Technical Explanations

Ferromagnetic

Magnetic properties of substances with a permeability μr » 1.

Open Magnetic Circuit

The entirety of all parts penetrated by the magnetic flux Φ which is supplemented by the workpiece (anchor).

Magnetic Pole N (North) S (South)

The place where the magnetic flux leaves resp. enters the holding solenoid.

Holding Force F_H

The force required to tear off a workpiece perpendicular to the holding surface when the device is switched on. The details in the data sheets refer to the total holding surface and an optimal material thickness.

Displacement Force F_V

The force required to displace a workpiece parallel to the holding surface when the device is switched on. Depending on the quality of the workpiece surface it amounts to 20...30% of F_H ($^1/_4$ F_H).

Air Gap δ_L

The mean distance between the holding surface of the solenoid and the bearing area of the workpiece. Shape and roughness of the surfaces facing each other and non-magnetic substances between them (e.g. galvanic coatings, varnish, scale) determine its size.

Remanence

The holding force remaining between holding solenoid and workpiece when the device is switched off without reversion of polarity. Depending on the workpiece and material it amounts to 20 and 40% of F_H.

Insulation Class

Depending on the permanent heat resistance the insulation classes are divided acc. DIN VDE 0580.

Thermal Class Insulation Class Temperature Class	Maximum permitted limit temperature
Y	95 °C
A	105 °C
E	120 °C
B	130 °C
F	155 °C
H	180 °C

Reversion of Polarity

Reduction of the remanence remaining between holding surface and workpiece by means of a time or current dosed reverse pulse.

Demagnetization

Reduction of the field intensity H_C. in the workpiece. It involves a polarity reversal with decreasing amplitude.

Relative Duty Cycle ED

The ratio between duty cycle and circular-trip time, e.g. expressed in per cent (% ED). In general, the electromagnetic holding solenoids are designed for 100% ED and Permanent Magnetic Holding Solenoids are designed for 25%.

Warmed Up Condition

The excessive temperature identified acc. DIN VDE 0580, increased by the reference temperature. Unless otherwise indicated the reference temperature is 35°C.

Protection Class

Designates the kind of shielding of the device against outer influences.

IP 6 5

Code letters — IP
Code no. 1 — 6
Code no. 2 — 5

Code no. 1	Scope of protection Protection against contact / foreign substances
0	no protection
1	protection against large foreign substances
2	protection against medium-sized foreign substances
3	protection against small foreign substances
4	protection against grain-shaped foreign substances
5	protection against dust deposit
6	protection against dust penetration

Code no. 2	Scope of protection Protection against water
0	no protection
1	protection against vertical dripping water
2	protection against dripping water falling at an angle
3	protection against spray water
4	protection against splashing water
5	protection against hose water
6	protection against flooding
7	protection during immersion
8	protection during submersion

Magnetic Flux Φ

Every permanent magnetic holding solenoid or electromagnetic holding solenoid generates a magnetic field at the holding surface between the north and south poles. By covering it with a workpiece the open magnetic circuit is closed and the usable magnetic flux F is increased. The number of lines of force penetrating a random surface A vertically per cm² is the flux density or the magnetic induction B .

$$\emptyset = B * A$$

The higher the magnetic flux Φ penetrating the workpiece is in case the holding surface remains unchanged or the higher induction B is the higher will be holding force F_H.

$$F_H = \left(\frac{B}{5000}\right)^2 * (A_1 + A_2)$$

It is determined by the unfavourable resistance in the magnetic circuit. So the maximum holding force a workpiece can achieve depends on:

- the size of its bearing area
- its material properties
- the roughness of its bearing area
- the covering of the magnetic holding surface in per cent
- the air gap δ_L

Workpiece and Bearing Area

The bearing area is the contact area with which the workpiece rests on the holding solenoid. It does not always equal the size of the workpiece. The holding force per surface unit of a holding solenoid is almost identical across thetotal holding surface.

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Particularly by the size of its bearing area the workpiece determines the maximum holding force to be achieved.

Workpiece and Material

The components of the holding solenoids which carry the magnetic flux are out of soft iron of high permeability. Due to the high magnetic conductivity of these parts the maximum holding force to be achieved depends, among other things, on the permeability of the workpiece. The workpieces differ in their structural constitution and composition. Additions of carbon, chrome, nickel, manganese, molybdenum, copper, etc. reduce the magnetic conductivity. In addition, the holding force is reduced if workpieces are hardened. The higher the hardness the more unfavourable is the magnetic conductivity.

$$B = f(H)$$

Fixing and grouping

Using several holding solenoids

a) A non-rigid fixing is required for every holding solenoid so that each one can adapt to uneven surfaces (Fig. 1).

b) Every holding solenoid should be springmounted below a transverse rail to dampen the stroke acceleration so that in the case of uneven bearing surfaces the difference between the loads carried by the individual magnets does not vary too greatly (Fig.2).

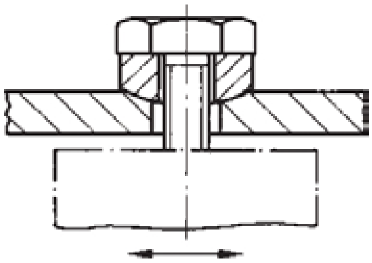

Fig. 1: Individual fixing

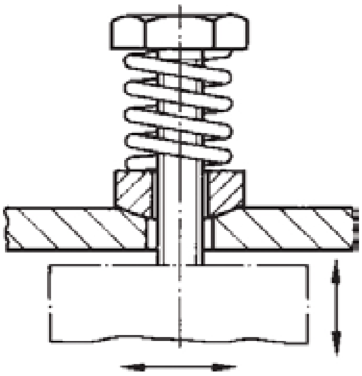

Fig. 2:Ideal fixing for group of magnets