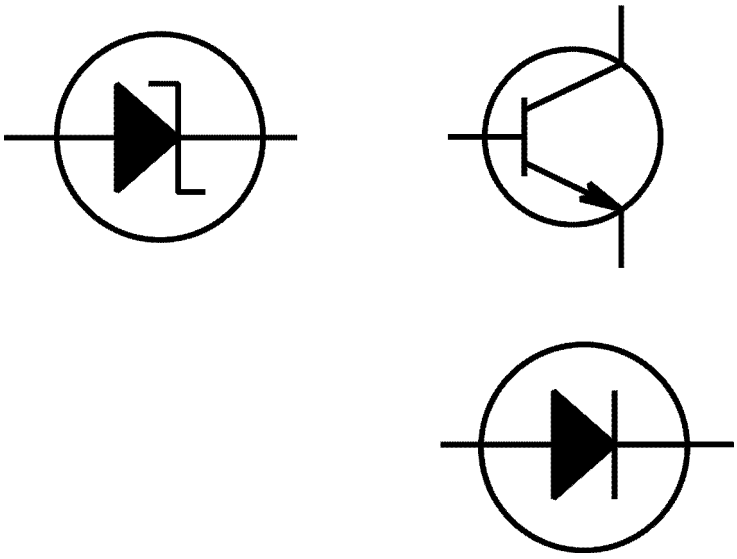


WORKSHOP MANUAL ELECTRICITY

GB reference : 754282 DC/ATR 04/2000

1. Electric units:

Current (I). Unit = the Amp (A). This is the amount of electricity which passes through a conductor in a given unit of time.

Voltage (V): Unit = the Volt (V). This is the difference in potential which either increases or decreases the amount of current passing through a conductor.

Power (P). Unit = the Watt (W) (1 hp = 736 W). This is the work done by the current in a given unit of time.

Frequency (F). Unit = the Hertz (Hz). This is the number of periods per second in an alternating current.

Resistance (R). Unit = the Ohm (Ω). This is the capacity of certain elements to resist current passing.

Capacity (C). Unit = the Farad (F). This unit defines the potential for storing current.

Inductance (L). Unit = the Henry (H). This unit defines the characteristics of a coil.

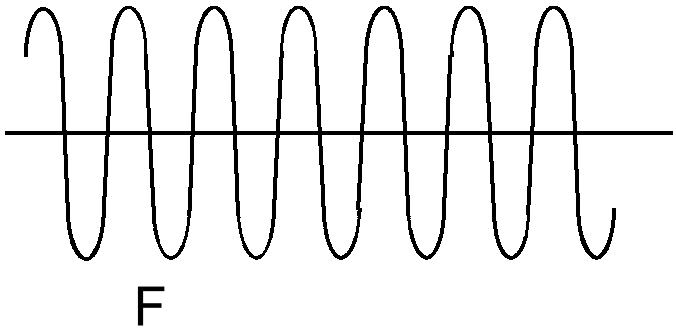
Flow (Φ). Unit = the Weber (Wb) or the Maxwell (Mx). This unit defines the intensity of a magnetic field.

2. Key formulae to remember:

V = RI where V is the voltage, R is the resistance and I is the intensity

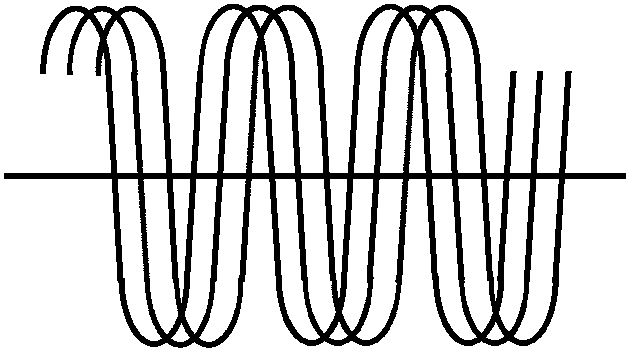
P = VI where P = is the power, V is the voltage and I is the intensity

3. Definitions:



Symbol for alternating current: ~ or AC. Periodic current, the average value of which over time is nil (i.e., as many positive periods as negative periods).

Symbol for direct current: = or DC. Current constant over time.

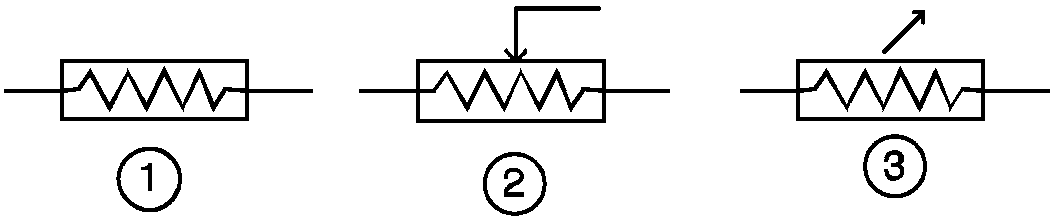


Three-phase current

This refers to three alternating currents offset in time.

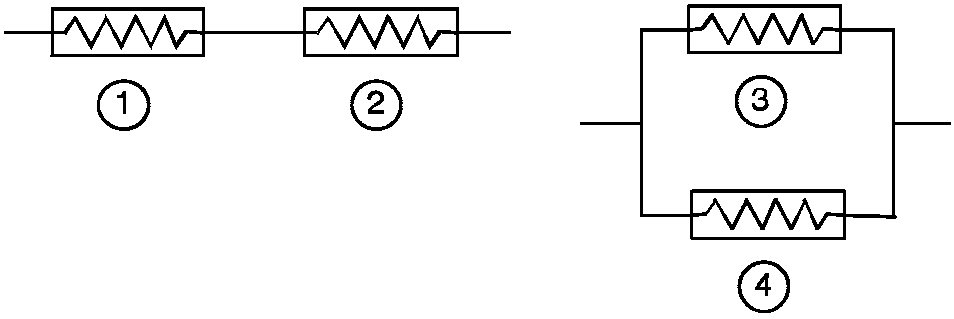
4. Elements:

Resistances:



A resistance limits the intensity of a current. The passage of current through the resistance causes it to heat up.
The different types of resistance are:
(1) Simple resistance: for limiting current. Lights are resistances etc.
(2). Potentiometer or variable resistance for fuel level etc.
(3). Thermistors for carburettor heating, sensors etc.

Association of resistances:



(1) In-series configuration: in this case, the resistances are added together. The current will be limited by both resistances one after the other and will be that much weaker. Total resistance will be:

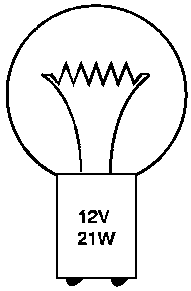
R = R1 + R2

(2) In-parallel configuration: in this case, the strongest current will pass via the smallest resistance. Total resistance will be:

R = R3 x R4 / R3 + R4

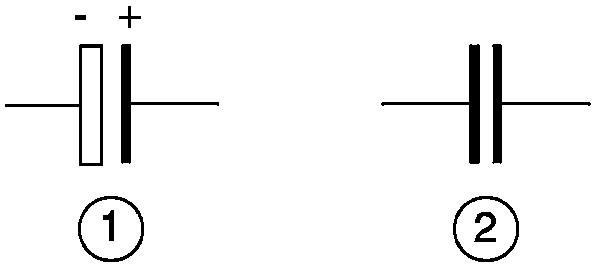
This shows that current will always look for the easiest path (i.e., where there is the least resistance). It is thus necessary to make sure that contacts are in perfect condition in order to avoid incidents.

Lights:

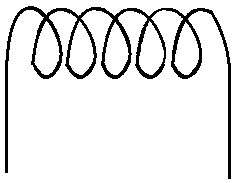


Current passing through the filament causes the latter to heat up to the point of incandescence, thus producing light.
The characteristics of a light are: its supply voltage in Volts and its power measured in Watts.
If the voltage supply to a light is too high (for example if the regulator is defective), the intensity of the current will be too high causing the filament to overheat and melt. The light will be burnt out.

Condensers:



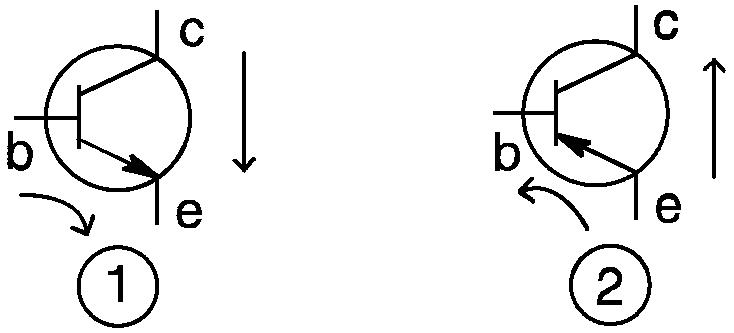
These are small storage units of current. They are charged and discharged according to requirements.
Different types are:
(1) Polarised condenser.
(2) Non polarised condenser.
Applications: filtering, absorption of interference currents.



Coils:

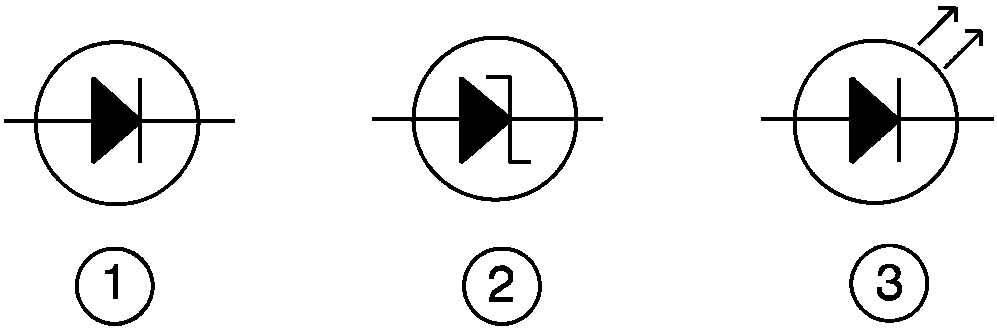
Their purpose is to produce current, to create magnetic fields and to filter.
Applications: flywheels, relays, starter motors.

Transistors:



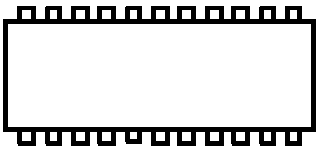
These are semi-conductors used in electronic circuits of all types.
Several types exist, for example the NPN (1) and the PNP (2). The latter function like a relay; when a so-called basic current exists between the base (b) and the transmitter (e), the latter triggers the passage of a main current between the commutator (c)and the transmitter (e).
Applications: calculators, indicator light unit.

Diodes:



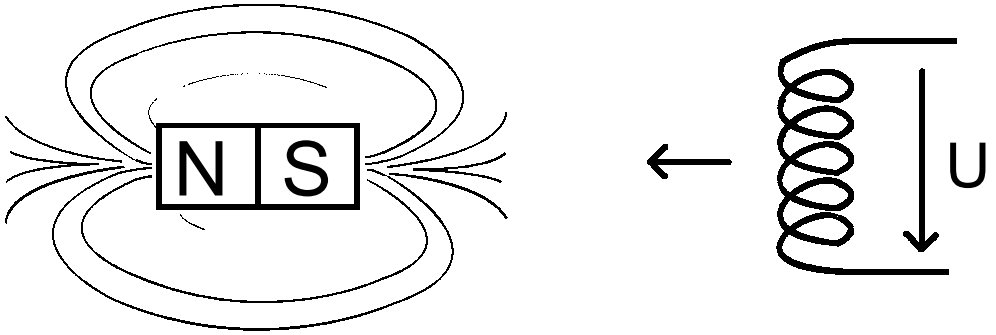
These are semi-conductors used in electronic circuits of all types.
Applications: rectifying current, limiting voltage, telltales.
Several types exist:
(1)- Simple diode: only allows current to pass in one direction (current rectifier).
(2)- Zener diode: allows the current to pass in one direction and only allows the current to pass in the other direction if the voltage is higher than a predetermined value (voltage regulator).
(3)- Light emitting diode (LED): allows the current to pass in one direction only and when the current passes through the diode produces light.

Integrated circuits:

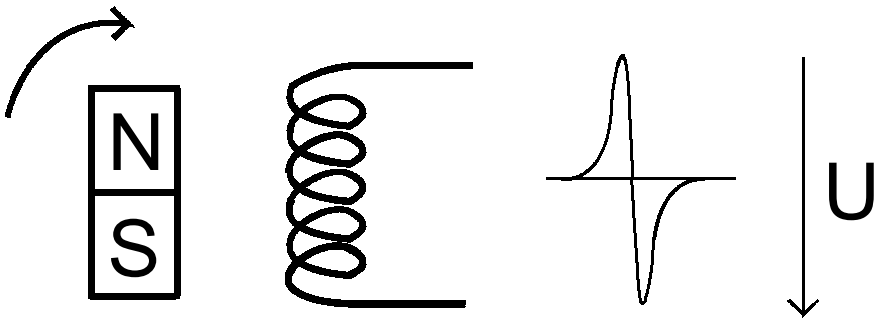


These are components containing one or several complete circuits made using miniature components. Several types exist, the functions of which are highly diverse. Applications: all electronic circuits.

5. Magnetic field:



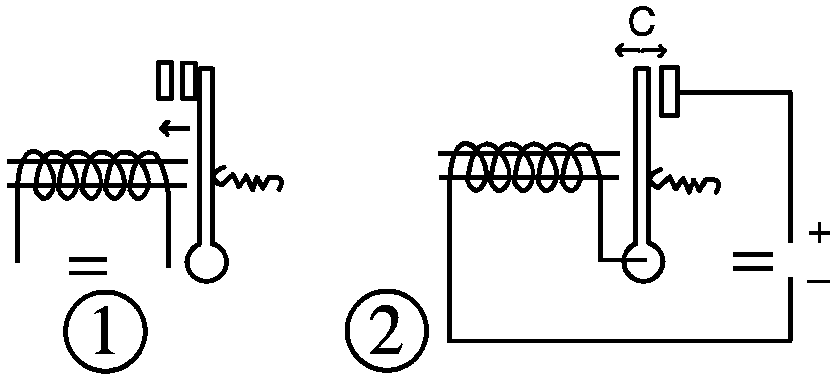
A magnet produces a magnetic field oriented from the north to the south of the magnet. If a coil is brought into proximity with this magnetic field, then an induced voltage V will be produced in the coil.



If a magnet is rotated next to a coil, then an induced alternating voltage is created within the coil, the value of which depends on the intensity of the magnetic field and the frequency of which depends on the speed of rotation of the magnet.
The higher the speed of rotation of the magnet, the greater the electrical voltage in the coil.

Field magnet:

The passage of current through the coil creates a magnetic field in a soft iron core. This magnetic field can be used to make a steel part move. This application is used in the functioning of relays, horns, etc.

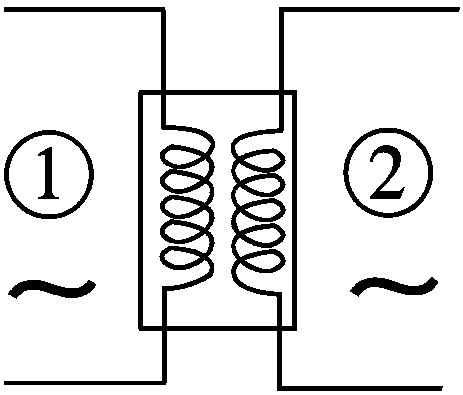


① Relay: by passing a direct current through the coil in the relay, the magnetic field thus created attracts the contact blade of the relay which makes contact with the outlet terminal.

② Horn: by passing a direct current through the coil in the relay, the magnetic field thus created attracts the connector strip of the horn and opens the contact (C) which cuts off the magnetic field thus causing the connector strip to vibrate.

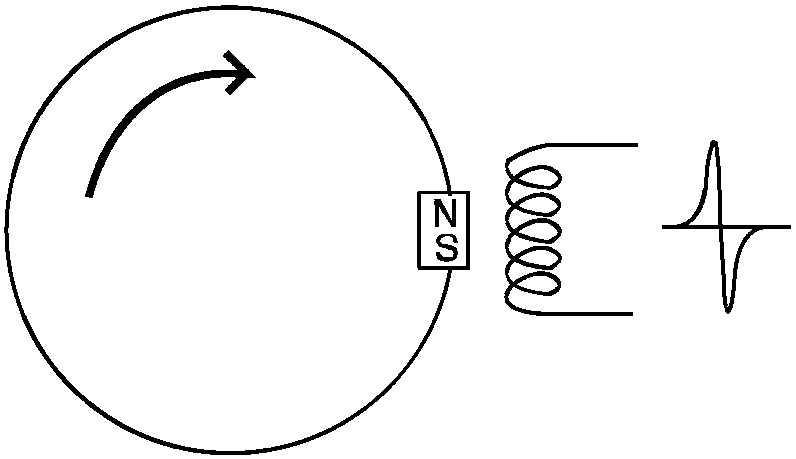
Transformer:

A current transformer can be created by putting two coils together.



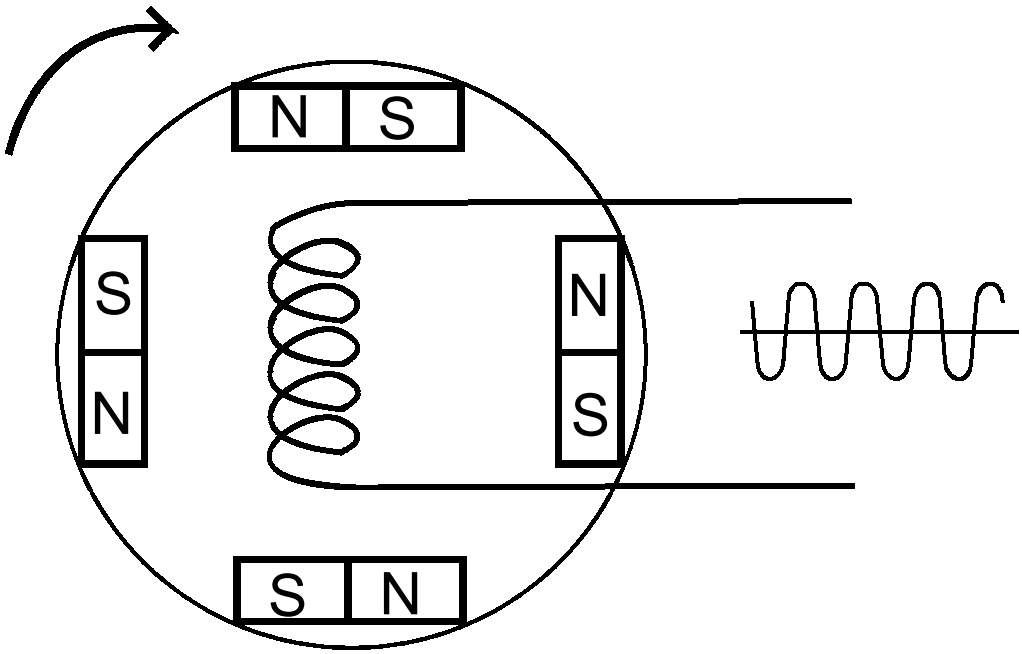
The current passing through coil n°. 1 creates a magnetic field, which acting on coil n°. 2 creates an induced electric current in the latter.
The voltage ratio between coil 1 and coil 2 is proportional to the number of turns in each of the coils. (Example: 220 turns in the primary (1) and 6 turns in the secondary (2) would give a transformer of 220 V / 6V).

Sensor:



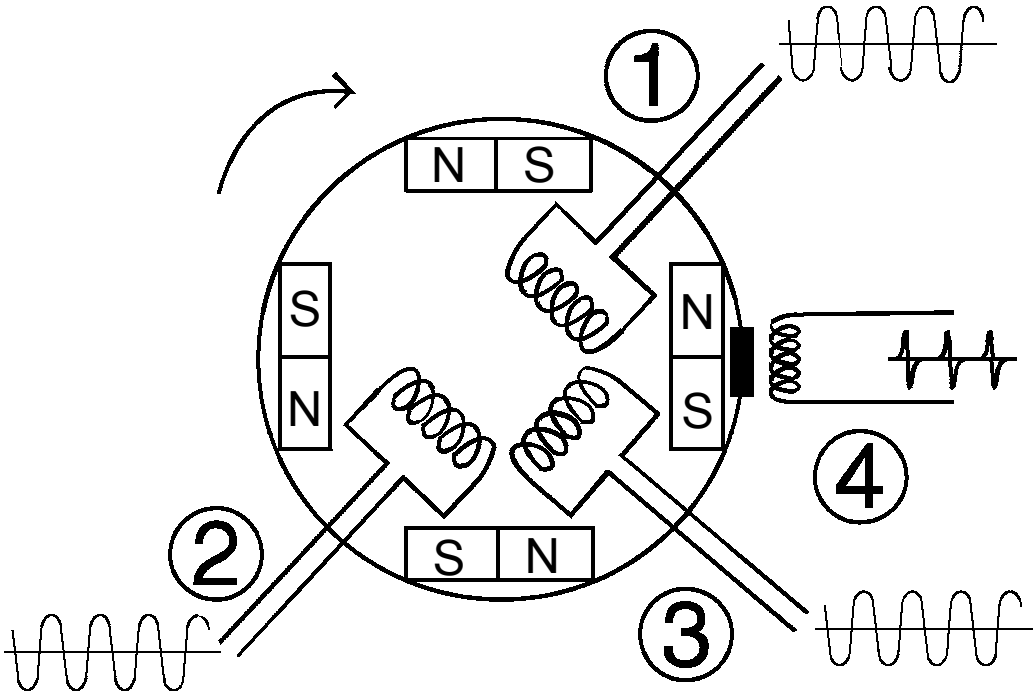
When the magnetised mark passes in front of the coil in the sensor, this creates an induced current in the coil which is used by the system to determine the position of the magnet.

Production of current:



The rotation of magnets around the coil create an induced current in the latter. This current can be used to supply an electric circuit.

6. Flywheel:



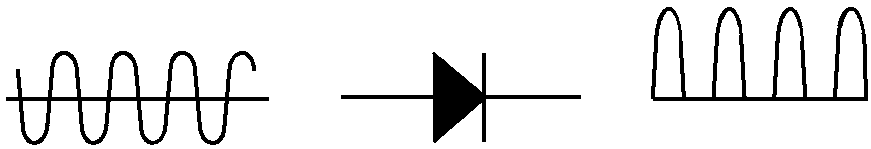
A flywheel consists of a rotor (a group of magnets mounted onto a rotating support) and a stator (a group of coils). When the rotor rotates around the coils, this produces alternating current in the coils.
Depending on the different types of flywheel, different applications for the coils can be identified:
(1) ignition circuit
(2) lighting circuit
(3) battery charging circuit
(4) ignition sensor circuit

All of these circuits operate on the same principle; different sizes of coils positioned in variable magnetic fields thus producing alternating current.

7. Current rectification:

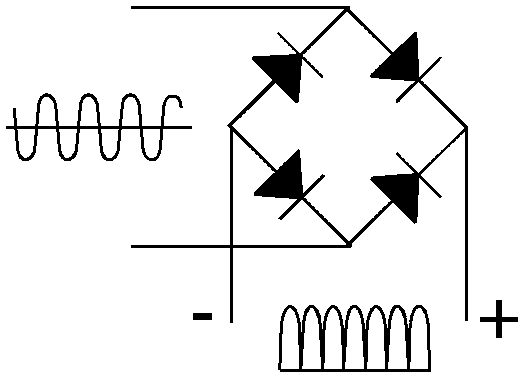
Certain circuits like for instance the battery charging circuit, electronic circuit supply require rectified current in order to operate. Other circuits only require a limitation of voltage, for example lighting circuits.

Rectification by diodes:



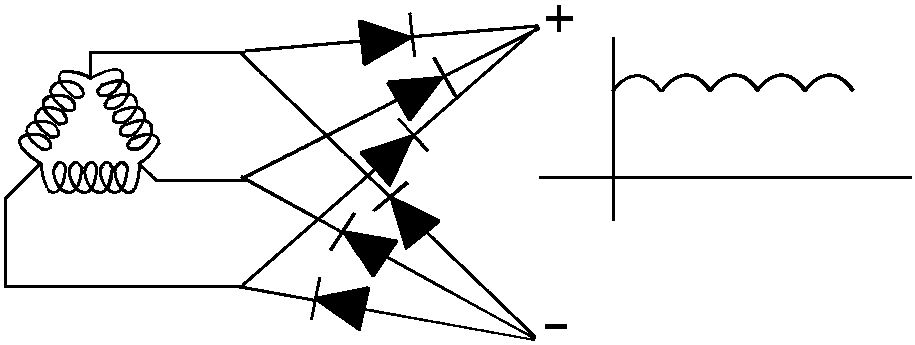
Single alternation rectification:

By fitting a diode, negative alternation is suppressed.



Dual alternation rectification:

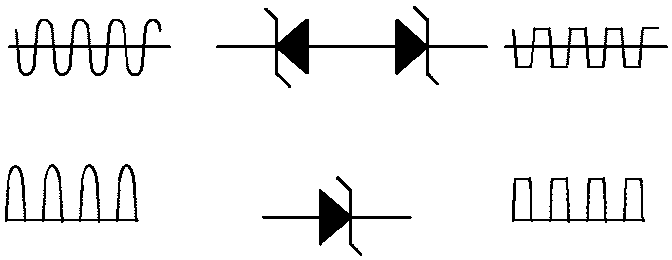
By mounting four diodes in a bridge configuration, the negative alternation is transformed into positive alternation. With the same size coil, this method enables twice as much power to be obtained.



Rectification for three-phase circuits:

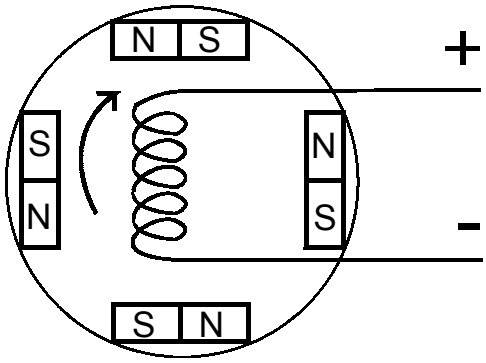
By mounting six diodes, dual alternation rectification can be obtained on the three coils which results in an almost constant voltage.

8. Voltage limiter:



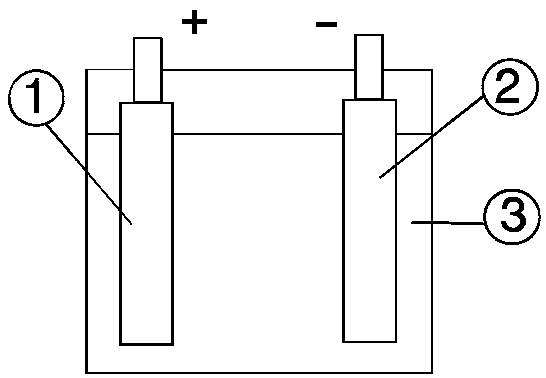
In order to limit maximum voltage, for instance in a lighting circuit, a zener diode is used. This system can be used either with alternating current or rectified current.

9. *Starter motor*:



The passage of direct current through the coil creates a magnetic field which opposes the field of the magnets thus causing the coil to rotate.

10. Battery:



Pb = lead
PbO^2 = lead oxide
$H2SO^4$ = sulphuric acid
$PbSO^4$ = lead sulphate
H^2 = hydrogen
O^2 = oxygen

Chemical reaction: $PbO^2 + H2SO^4 + Pb = H^2 + O^2 + PbSO^4$

A battery consists of components themselves made up of lead and lead oxide plates (one positive plate (1) and one negative plate (2)), which are immersed in a reservoir of diluted sulphuric acid (electrolyte (3)). The combination of these components produces a chemical reaction which results in the production of an electric voltage at the battery terminals.
The electric voltage produced by a battery consisting of lead components is 2.2 Volts.

This chemical reaction is said to be reversible; on one hand, when new, it produces electric current and on the other hand when it receives current, this allows the battery to reconstitute the plates and the electrolyte.

Precautions: When recharging a battery, the chemical reaction which occurs results in the production of two gases, oxygen and hydrogen. If these two gases combine and are exposed to flame, the mixture will explode producing water. It is thus important to make sure that the batteries are charged in a well-ventilated area and that a suitable charger is used.
A battery is characterised by two values:

Voltage (V): this depends on the number of components used; 3 components for a 6-Volt battery, i.e., a real voltage of 6.6V and 6 components for a 12-Volt battery, i.e., a real voltage of 13.2 V.

Capacity (Ah): This defines the amount of current which a battery can produce in one hour. For example; a 4 Ah battery can produce 4 A in 1 hour or 8 A in ½ hour. Normal charging of a battery is done using a current 1/10 of its capacity. For example, for a 4 Ah battery, charging intensity will be 0.4 A and the charging operation will take 10 hours, hence the importance of using chargers suited to the capacity of the battery. Note: electronically adjustable charging units enable batteries to be charged more quickly with better response to current requirements (i.e., more current at the beginning of the charge and less towards the end).

11. Electric diagrams of functions:

Identification of circuit components

VE	Vert
BA	Blanc
BC	Bleu Clair
JN	Jaune
RG	Rouge
BE	Bleu
VI	Violet
MR	Marron
GR	Gris
OR	Orange
NO	Noir
JN-VE	Jaune Vert
NO-BE	Noir Bleu
JN-MR	Jaune Marron
JN-BE	Jaune Bleu
JN-BA	Jaune Blanc
VE-NO	Vert Noir
JN-NO	Jaune Noir
BA-BE	Blanc Bleu

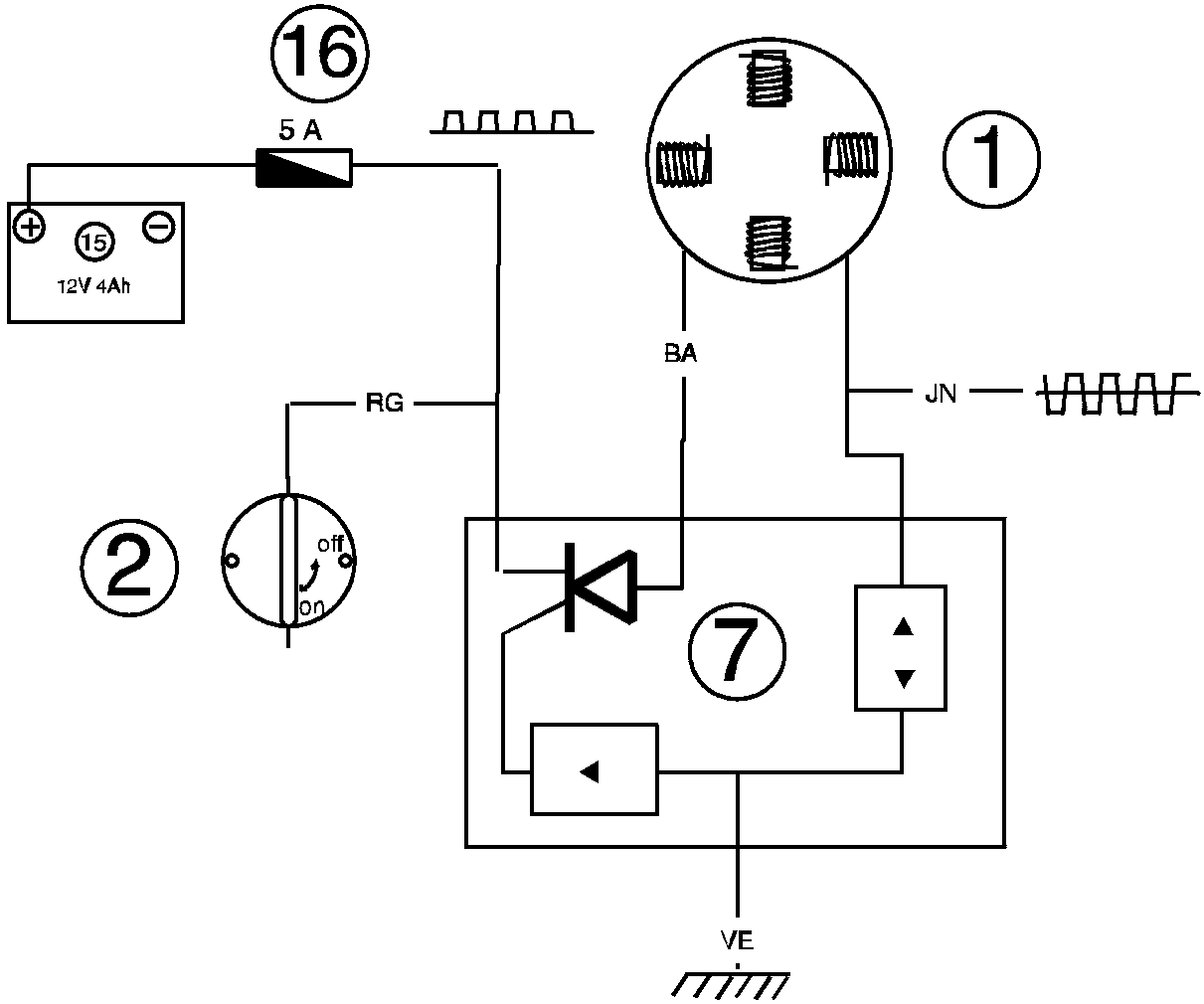
A Instrument panel lighting
B Headlight telltale
C Low oil level telltale
D Indicator telltale
E Gauge receiver
F Ignition telltale
G Temperature dial
H Fuel reserve telltale
J Oil pressure telltale
K Temperature telltale

1 Flywheel
2 Anti-theft contact
3 Ignition unit
4 High voltage coil
5 Spark plug interference suppressor 5 KΩ
6 Resistive spark plug 5 KΩ
7 Rectifier regulation unit
8 Choke
9 Resistance 6.7 Ω - 5 W
10 Lighting control
11 Résistance 6,9Ω - 30W
12 Headlamp control
13 Main beam lamp
14 Rear and stop light lamp
15 Battery
16 Fuse
17 Horn
18 Horn button
19 Indicator unit
20 Indicator control
21 Indicator lamp
22 Fuel gauge
23 Stop contact
24 Starter motor relay
25 Starter motor control
26 Starter motor
27 Stop light current limiter
28 Low oil level contact
29 Coolant temperature sensor
30 Immobiliser unit
31 Transponder aerial
32 Sidelights
33 Registration plate light
34 Stand contact

35 Emergency stop
36 Neutral position contact
37 Oil pressure contact
38 Fan unit
39 Fan thermocontact
40 Carburettor heater
41 Carburettor supply unit
42 Fuel reserve contact

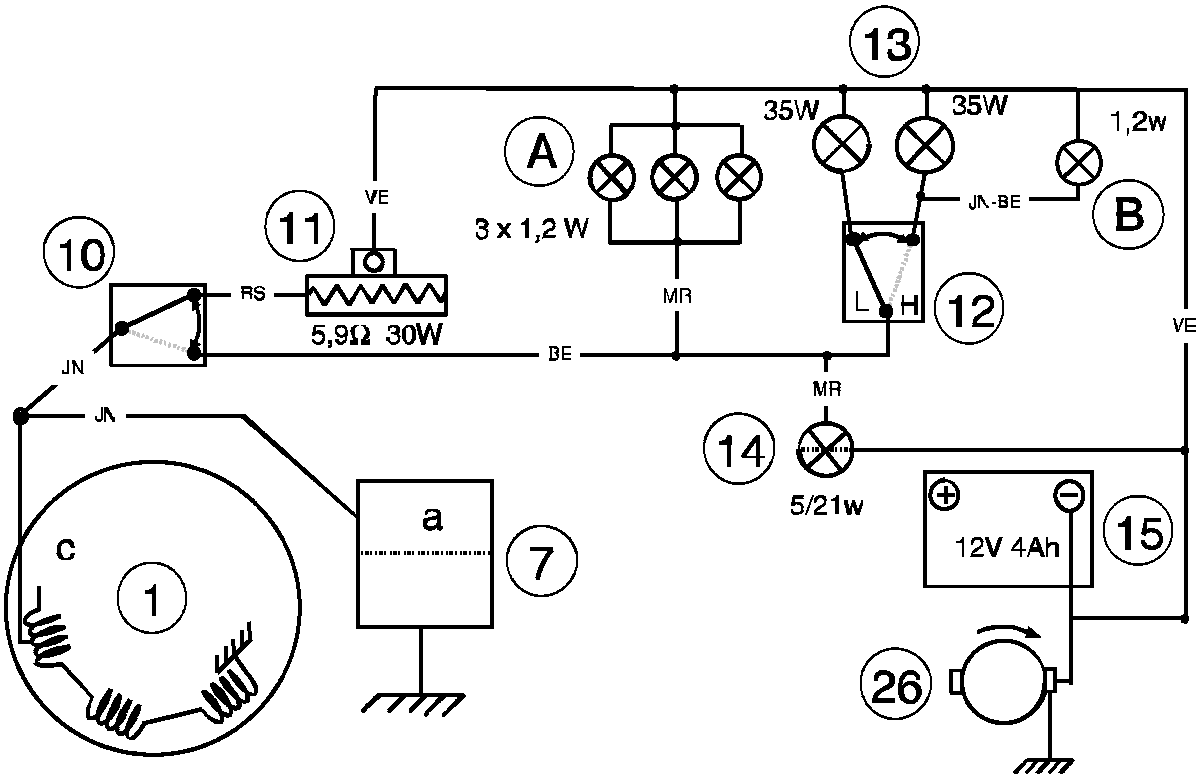
Green, White, Light blue, Yellow, Red, Blue, Purple, Brown, Grey, Orange, Black
Yellow green, Black blue, Yellow brown, Yellow blue, Yellow white, Green black
Yellow black, White blue

Current supply circuit:



Two supply circuits exist: one circuit with alternating current limited in voltage for lighting, the choke etc., and one circuit with rectified and regulated current for battery charging, ignition etc.....

Lighting circuit:

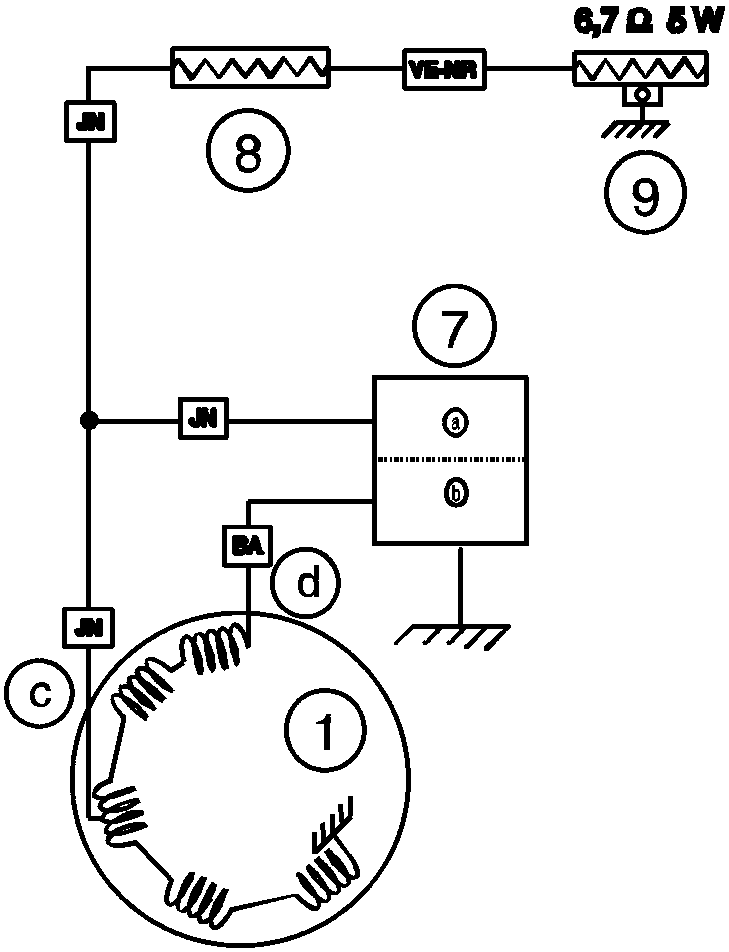


The lighting circuit is fed by the alternating current circuit limited in voltage. In the event that the lighting is not used, the current produced by the lighting coil must be destroyed so as not to burn out the coil. This current is thus directed towards the resistance (11) where it will be consumed.

Important:
If an incident occurs on the voltage limiter (7) (overvoltage), this will lead to all the lamps being destroyed.

The earth for the lighting circuit passes via the earth on the starter motor; hence, in order for the lighting circuit to work, the starter motor must be in place and the earth cable connected.

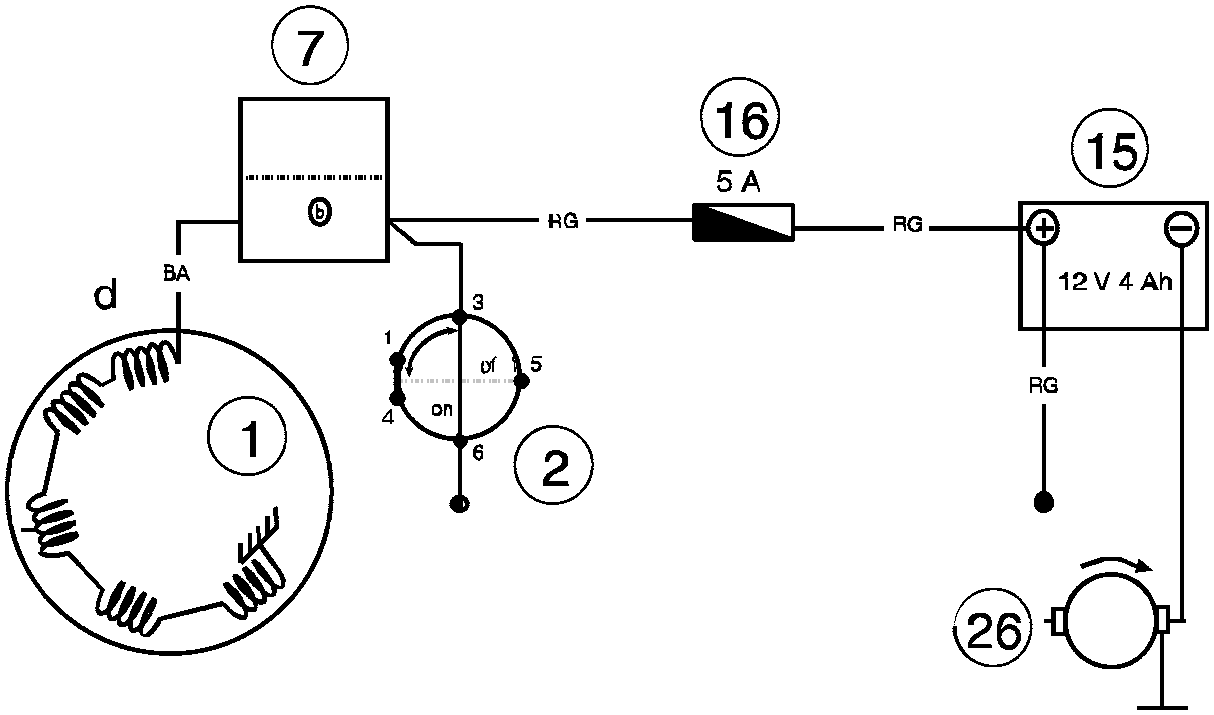
Choke circuit



The choke circuit is fed by the alternating current circuit limited in voltage. The heat expandable component (8) is thus supplied only when the motor is working. The latter is supplied through a limitation resistance (9), in this case 6.7 Ω 5 W which limits the amount of current passing through the heat expandable component.
The heat expandable component (8) sees its resistance increase in relation to its temperature, which consequently limits the current in the component to the point of not passing through at all when the latter is hot. This is how the operating time of the choke is determined.

Important:
The earth for the choke circuit passes via the earth on the starter motor; hence, in order for the circuit to work, the starter motor must be in place and the earth cable connected.

Battery charging circuit



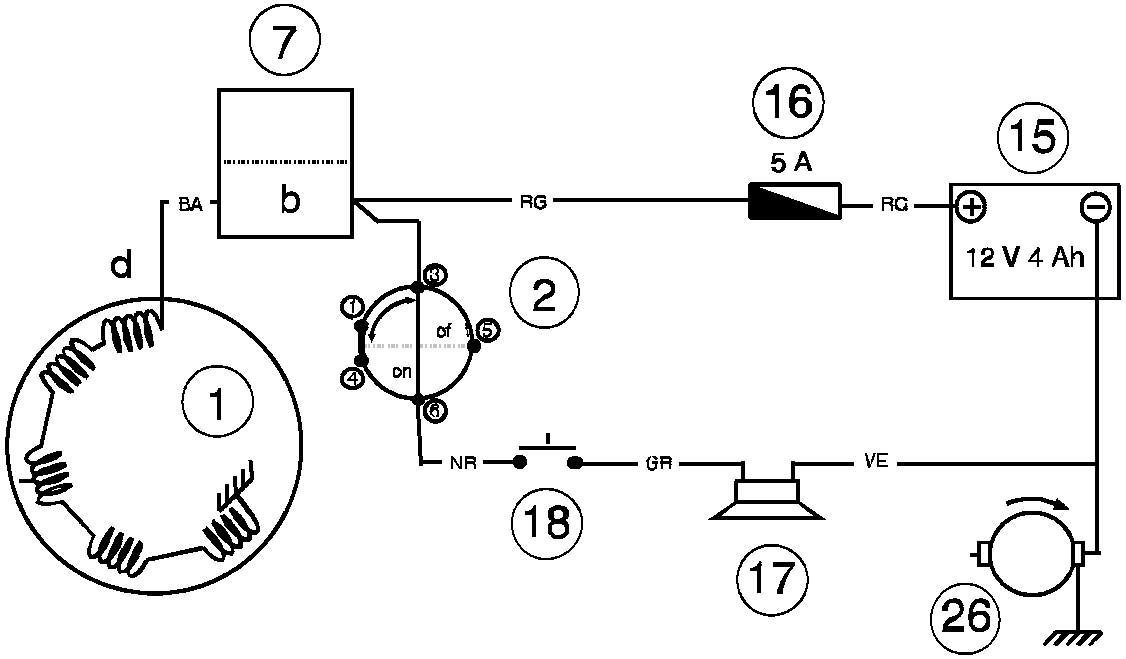
The rectified and regulated current which is given out by the regulator (7) is sent towards the battery through the 5A (16) protection fuse. Once the voltage given out by the regulator is higher than battery voltage, then the battery will start to charge.

A charging circuit operating correctly is a circuit which gives out a voltage of 14 Volts minimum when the engine is running.

Important:
The earth for the battery charging circuit passes via the earth on the starter motor; hence, in order for the circuit to work, the starter motor must be in place and the earth cable connected.

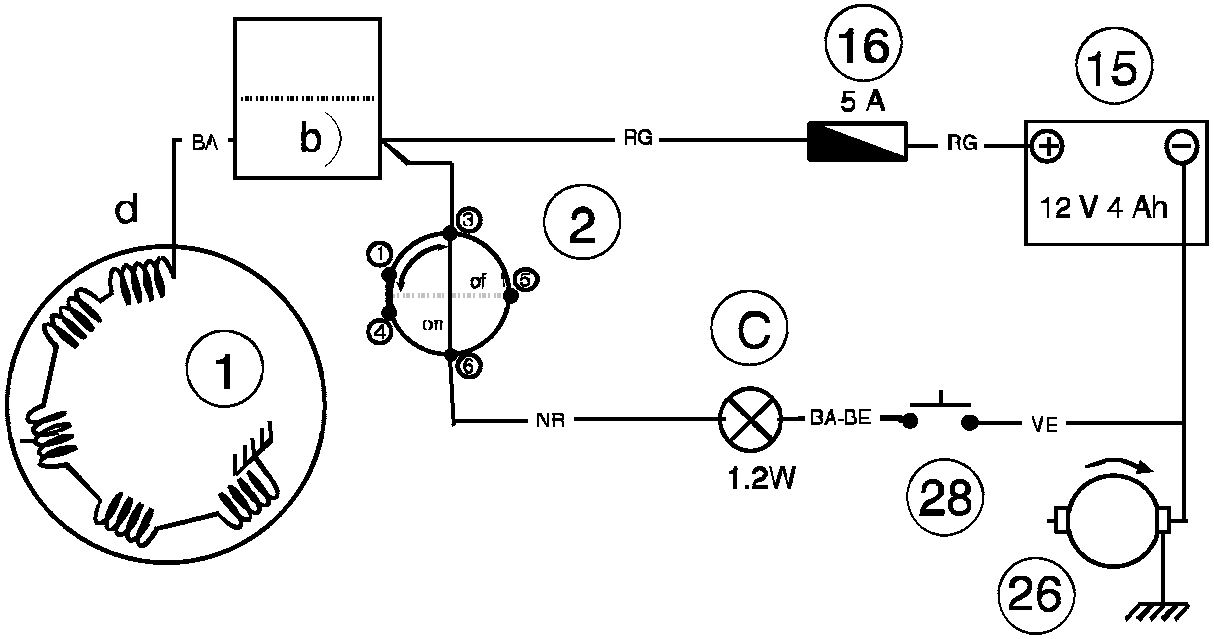
If the fuse (16) has blown, the battery will no longer be charged and the various functions requiring the battery will no longer be operational (starter, indicators, stop light, horn).

Horn circuit



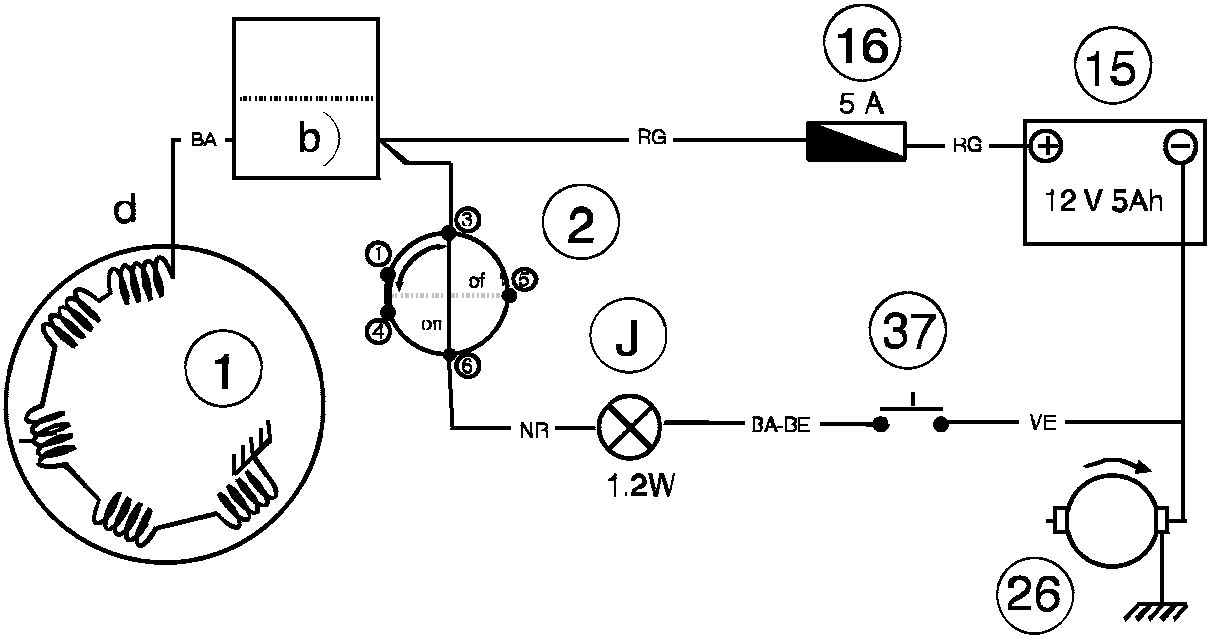
The horn circuit is supplied by direct current.

Low oil level telltale circuit



The low oil level telltale circuit is supplied by direct current.
When the oil level is low, the low oil level telltale is supplied by a low oil level contact located in the reservoir (28).

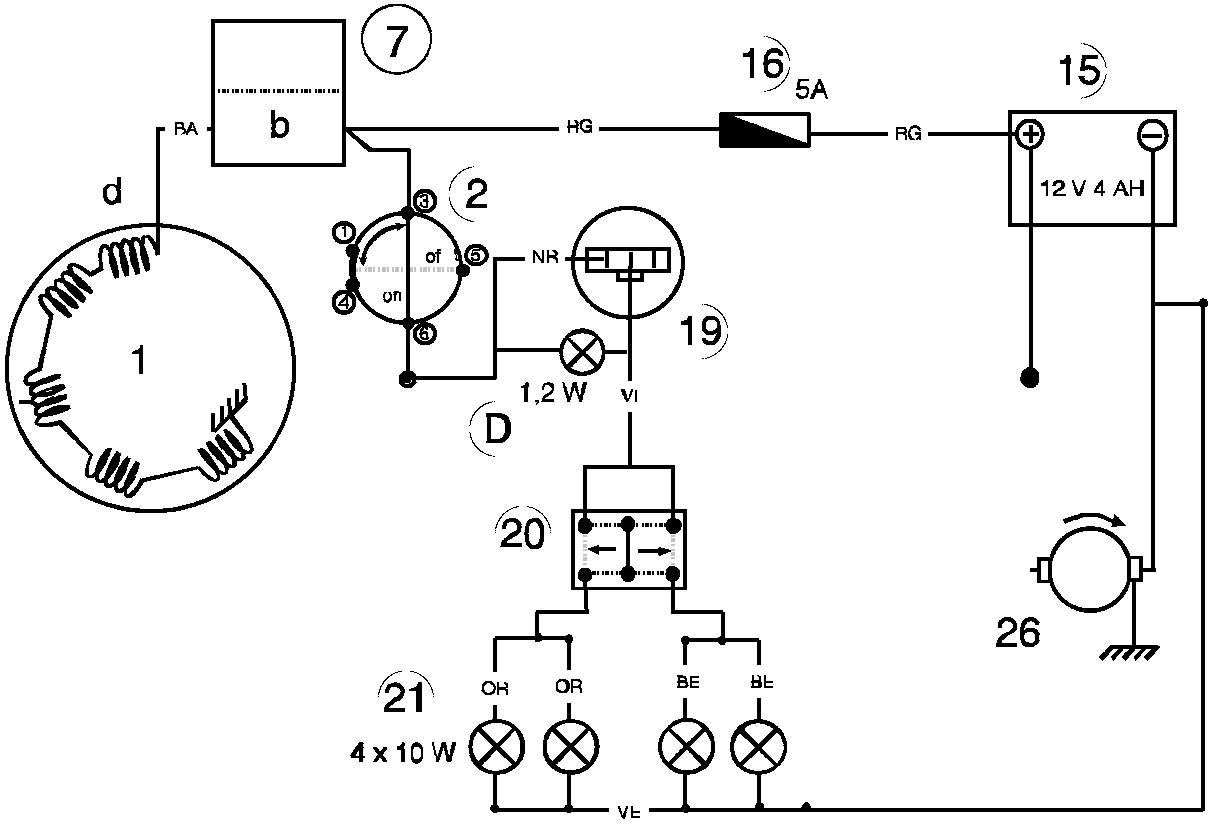
Oil pressure circuit



The oil pressure telltale circuit is supplied by direct current.
When the oil pressure is low (< 0.4 b), the oil pressure telltale is supplied by a low oil pressure contact located on the engine (37).

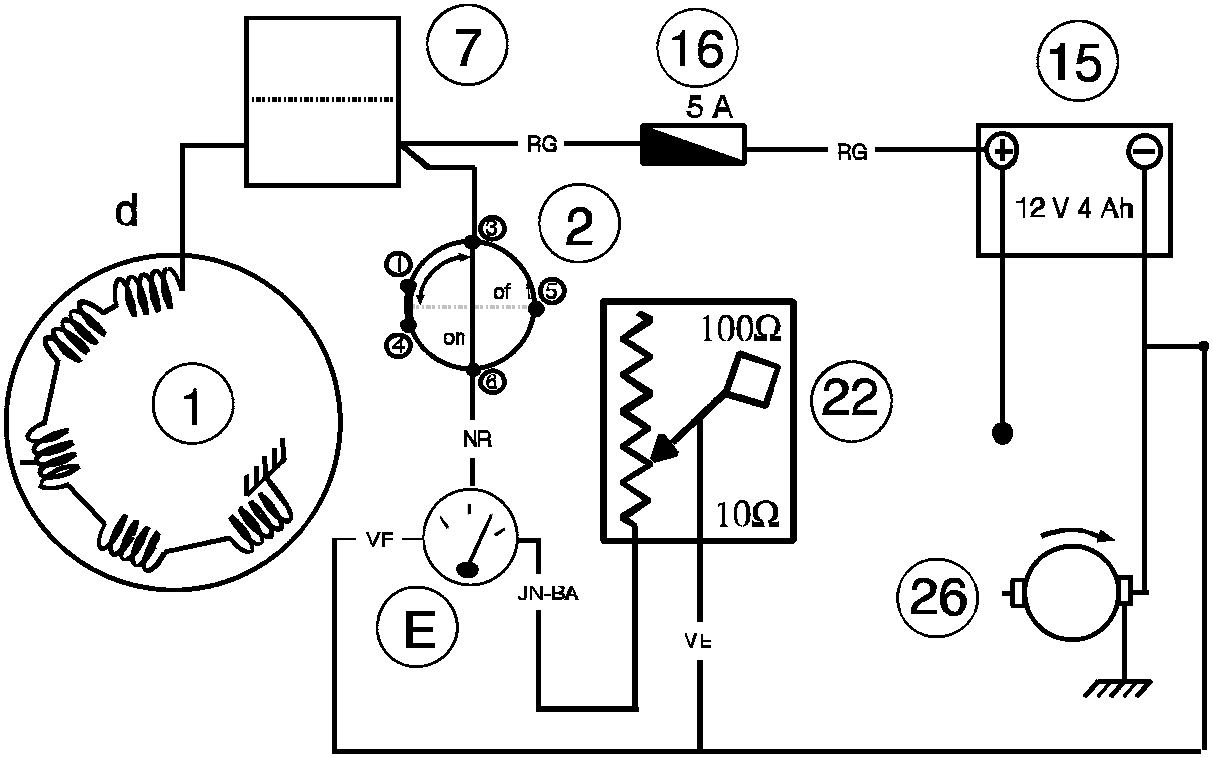
Note: in the ignition positive position but with the engine at a standstill, there is no oil pressure and therefore the telltale will come on.

Indicator circuit



The indicator circuit is supplied by direct current.
Having selected the side for the indicator function using the control button (20), the indicator control unit supplies the lamps (21) with an intermittent current.

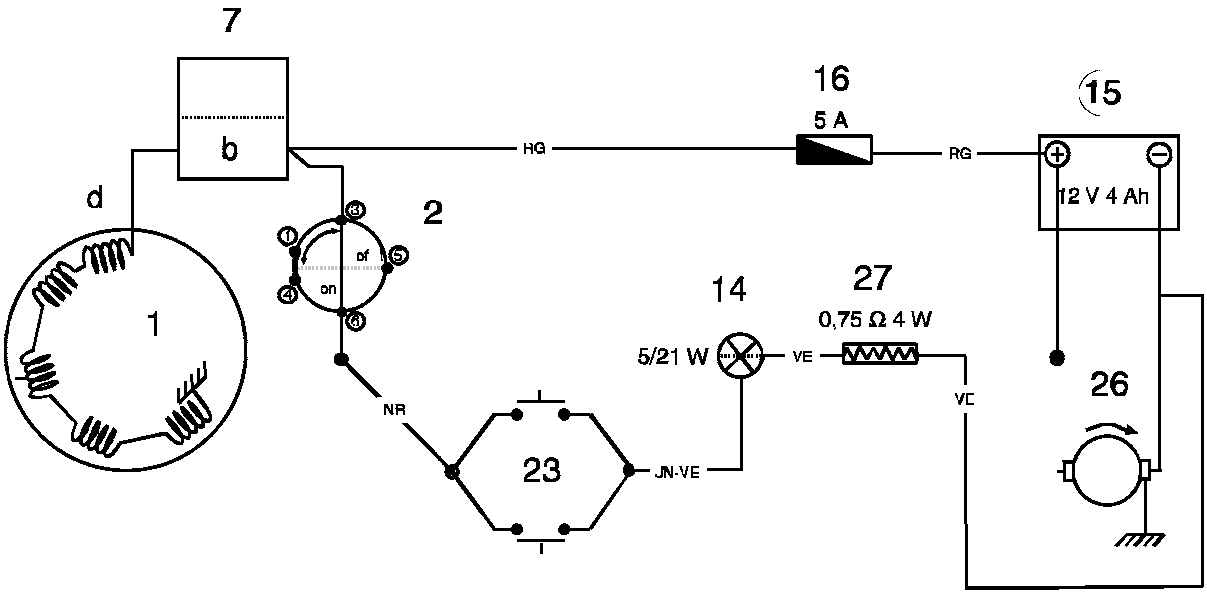
Fuel gauge circuit



The fuel gauge circuit is supplied with a direct current.
The dial (E) analyses the variation in intensity of the current passing through the variable resistance linked to the fuel gauge float (22) and displays this value, which is proportional to the level of fuel, on the dial (E). If the tank is full, resistance is minimum, hence maximum current; if the tank is empty, resistance is maximum, hence minimum current.

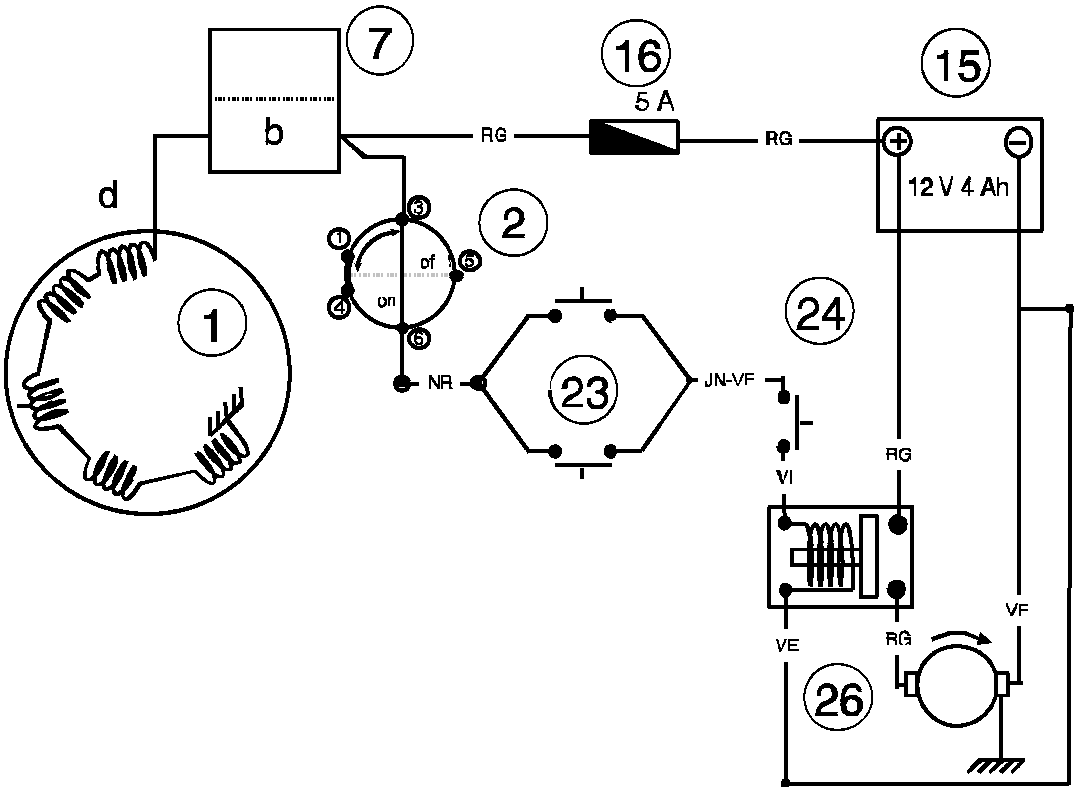
Note: a short circuit on the wire linking the dial to the gauge results in the level indicator remaining blocked on the maximum level. In the case of a wire being cut, the dial remains blocked on the empty position.

Stop light circuit



The stop light circuit is supplied by a direct current.
On certain vehicles, in order to avoid the stop light contacts (23) being damaged during repeated lighting up of the stop light (14), the current can be limited by the resistance (27).

Starter motor circuit

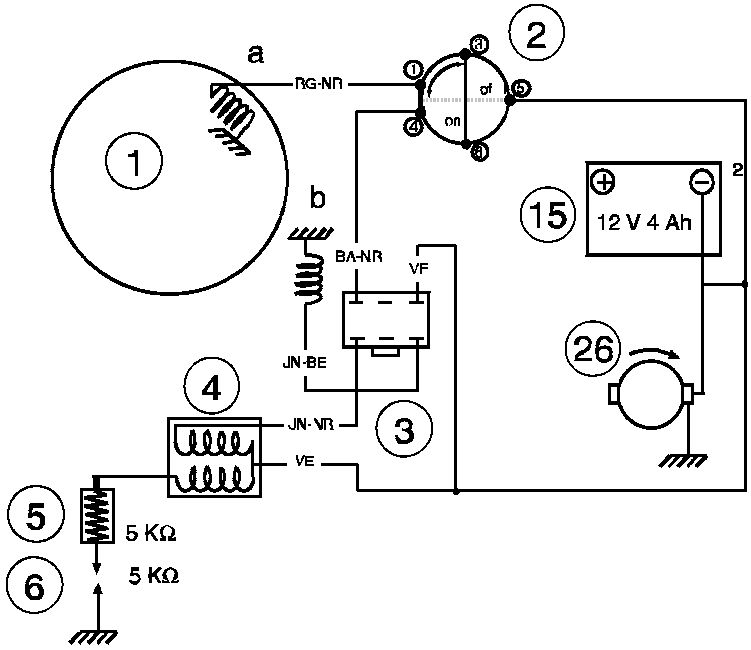


The starter motor is supplied by the battery, which must thus be sufficiently charged in order to allow it to operate. The starter motor is the biggest consumer of current on the vehicle. Furthermore, frequent use of the starter motor on a vehicle which does not do a lot of mileage will rapidly lead to complete discharging of the battery.

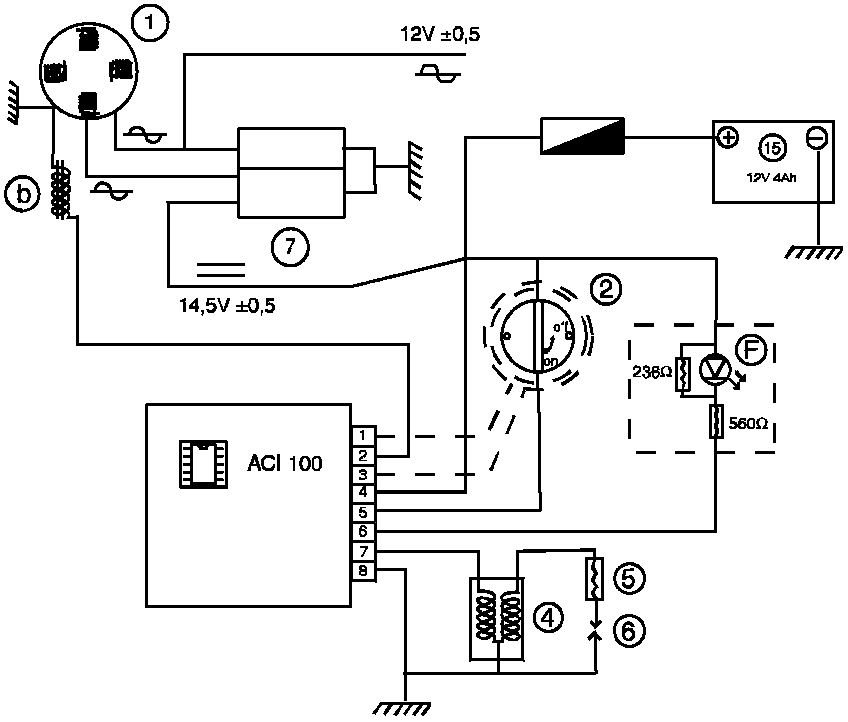
To start, it is necessary to activate one of the brake contacts (23) at the same time as the starter contact (26) in order to supply the starter motor relay (24).

Note: if the battery fuse (16) has blown, the starter motor can not function.

Ignition circuit

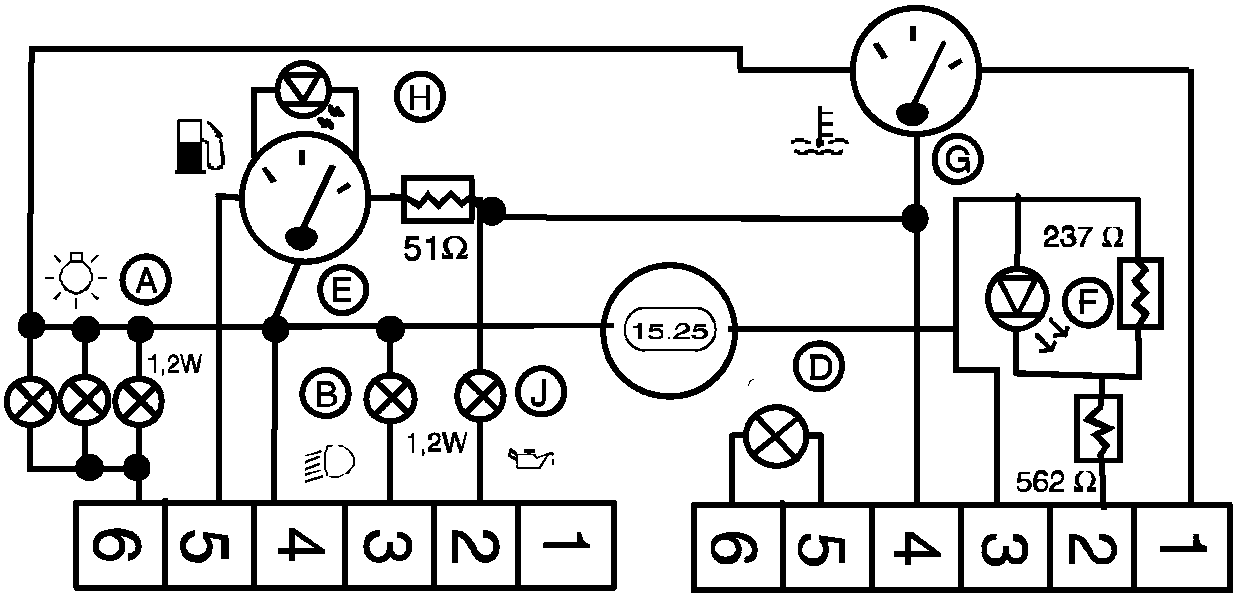


CDI ignition:
The ignition circuit is supplied by the flywheel.
A position sensor (b) integrated into the flywheel triggers the ignition (3), which supplies the coil (4) thus providing the spark at the spark plug (6).



ACI 100 ignition:
The ignition is normally supplied by the battery, but it can function directly off the flywheel.

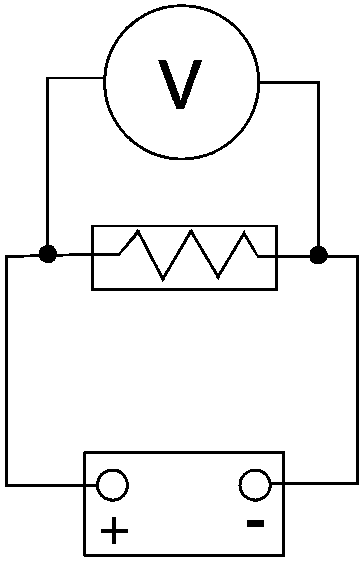
Instrument cluster circuit



The instrument cluster provides all the information necessary for the driver, diagnostic warning light, dials, control lights.

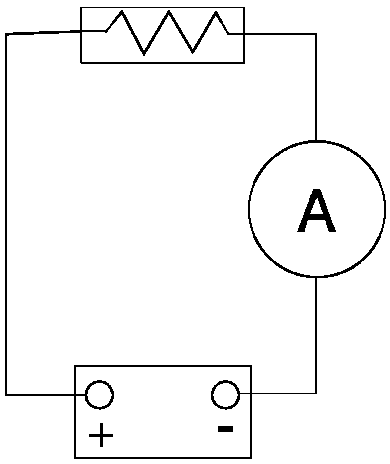
12. Measuring equipment

The Voltmeter



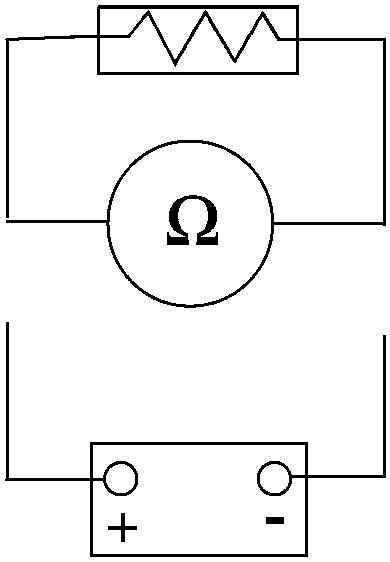
This enables the voltage to be checked. It is connected up in parallel on the component to be checked. Two types of voltmeter are available, one for alternating current and one for direct current.

The Ammeter



This enables current to be measured. It is connected up in series on the component to be checked.

The Ohmmeter



This enables the resistance to be measured.
Important: In order to carry out the measurement, the component must be disconnected from the supply and from the circuit. If an Ohmmeter is used on a circuit with the supply on, this could lead to destruction of the Ohmmeter.
It is connected up in parallel with the component to be checked.

The Multimeter

This is a piece of equipment which groups together all the checking functions, ammeter, voltmeter, ohmmeter, as well as providing other functions such as checking diodes, checking continuity etc.