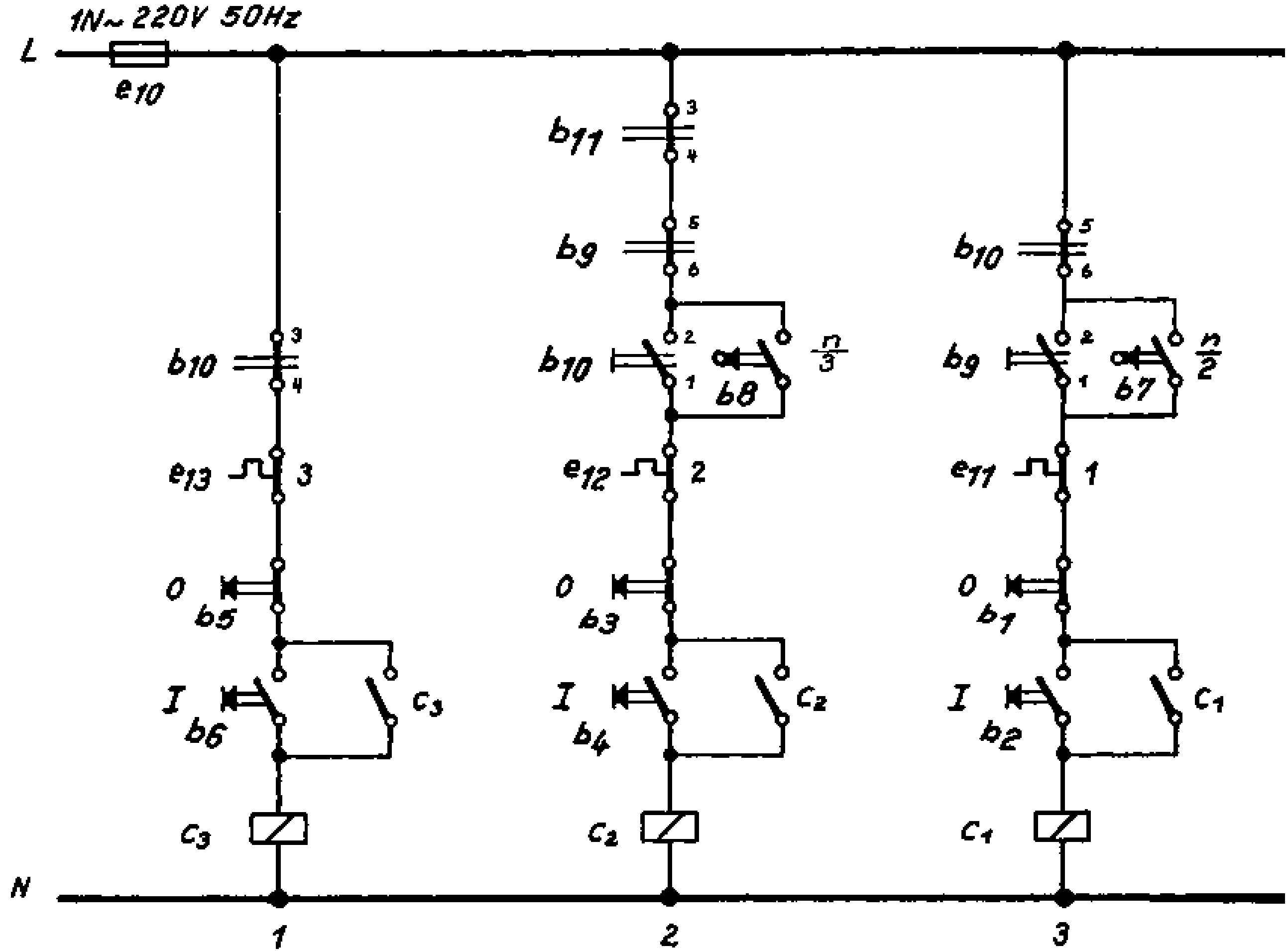
Switching-on only possible in the sequence of C_1, C_2, C_3;
when C_1 drops, C_2 and C_3 must also drop.

Circuit diagram for the control of the sequential circuit



b 9 - b 11 unlocking switches

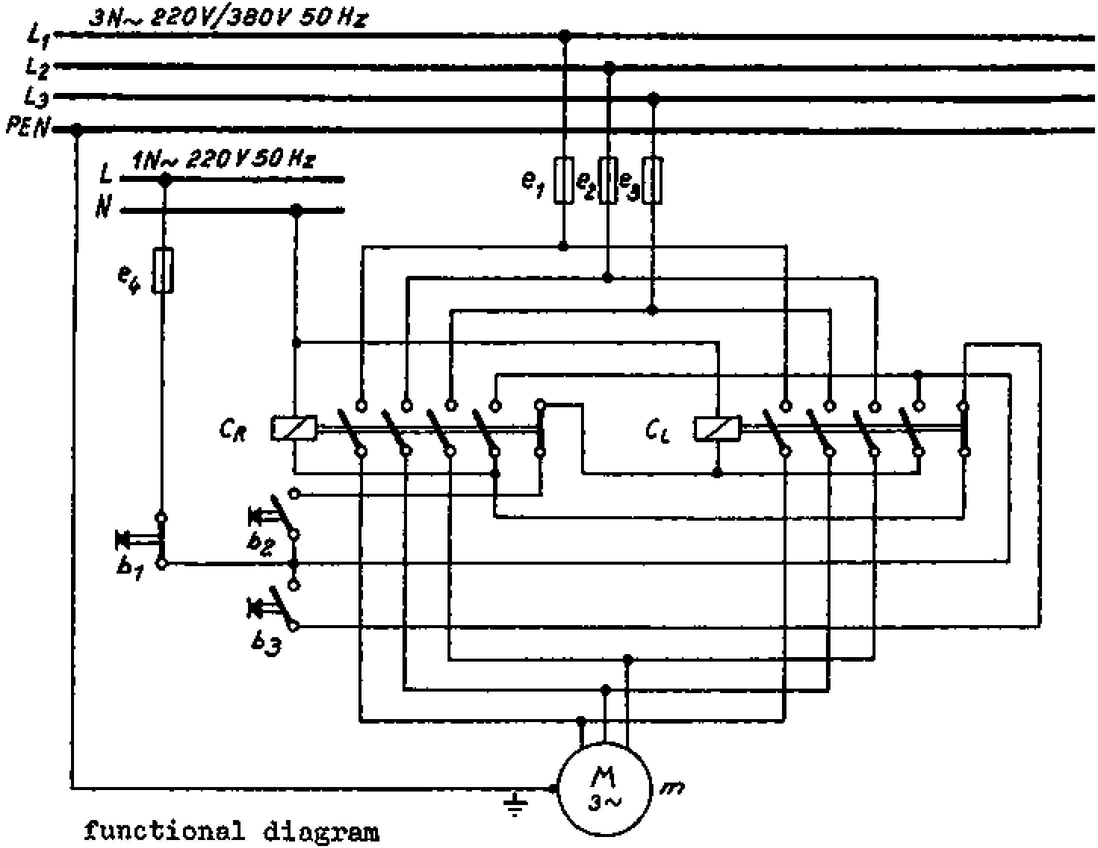
Sequential circuit with rotation monitors and unlocking switches



1N~ 220V 50Hz
L
e10
N
b11
3
4
b9
5
6
b10
3
4
e13
3
0
b5
I
b6
c3
c3
b10
2
1
b8
n/3
e12
2
0
b3
I
b4
c2
c2
b10
5
6
b9
2
1
b7
n/2
e11
1
0
b1
I
b2
c1
c1
1
2
3

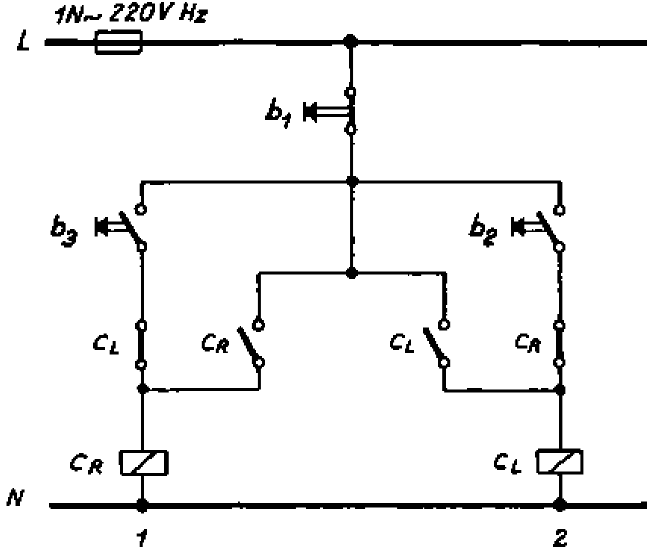
Circuit diagram for the sequential circuit with rotating monitors and unlocking switches

5.3. Reversing Contactor Circuits



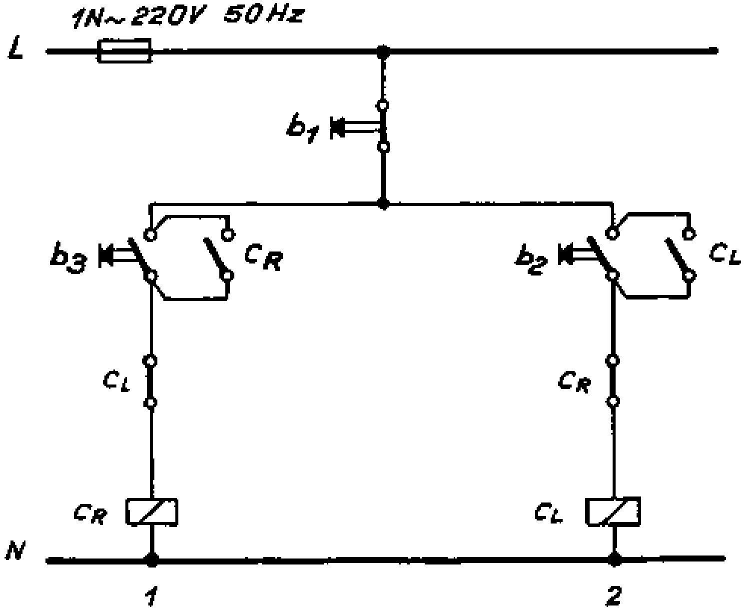
functional diagram

control current - pulse locking

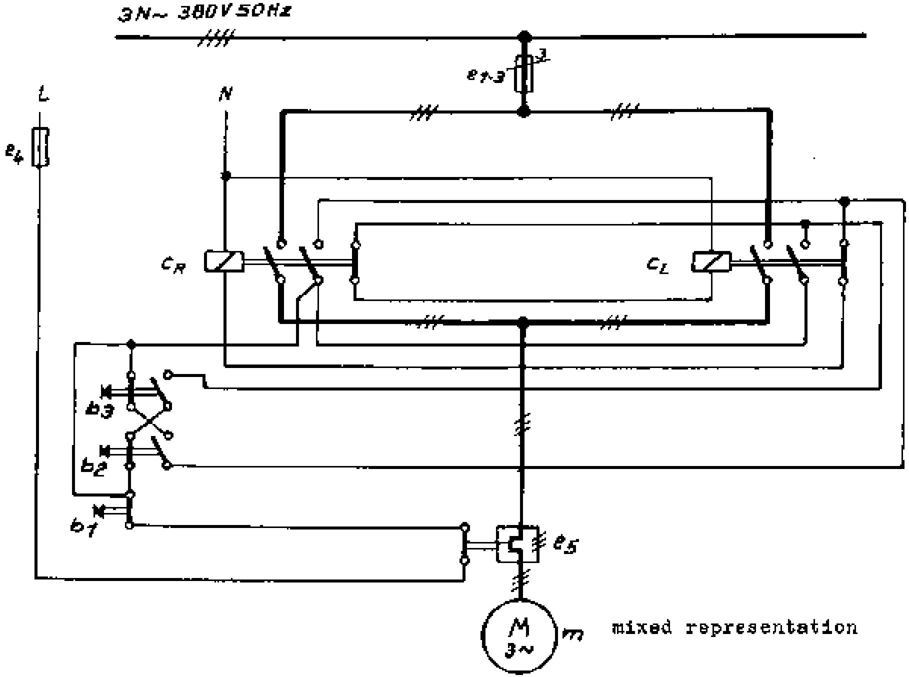


Circuit diagrams for reversing contactor circuits (pulse locking)

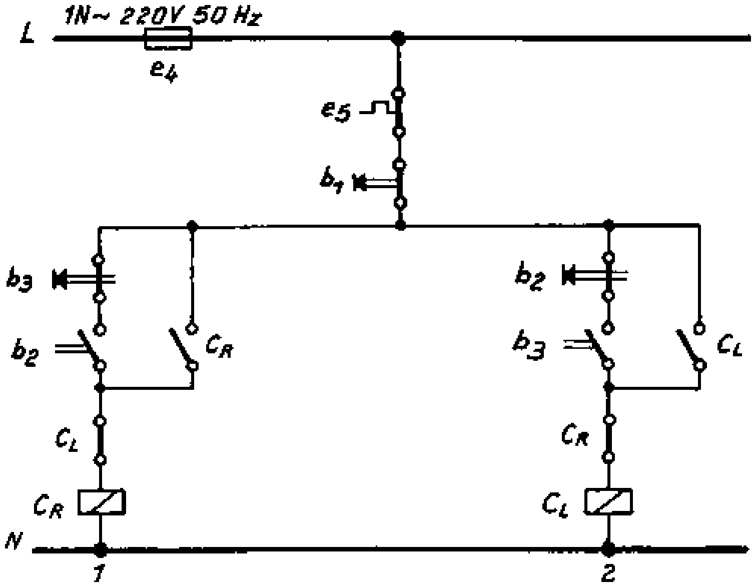
To be used for single drives only, circuit is not safe!



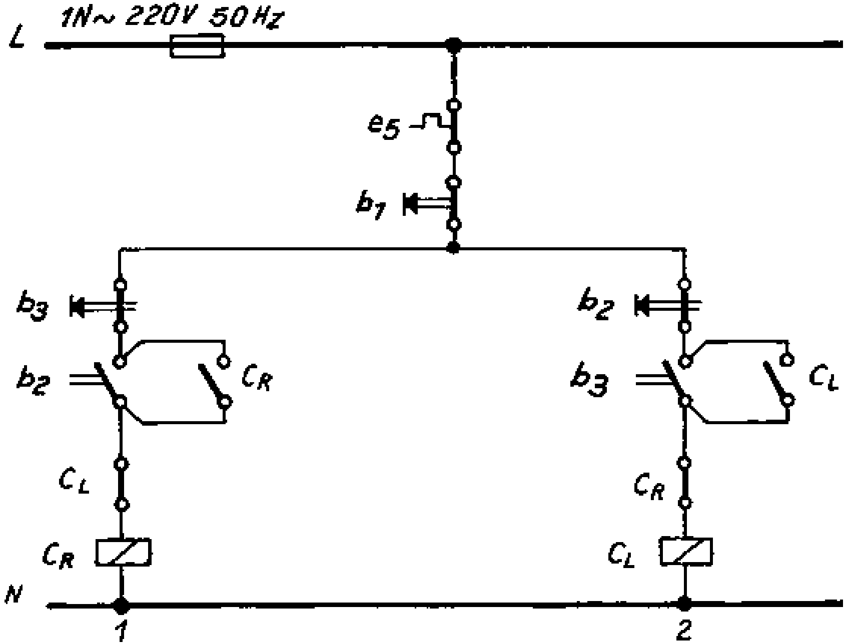
Circuit diagrams for reversing contactor circuits (pulse and holding current locking)



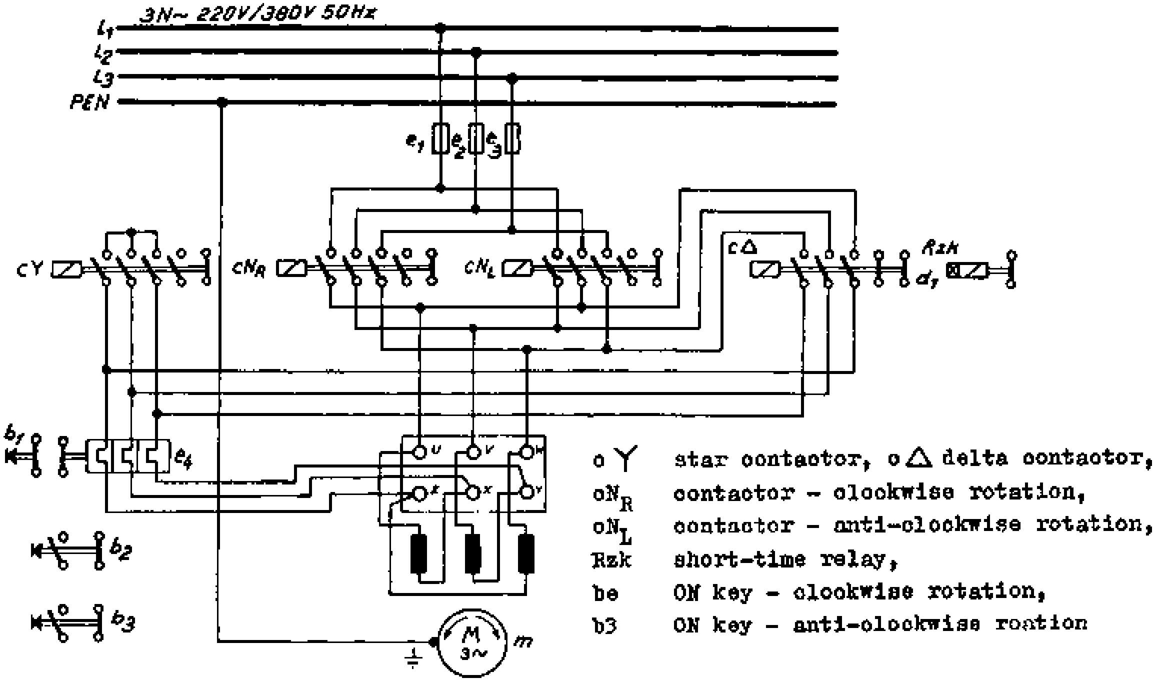
reversing contactor circuit - push - button locking



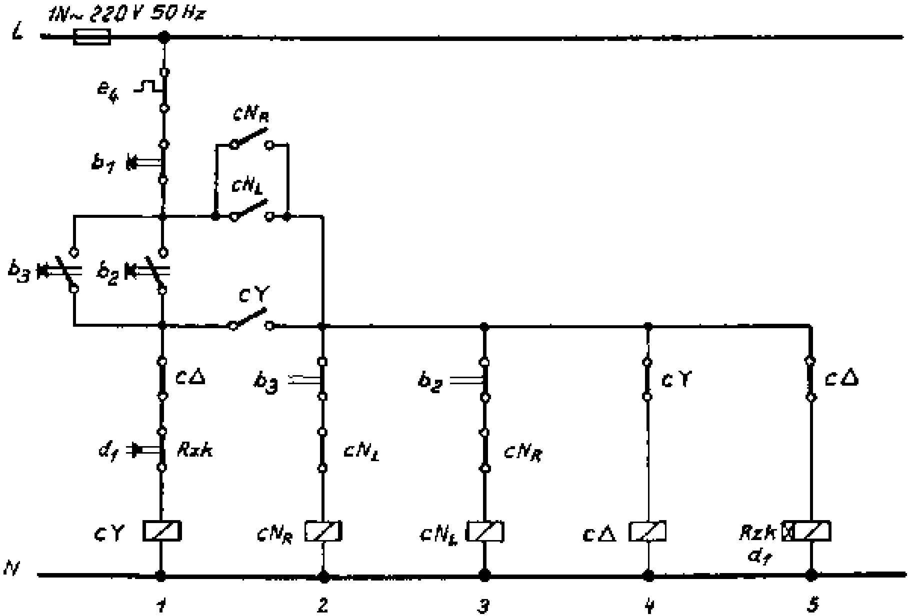
Circuit diagrams for reversing contactor circuits (Push-button locking)



Circuit diagrams for reversing contactor circuits (Push-button locking arranged as rapid change-over circuit; suitable for smaller motors only)

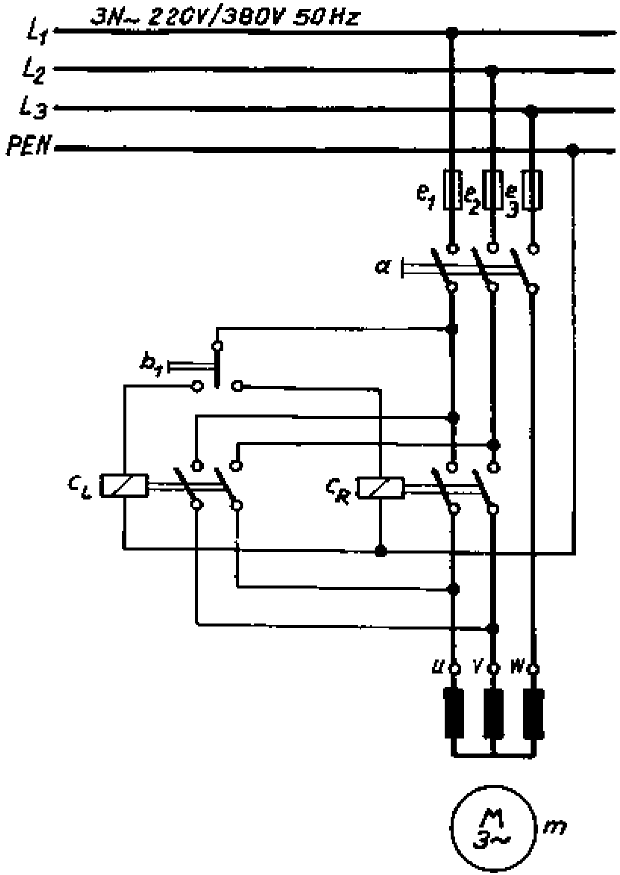


Reversing contactor circuit with star-delta starting main circuit

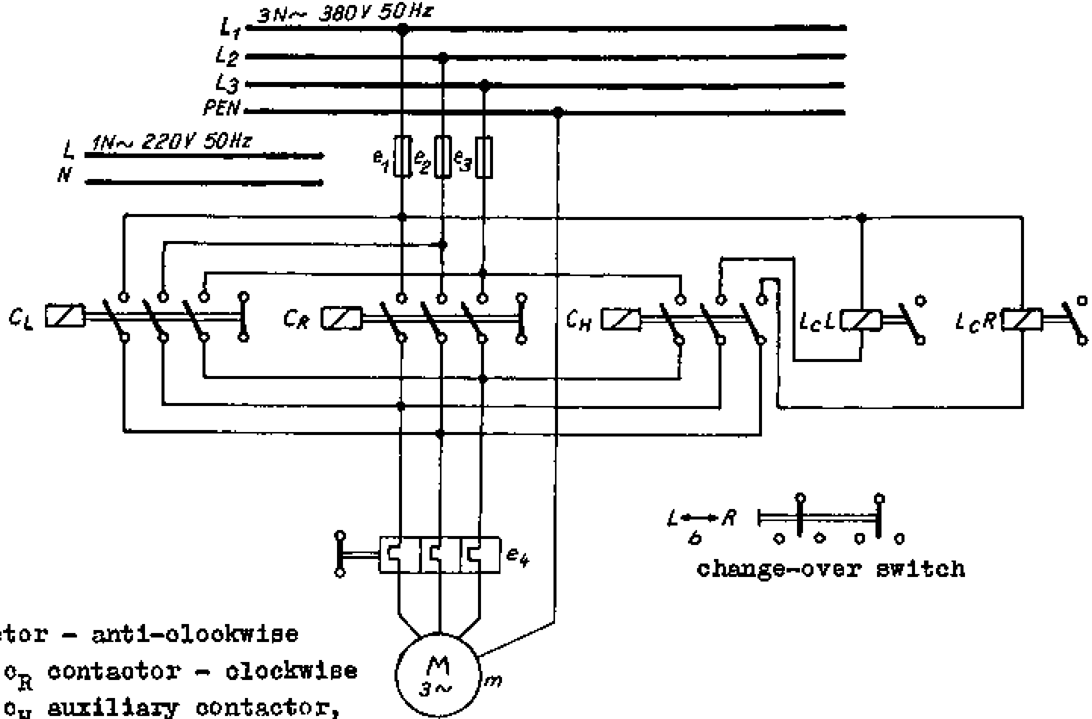


Circuit diagram for the control of the reversing contactor circuit with star-delta starting

5.4. Arc Extinguishing Circuits

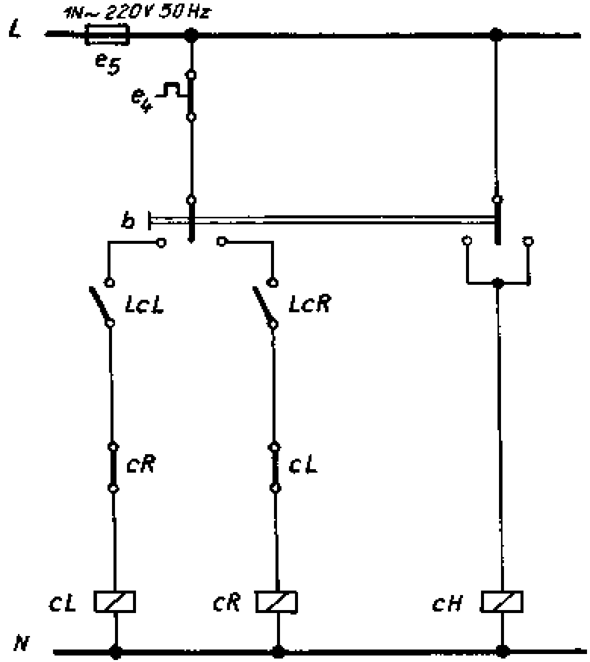


reversing contactor - rapid changing-over



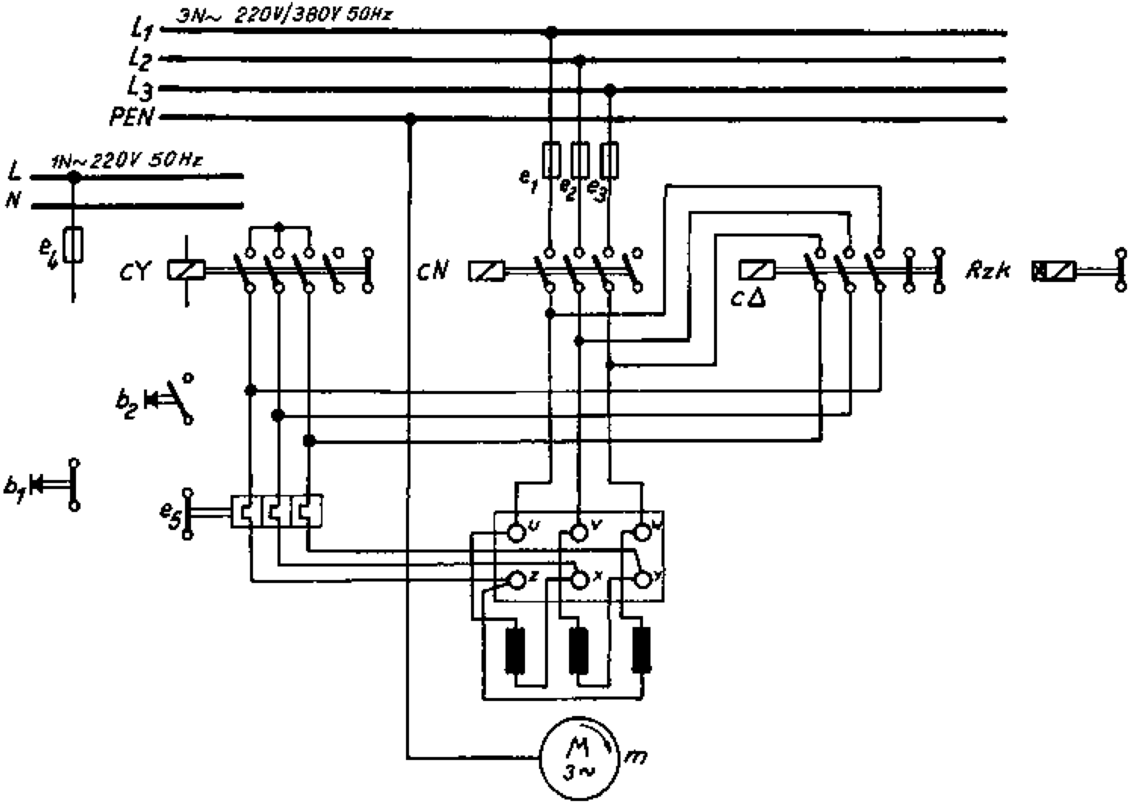
c_L contactor - anti-clockwise rotation, c_R contactor - clockwise rotation, c_H auxiliary contactor, L_cL arc blocking contactor - left-hand, L_cR arc blocking contactor - right-hand

Arc extinguishing circuit for separate excitation



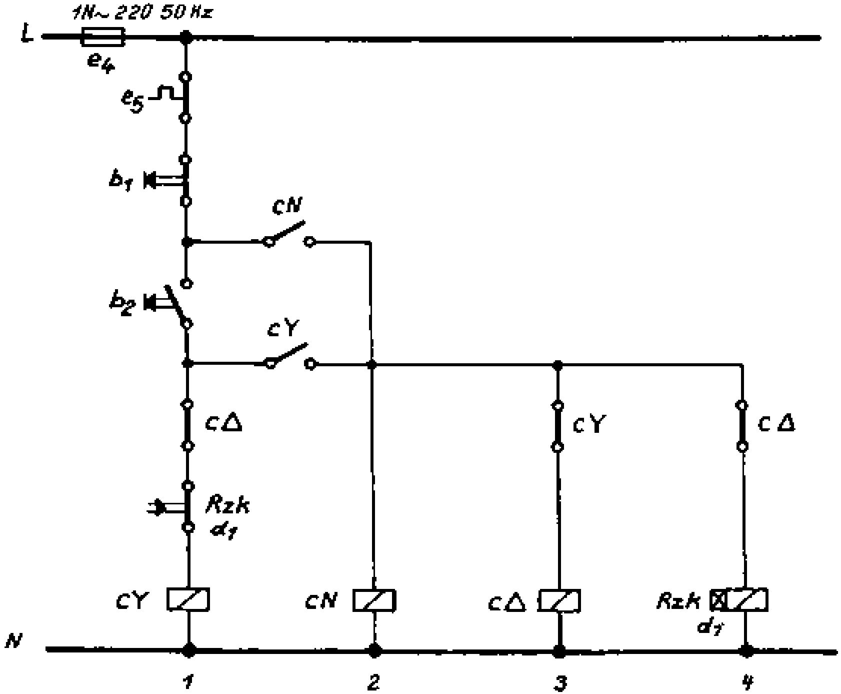
Circuit diagram for the control of the separately escited arc extinguishing circuit

5.5. Three-contactor Star-delta Connection



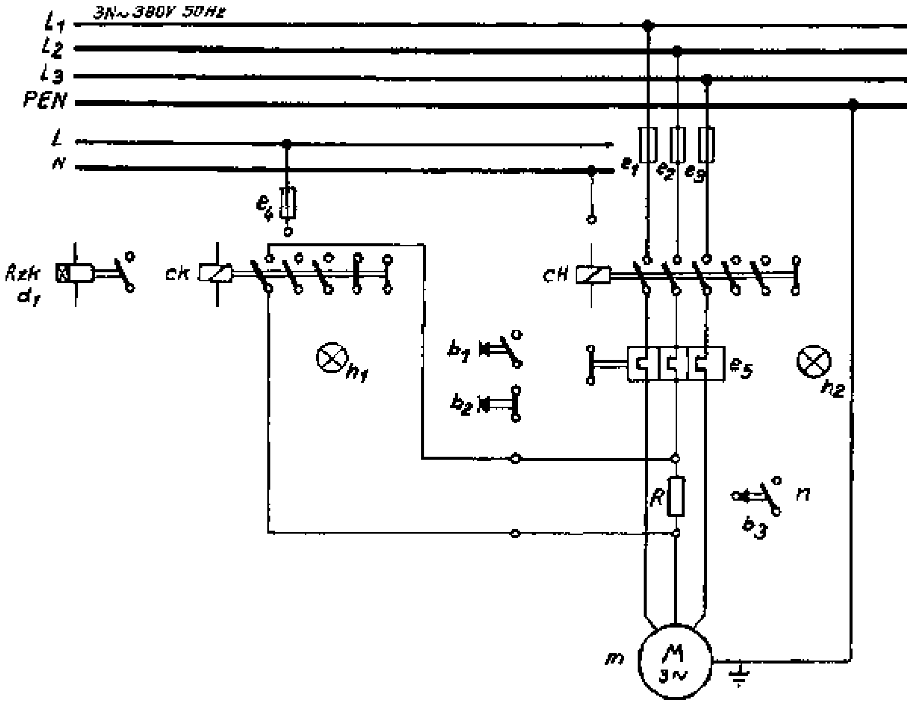
cY star contactor, cN mains contactor, cΔ delta contactor,
RzK short-time relay

main circuit



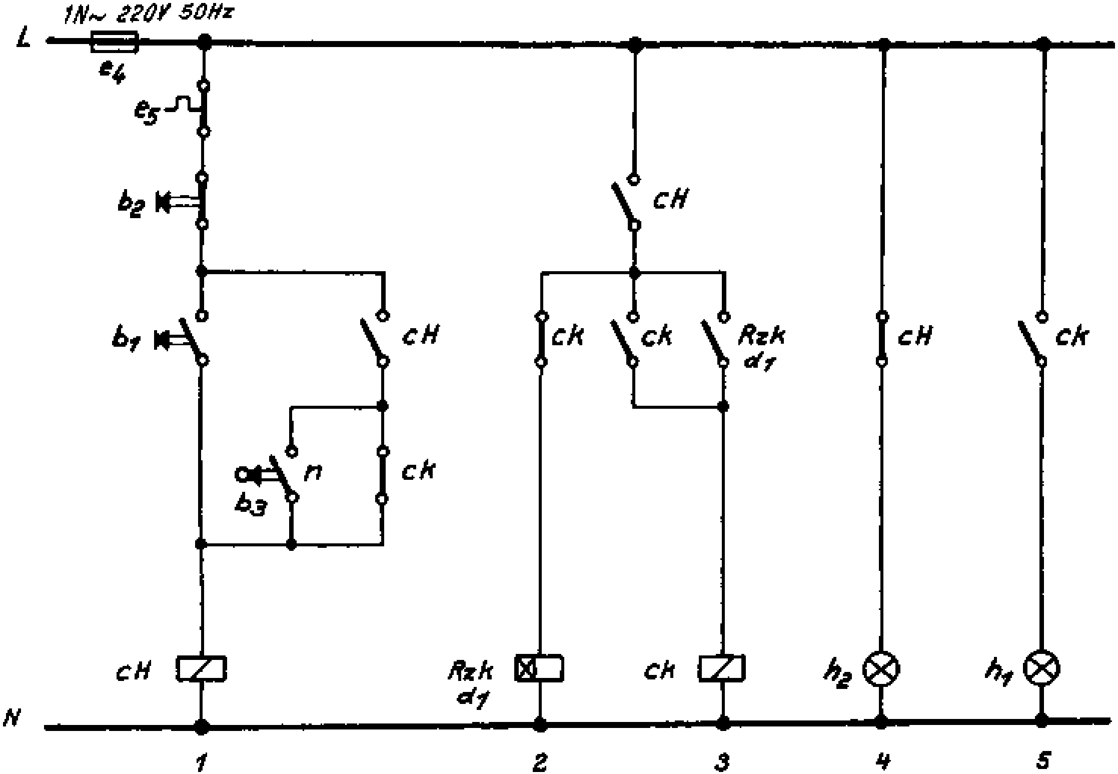
Circuit diagram for the control of the three-contactor star-delta connection

5.6. Squirrel-cage Induction Motor



RzK short-time relay, cK contactor for short-circuiting of the effective resistance, cH main resistor

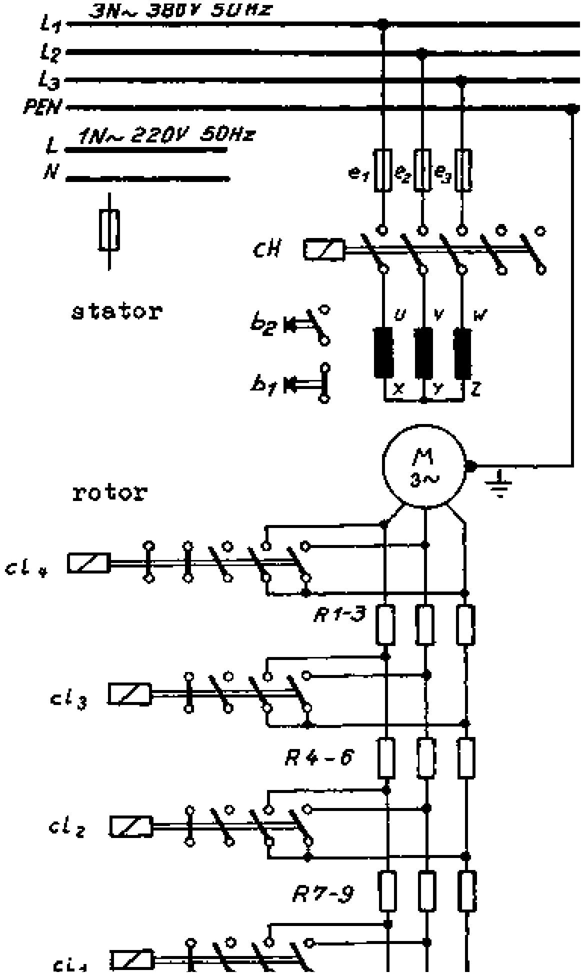
with effective resistance for starting in the stator and self-monitoring (unsymmetric circuit)

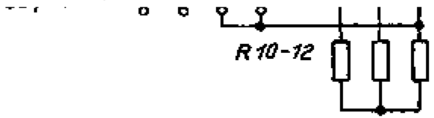


Circuit diagram for the control of the starting action with effective resistance

5.7. Sliping Rotor

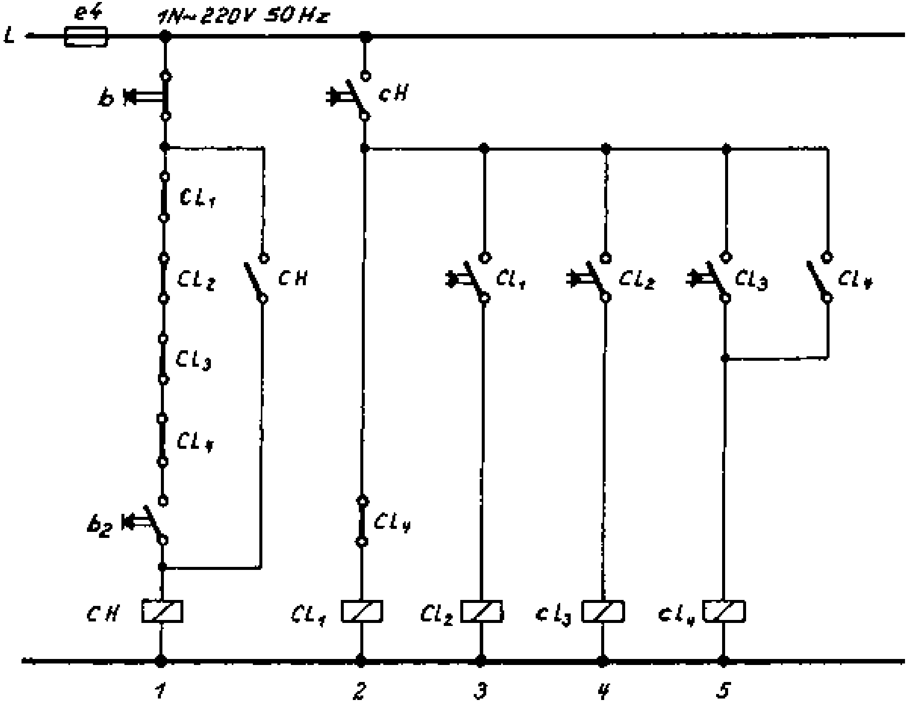
main circuit


3N~ 380V 50Hz
L1
L2
L3
PEN
1N~ 220V 50Hz
L
N
e1
e2
e3
cH
stator
b2
b1
U
V
W
X
Y
Z
M
3~
rotor
cl4
R1-3
cl3
R4-6
cl2
R7-9
cl1



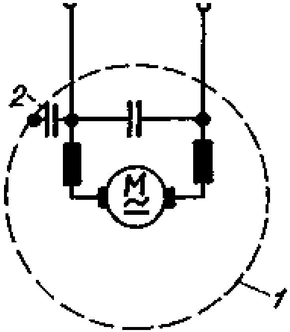
cL = rotor contactor

with rotor contactor starter



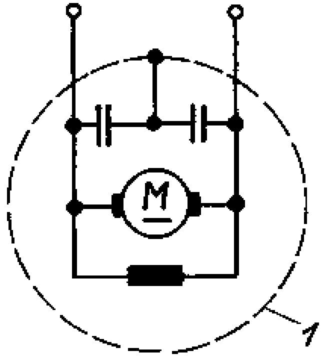
Circuit diagram for the control of the slip-ring rotor with rotor starter

5.8. Interference Suppression



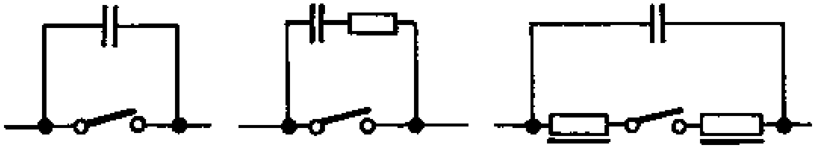
1 housing, 2 shock-protection capacitor

Interference suppression of a universal motor

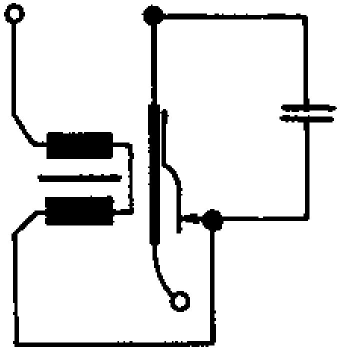


1 housing

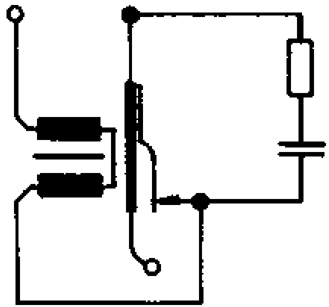
Interference suppression of a direct-current shunt motor



Interference suppression of switch gears

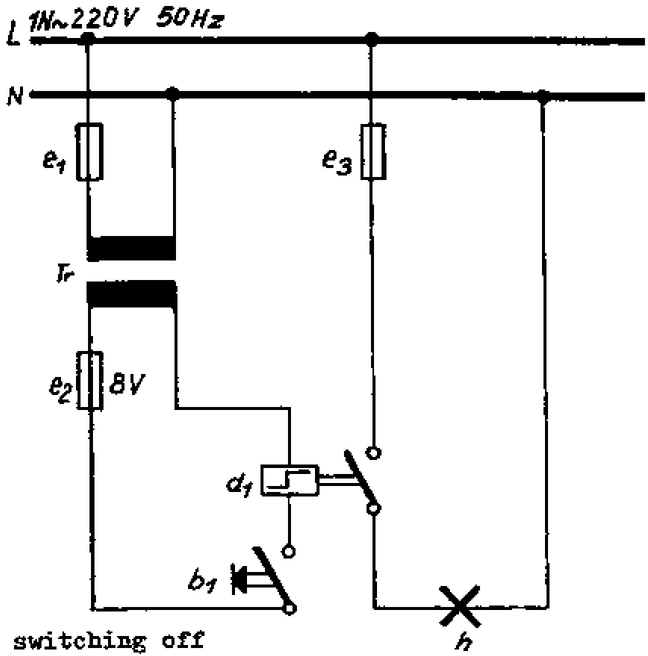


Interference suppression of electric bells (A)

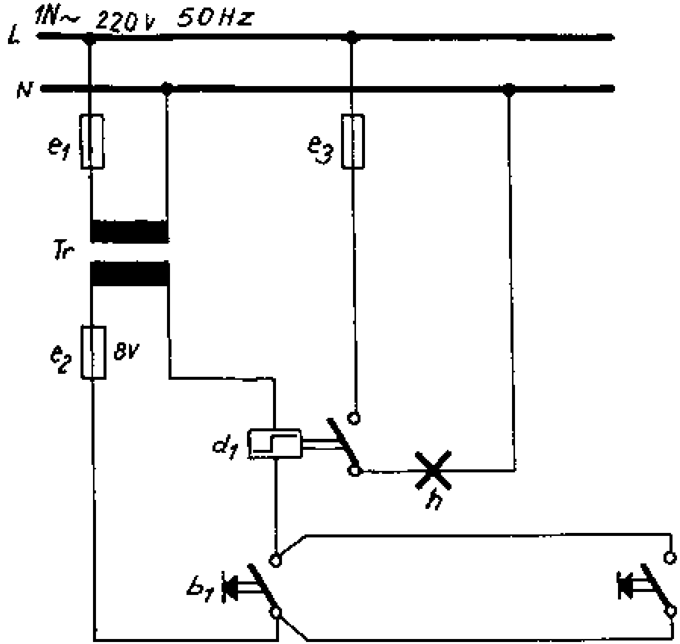


Interference suppression of electric bells (B)

5.9. Light-current Controlled Power Plant with Impulse Relay

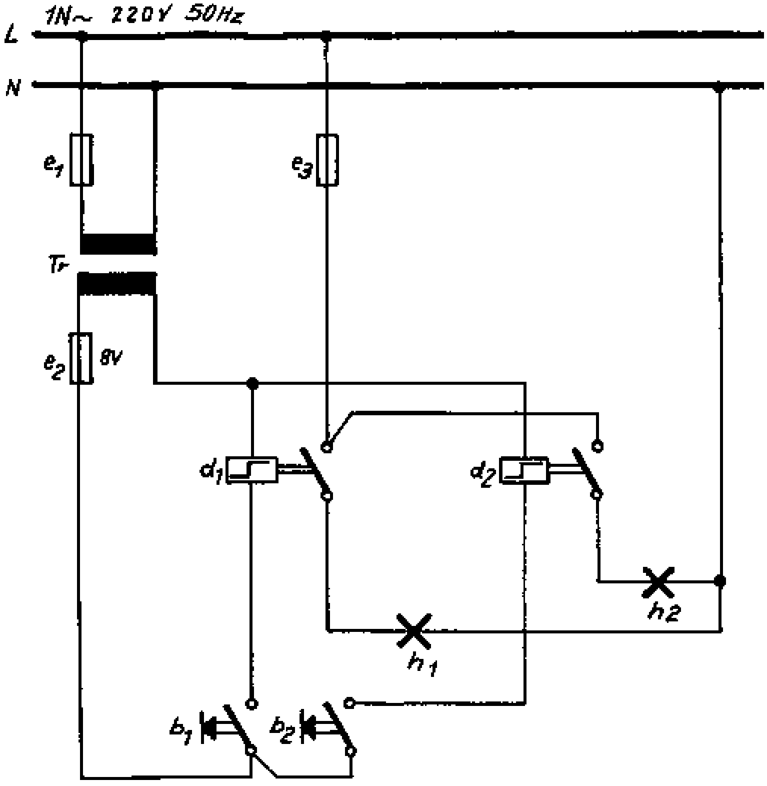


Figure

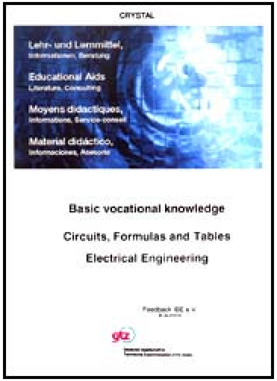


two-way switching

Figure


1N~ 220V 50Hz
L
N
e1
e3
Tr
e2
8V
d1
d2
h2
h1
b1
b2
series connection

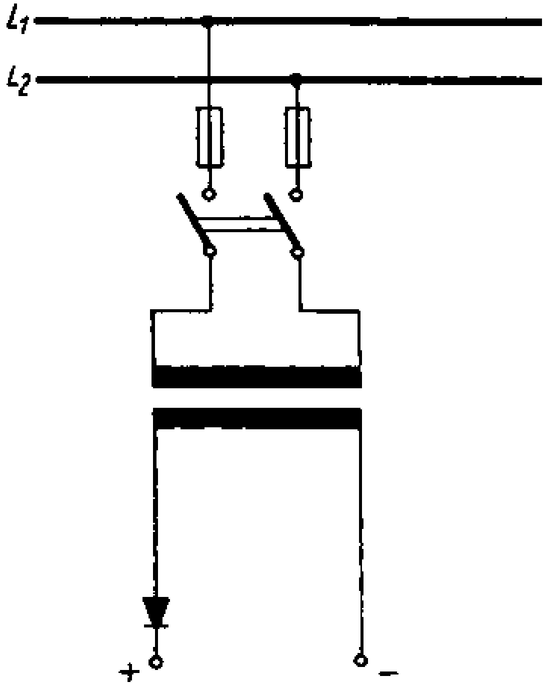
Figure



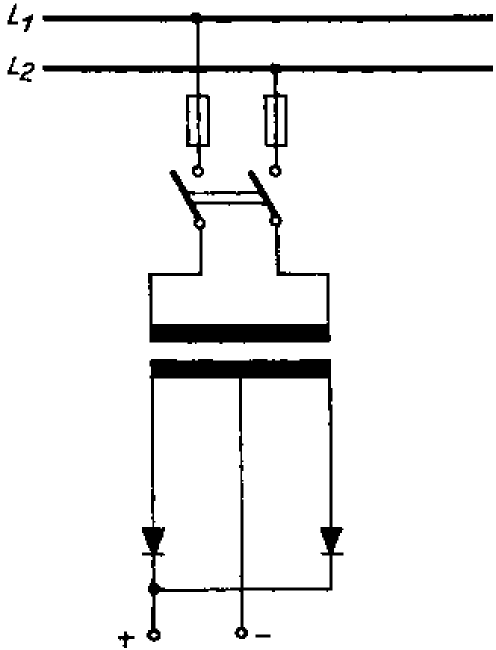
Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

6. Rectifier Circuits

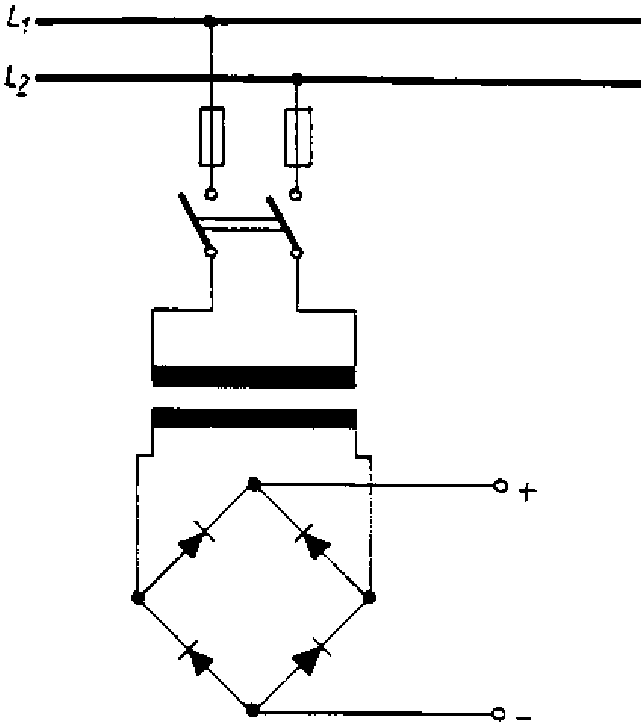
6.1. Rectifier Circuits of Alternating Current



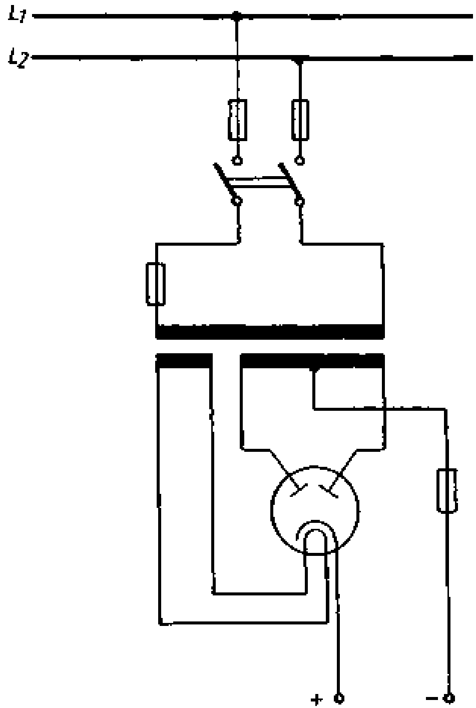
half-wave rectification



full wave rectification opposite-contact connection

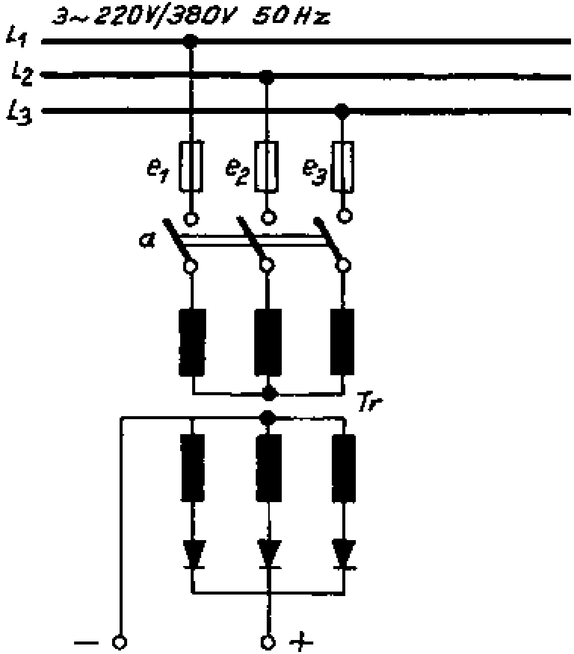


full-wave rectification - bridge connection

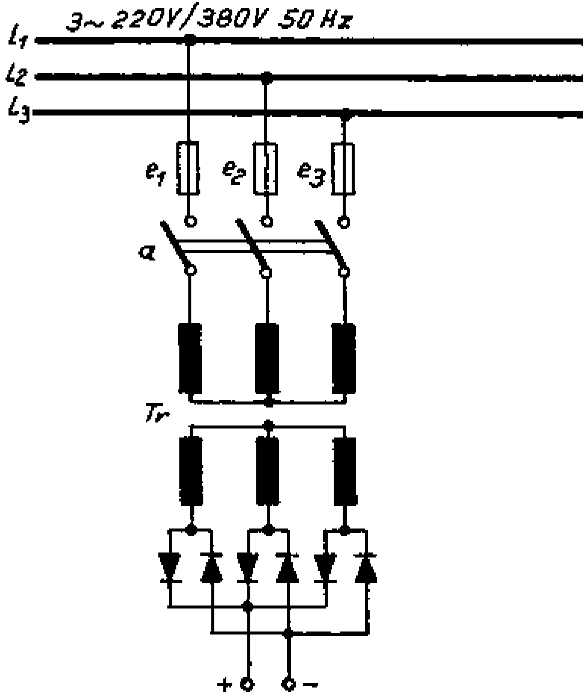


full-wave rectification - thermionic rectifier in double-way connection

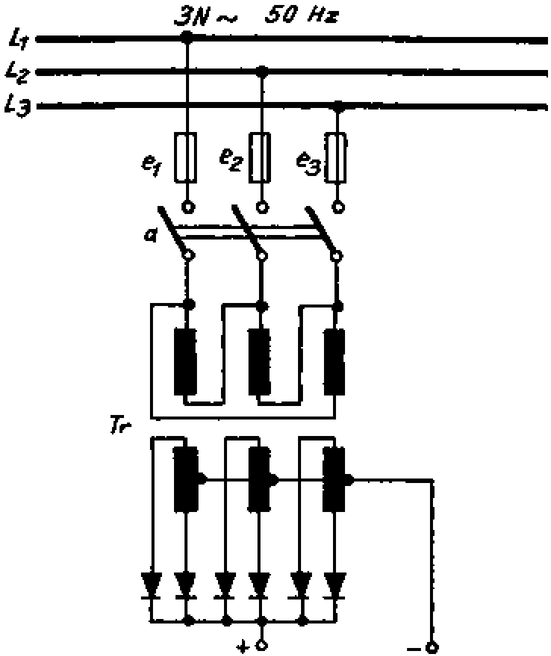
6.2. Rectifier Circuits of Three-phase Current



half-wave rectification



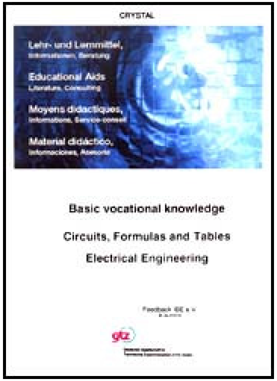
full-wave rectification - bridge connection



full-wave rectification - transformer with central tapping

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

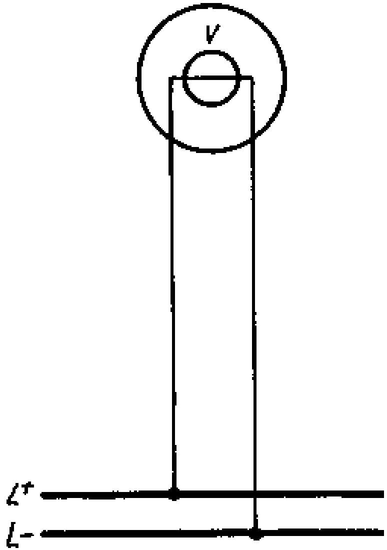
Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche



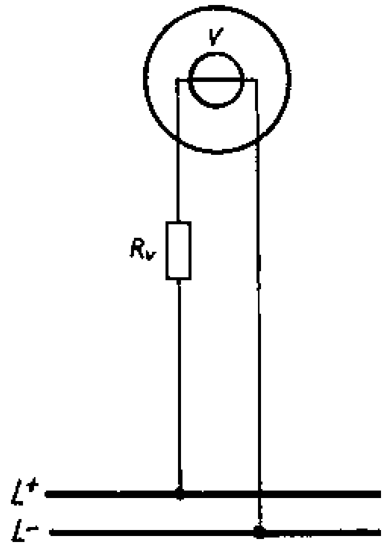
Circuits, Formulas and Tables Electrical Engineering - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 201 p.)

7. Measurement Circuits

7.1. Measurement Circuits in Direct-current Installations

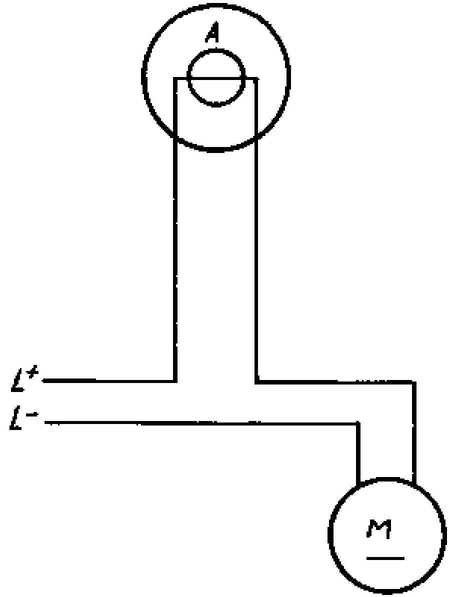


Voltage measurement (A)

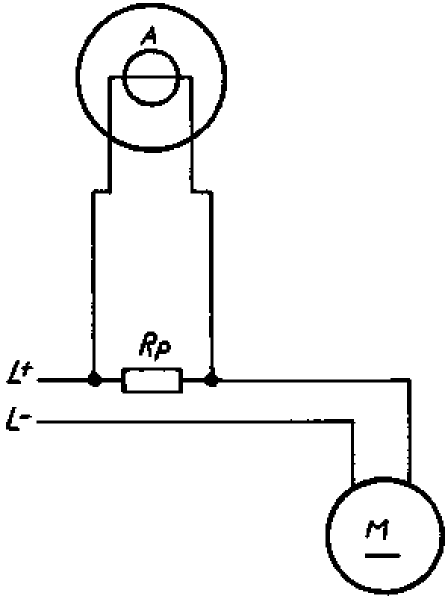


Voltage measurement (B)

By connecting in series of a resistor (Rv), an extension of the measuring range of the voltmeter is obtained

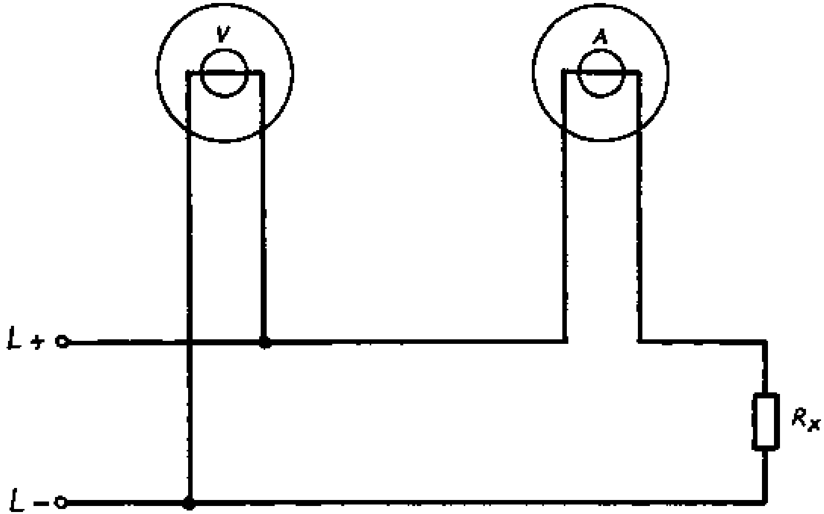


Current measurement (A)



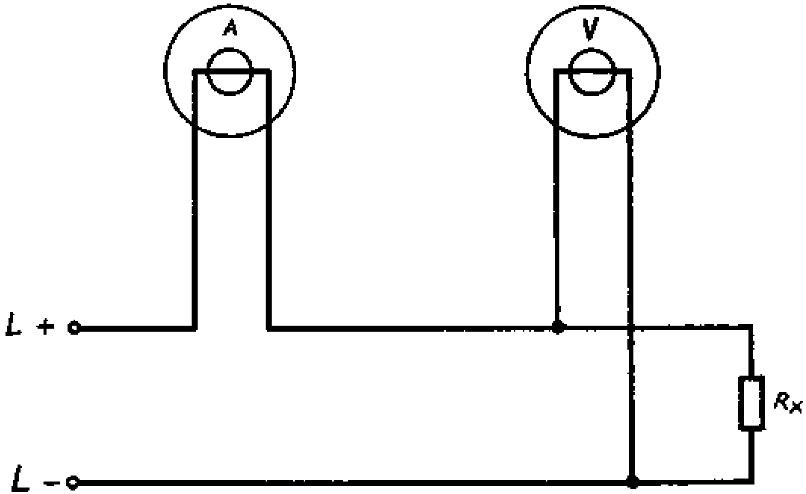
Current measurement (B)

By connecting in parallel a shunt resistor (Rp), an extension of the measuring range of the ammeter is obtained.



Voltage and current measurement for the determination of the resistance

The current-exact connection is used when the resistance (Rx) to be determined, is very high.

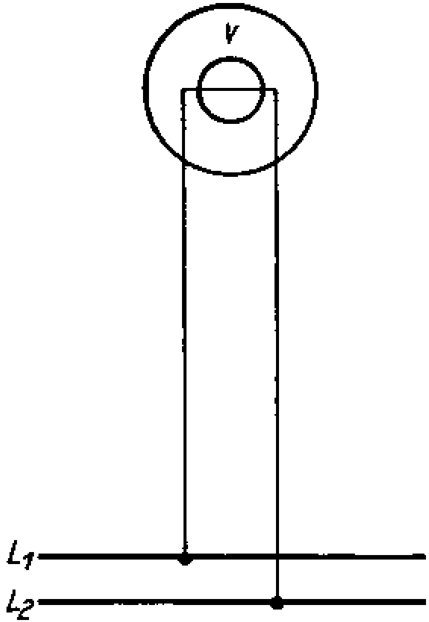


Current and voltage measurement for the determination of the resistance

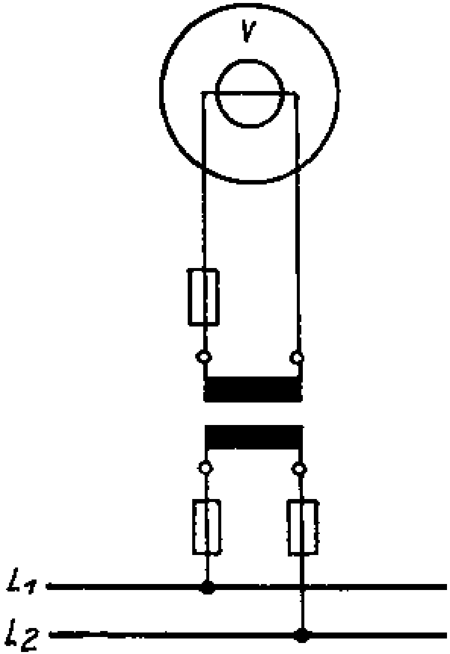
The voltage-exact connection is used when the resistance (Rx) to be determined is very small if the resistance Rx is calculated according to the following equation:

$$R_x = \frac{U}{I} [\Omega]$$

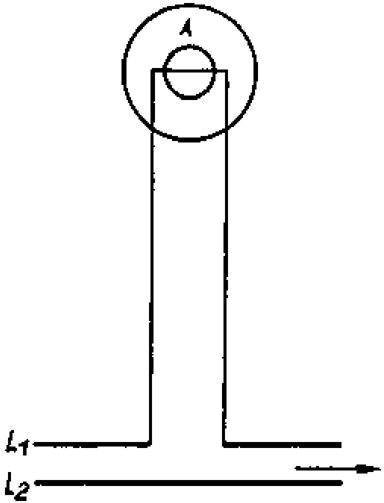
7.2. Measurement Circuits in Alternating-current Installations



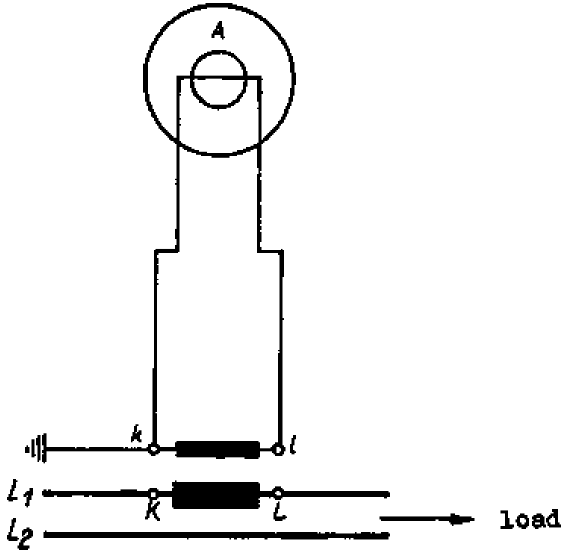
Voltage measurement (low voltage)



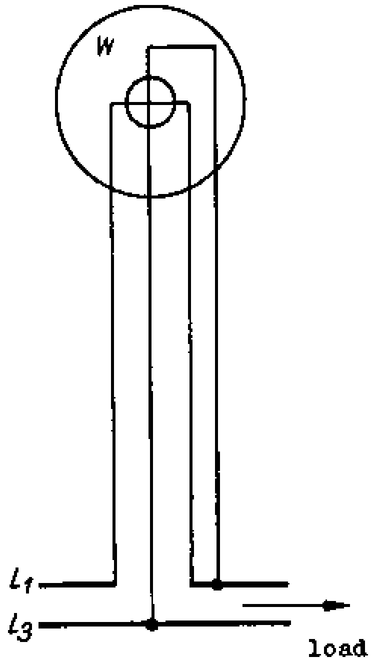
Voltage measurement (high-voltage - voltmeter with voltage transformer)



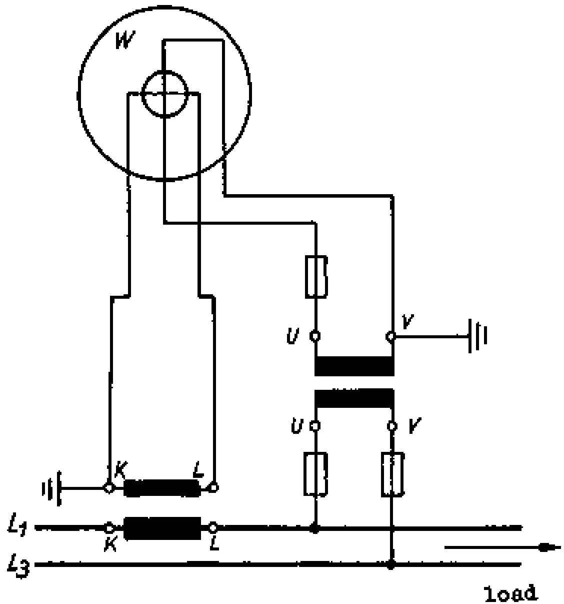
Current measurement



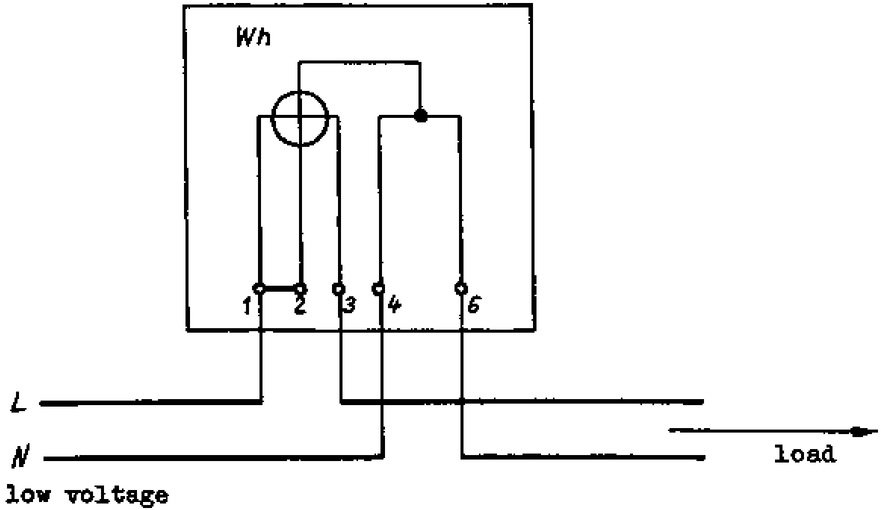
Current measurement (amperemeter with current transformer)



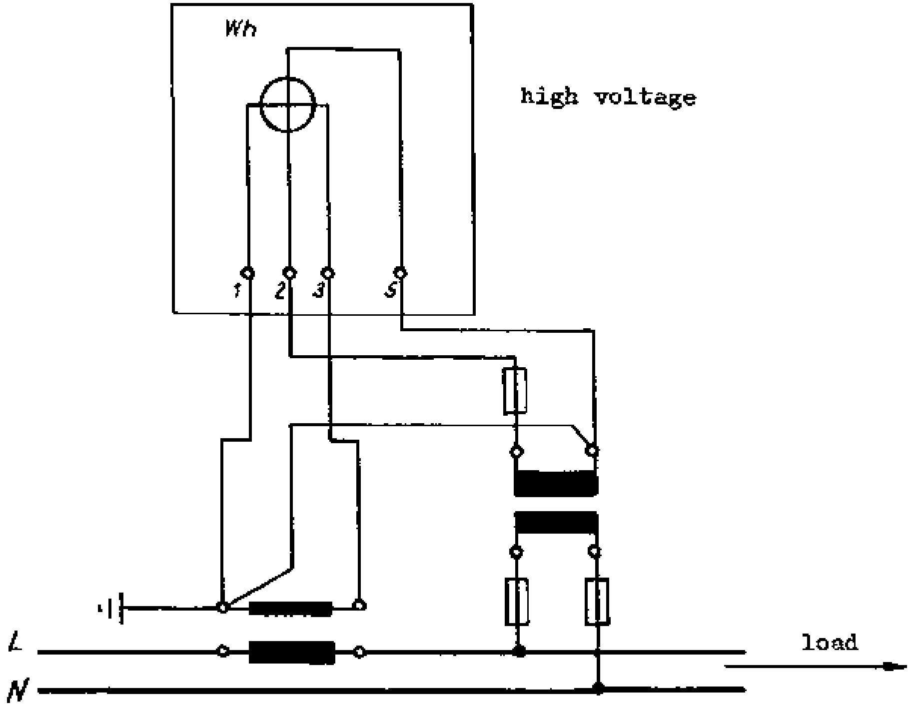
Power measurement (low voltage)



Power measurement (high voltage)

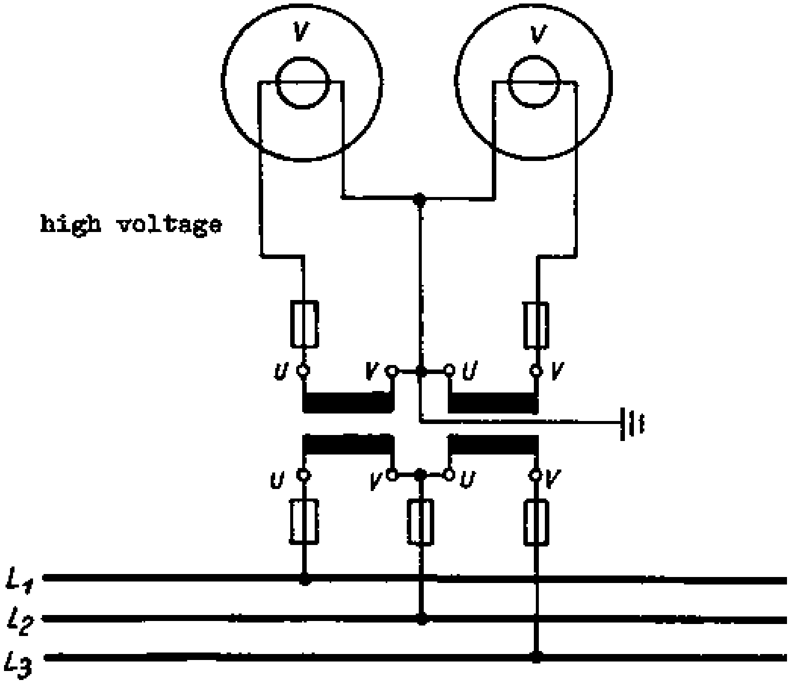


electric meter connections

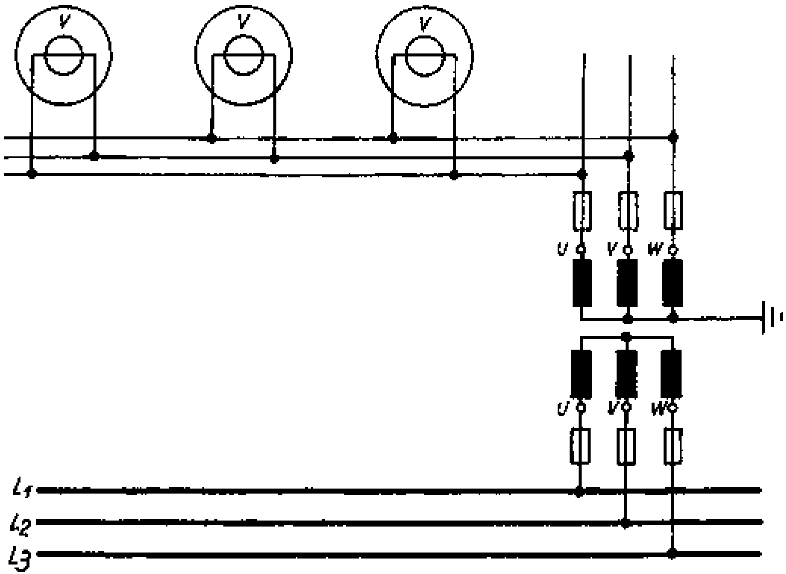


electric meter connections

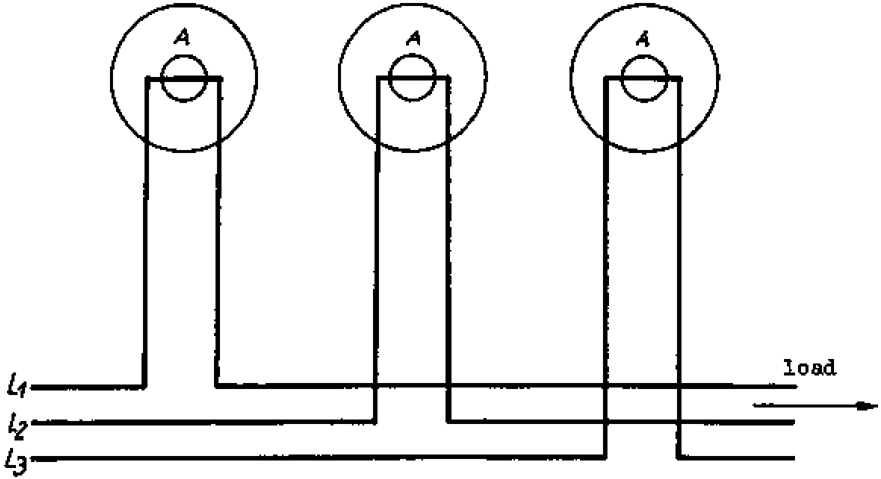
7.3. Measurement Circuits in Three-phase Installations



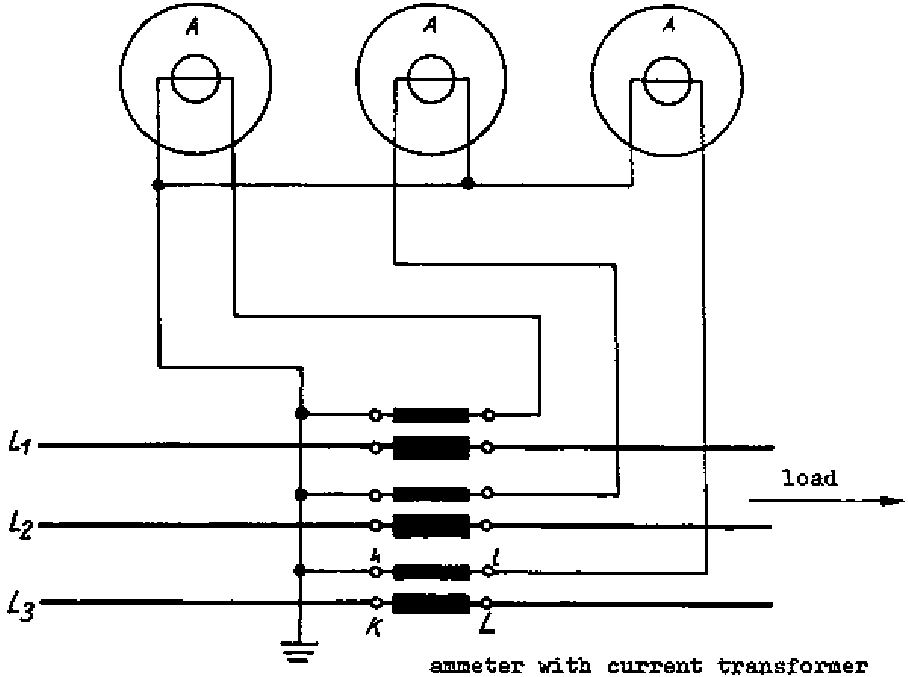
Voltage measurement



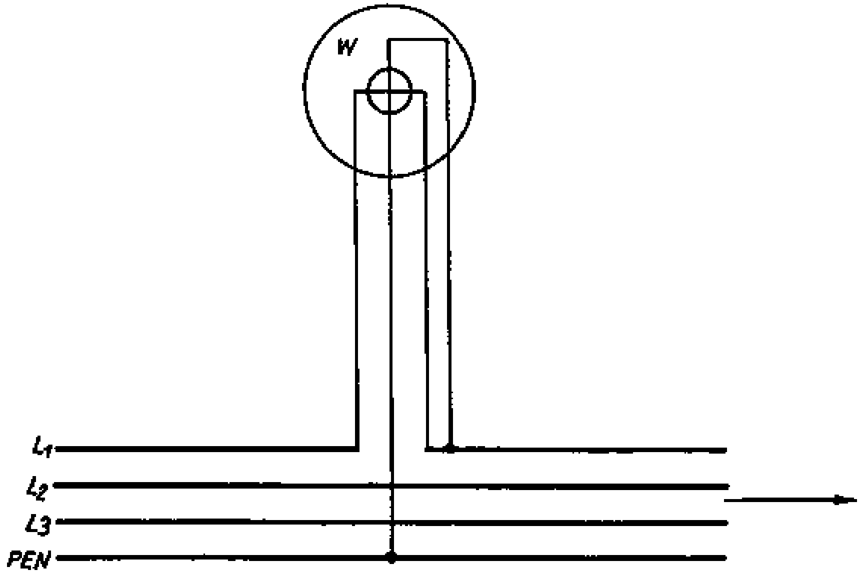
2 voltage transformers in V-connection



Current measurement



Current measurement



Power measurement

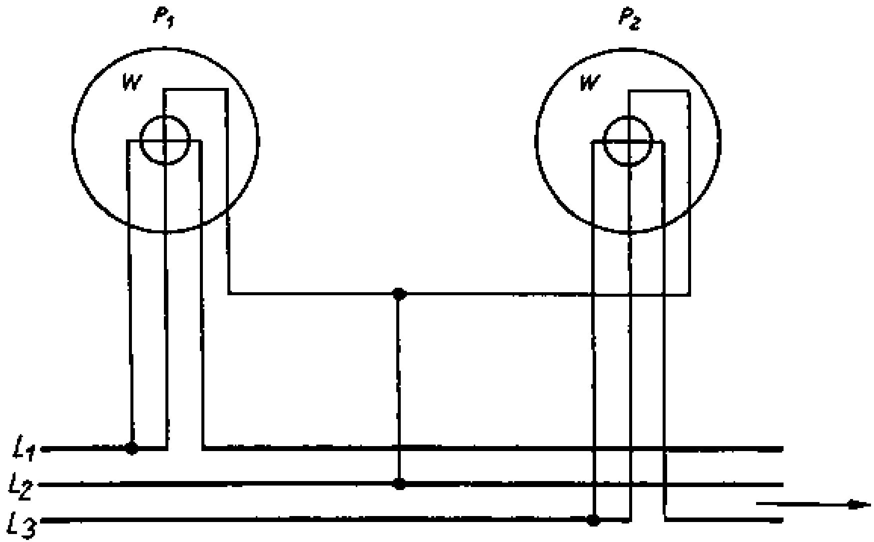
Single wattmeter method

use:

equal phase loading, accessible PEN-conductor

result:

total power = 3 × measuring result



Power measurement

Two-wattmeter method

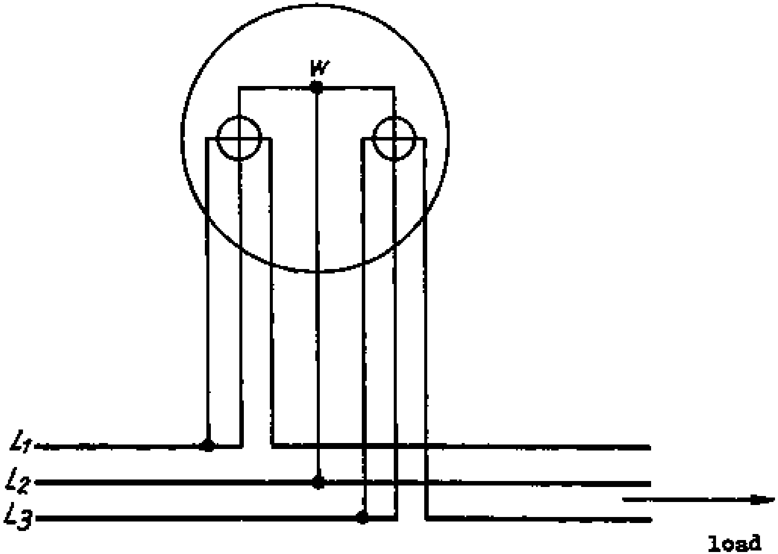
use:

unequal phase loading, non-accessible PEN-conductor; measuring instruments of the same type have to be used

result:

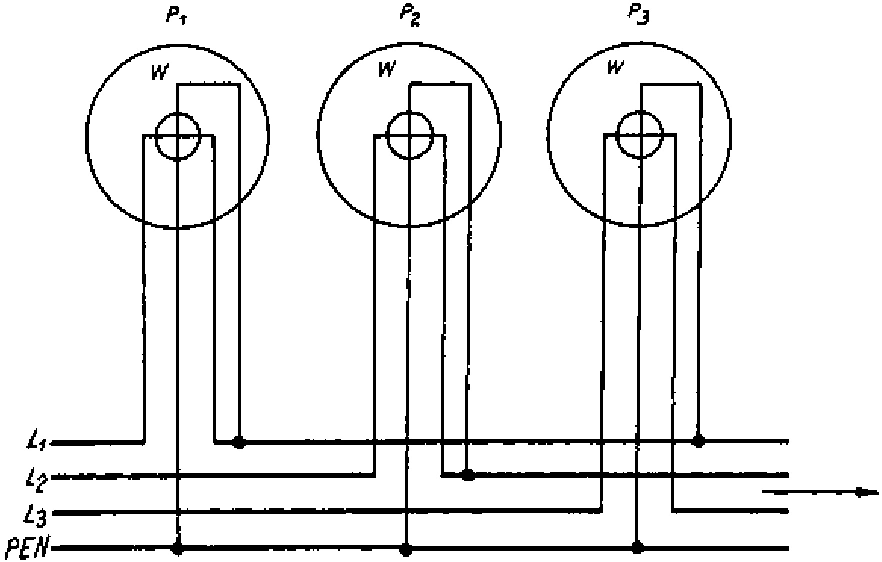
total power = $P_1 + P_2$,

when $P_1 > P_2$, the total power = $P_1 - P_2$



Power measurement

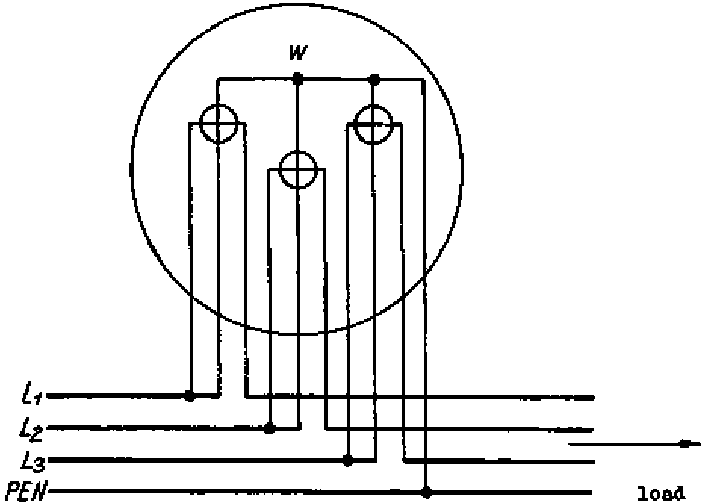
Two-wattmeter method
2 movements combined into one instrument



Power measurement

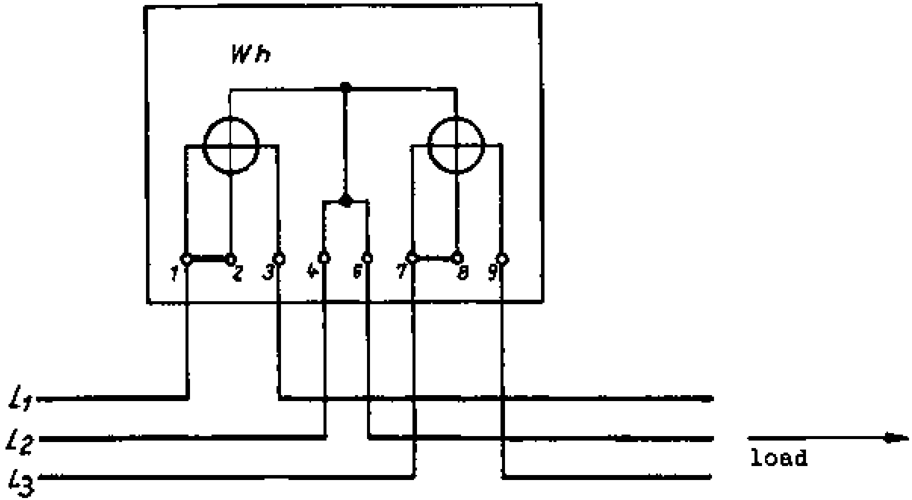
Three-wattmeter method

use: unequal phase loading, accessible PEN-conductor
result: total power = $P_1 + P_2 + P_3$

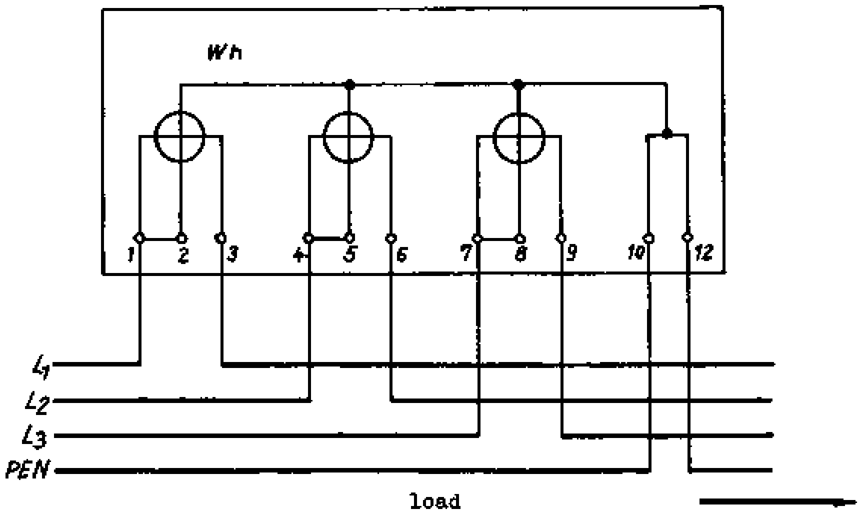


Power measurement

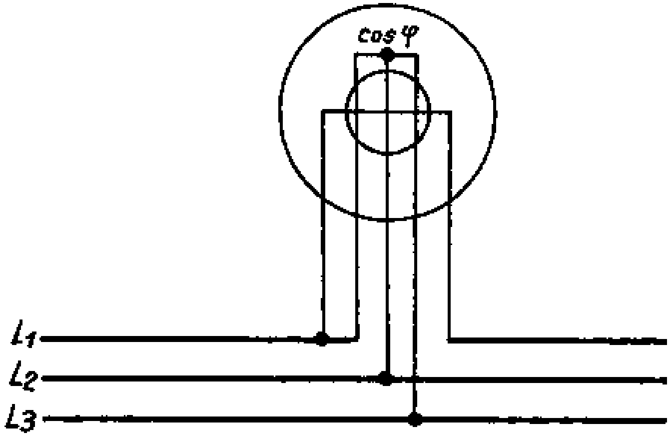
Three - wattmeter method
3 movements combined into one instrument



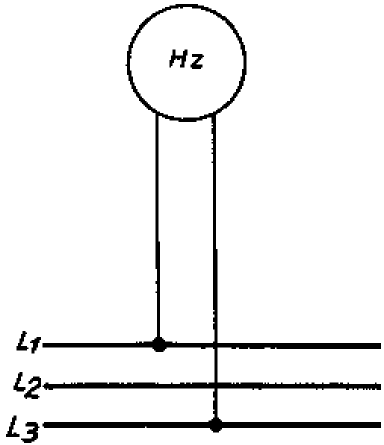
Meter circuit (three-wire meter)



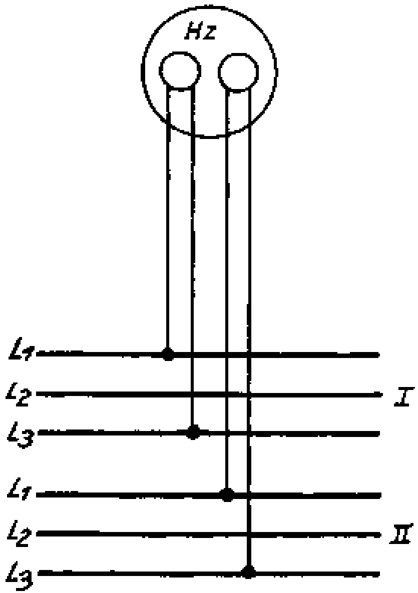
Meter circuit (four-wire meter)



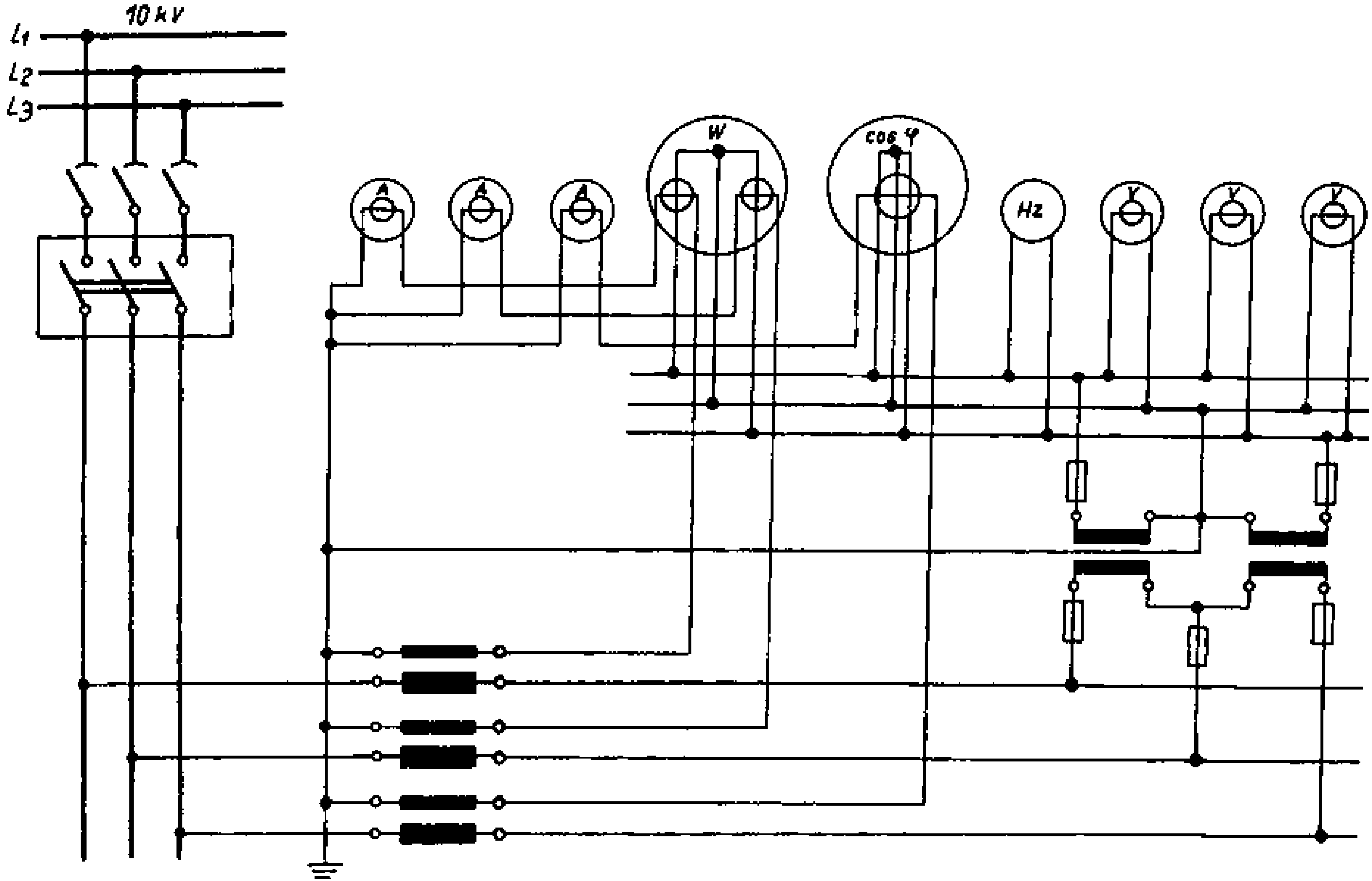
Measurement of the power factor (cos φ)



Measurement of the frequency (single frequency meter)



Measurement of the frequency (double frequency meter)



Measurements in a High-voltage Power Plant