09/90 -Sr-

Instruction Sheet **560 31**

Pair of Bored Pole Pieces

The pole pieces in conjunction with the U-core (562 11) or the large coil holder (562 34) and coils (562 13 or 562 14) are used to assemble an electromagnet with homogeneous or inhomogeneous magnetic field so that, using further accessories, a variety of experiments in the magnetic field can be performed.

1 Description

The standard equipment includes: (see Fig. 1)

① 2 pole pieces of magnetic soft iron, 4 cm x 4 cm cross-sectional area, approx. 10 cm length; with a longitudinal borehole, one conical and one flat, ground end and one ground side.

② 2 additional pole pieces, disk-shaped, 55 mm dia., provided with threaded stems for screwing into the longitudinal boreholes at the flat end of the pole pieces.

③ 2 soft-iron inserts for screwing into the longitudinal boreholes at the flat end of the pole pieces.

④ 2 clamps for fitting the pole pieces to the U-core (562 11).

2 Notes on Experiments

2.1 Assembly of an electromagnet

2.1.1 General

Depending on the desired strength of the magnetic field, the following equipment is required:

a) For strong magnetic fields:

When using the U-core (562 11): 2 coils with 250 turns (562 13) with 2 pole pieces and accessories (560 31), placing the pole pieces with their ground sides on the U-core arms and fixing them by means of the clamps (see Figs. 2.1, 3.1 and 4.1).

When using the large coil holder (562 34): 1 coil with 250 turns (562 13) with one pole piece and accessories (from 560 31) (see Figs. 5 and 6).

b) For weak magnetic fields:

Instead of coil with 250 turns, use coil with 500 turns (562 14).

2.1.2 Different assemblies

See fig. 2.1-6 on separate sheet.

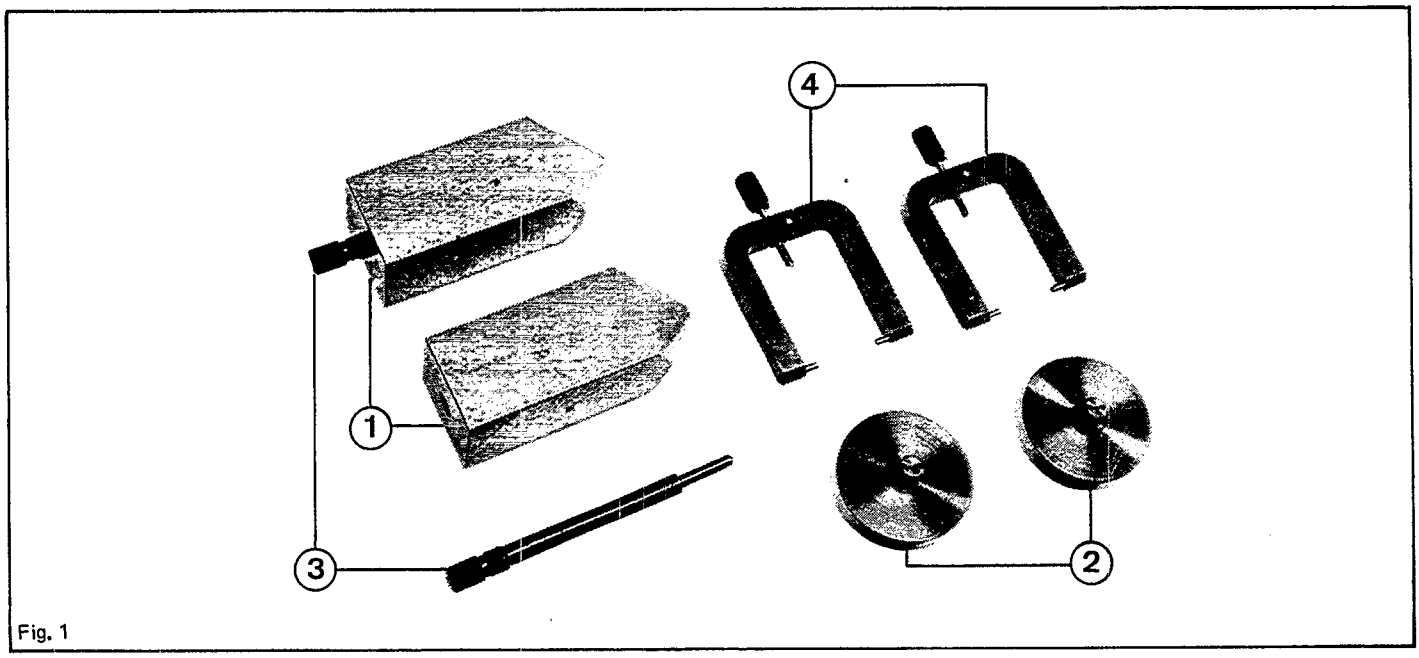

Fig. 1

2.2 Suitable d. c. low-voltage sources, max. load 10 A, are:

Variable low-voltage power supply (522 39)
Low-tension tapping transformer (522 38)
Nickel-cadmium accumulator, 30 Ah (522 71)

Note:

Connect d. c. voltage source and pair of coils according to Fig. 7.1 or 7.2 by connecting cables (501 20 et seq) so as to achieve unlike poles on the pole pieces.

When performing current measurements in the parallel circuit according to Fig. 7.2, make sure that the coil current is half the total current.

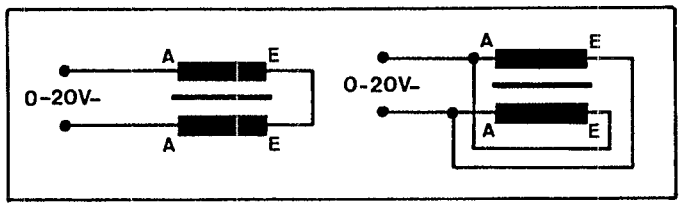

Fig. 7.1 Fig. 7.2

2.3 General notes on the coils used

When using the coils mentioned under 2.1.1 to assemble an electromagnet, approximately the following current-voltage characteristics will be obtained (see Fig. 8).

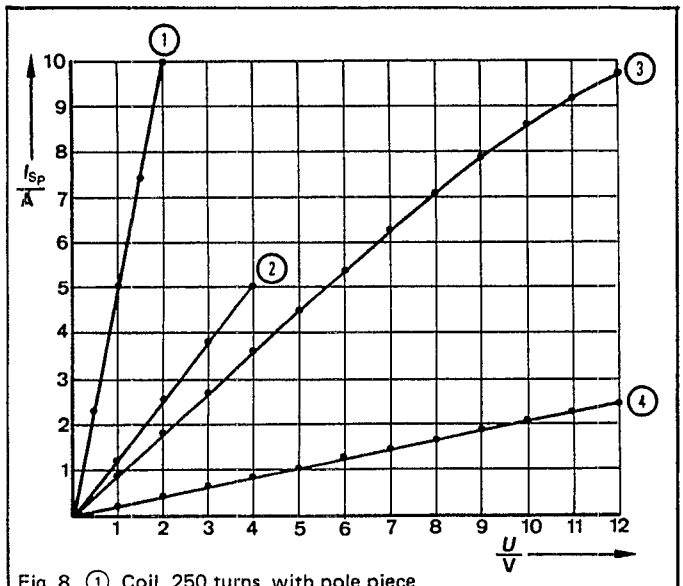

Fig. 8 ① Coil, 250 turns, with pole piece
② Coil, 500 turns, with pole piece
③ 2 coils with 250 turns on U-core
④ 2 coils with 500 turns on U-core
Power supply: for ① to ④ variable low voltage power supply (522 39)

Note:

The coils with 250 and 500 turns, max. admissible constant currents 5 A and 2.5 A, can be loaded for short times to twice these values.

For constant currents exceeding 3 A preferably coils with 250 turns should be used.

3 Examples of Experiments

For setting up the experimental assemblies see respective Instruction Sheets.

a) Waltenhofen's pendulum (560 34)
The two flat ends of the pole pieces should face each other with a spacing of approx. 8 mm. To fit the pendulum use the clamp with knife-edge bearings (342 07) fixed on stand material.

b) Rotatable aluminium disk with U-shaped iron staple (560 32)
The assembly of the pole pieces is the same as under a); the aluminium disk is fitted using stand material.

c) Barlow's wheel (560 35)
The pole pieces provided with soft-iron inserts are arranged so that their conical ends are facing each other with a spacing of approx. 12 mm. Barlow's wheel is fitted by stand material.

d) Apparatus for experiments on para- and diamagnetism (560 41)
The pole pieces provided with soft-iron inserts are arranged so that their conical ends are facing each other with a spacing of approx. 12 mm. The holding device for the test rods is mounted on stand material.

e) Verification of the Faraday effect using the apparatus for demonstrating the rotation of the plane of polarization (560 48)
The pole pieces should face each other with their conical pole surfaces and be fitted in such a way that the flint glass rod can be arranged longitudinally between the pointed ends of the pole pieces using its holding rod.

f) Experiments on the magnetic deflection of β-rays using the swivelling clamp (559 23)
The flat ends of the pole pieces should be spaced 12 to 15 mm apart after fastening the swivelling clamp in the longitudinal borehole of one pole piece.

g) Hall effect apparatus (586 81)
After the Hall effect apparatus has been arranged between the arms of the U-core, the pole pieces should be approached by their flat ends on both sides to the aluminium plate and secured.

h) Ampere balance (516 32)
for demonstrating the dynamic effect on life conductors within a magnetic field.

i) Deflection chamber for nuclear rays (559 22)
for determining the specific charge of α-particles.

j) Hall probe (516 50)
for detecting and measuring magnetic fields.

For descriptions of experiments see booklet by Friedrich and Kröncke „The Demountable Transformer" (562402).

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c)

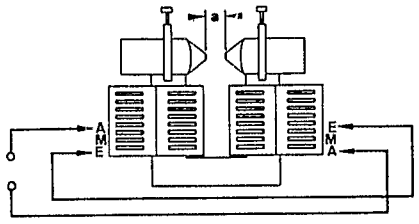

Fig. 4.1
Aufbau eines Elektromagneten mit inhomogenem Magnetfeld (stärkere, inhomogenere Felder bei Einschrauben der Weicheiseneinsätze)
Asembly of an electromagnet with inhomogeneous magnetic field (stronger, inhomogeneous fields are obtained when screwing in the soft-iron inserts)
Montage d'un électro-aimant à champ magnétique inhomogène (champ magnétique plus intense et plus inhomogène par vissage des noyaux polaires en fer doux)
Montaje de un electroimán con campo magnético inhomogéneo (campo magnético más intenso y más inhomogéneo con los núcleos de hierro dulce atornillados)

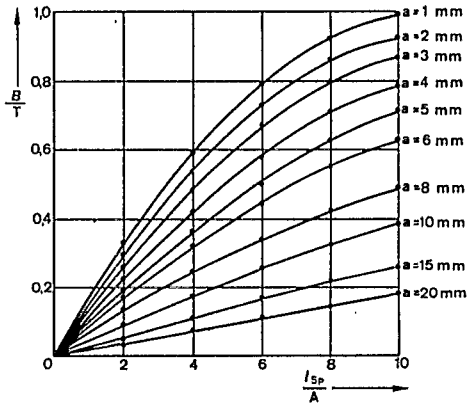

Fig. 4.2
Diagramm der in der Mitte zwischen den Polschuhen gemessenen Feldstärke B in Abhängigkeit vom Abstand a und dem Spulenstrom I_{Sp}*
Graph of the field strength B measured in the middle between the pole pieces as a function of distance a and coil current I_{Sp}*
Diagramme montrant la valeur de l'induction magnétique B mesurée au milieu de l'espace inter-polaire, en fonction de l'intensité I_{Sp} dans la bobine pour diverses valeurs de la distance a*
Diagrama de la intensidad de campo B medida en la mitad entre las piezas polares en función de la distancia a y la corriente de bobina I_{Sp}*.

d)

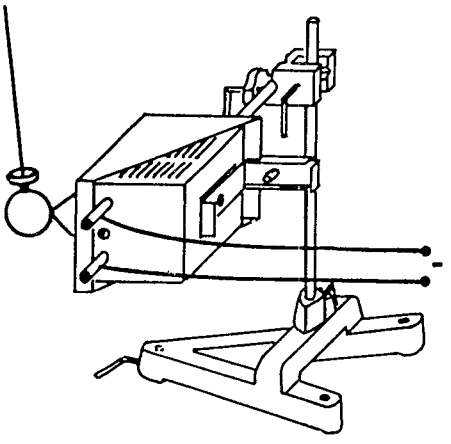

Fig. 5
Elektromagnet mit konischer Polfläche; dient zum Festhalten von Kugeln, z.B. im Versuch zum Foucault Pendel oder Freier Fall
Electromagnet with conical pole face; is used for holding spheres, e.g. in experiments on Foucault pendulum or free fall
Electro-aimant à extrémité polaire conique. Sert à maintenir des sphères, par ex. dans l'expérience du pendule de Foucault ou pour la chute libre
Electroimán con extremo polar cónico; sirve para sujetar esferas por ej. en el experimento del péndulo de Foucault o de la caída libre

e)

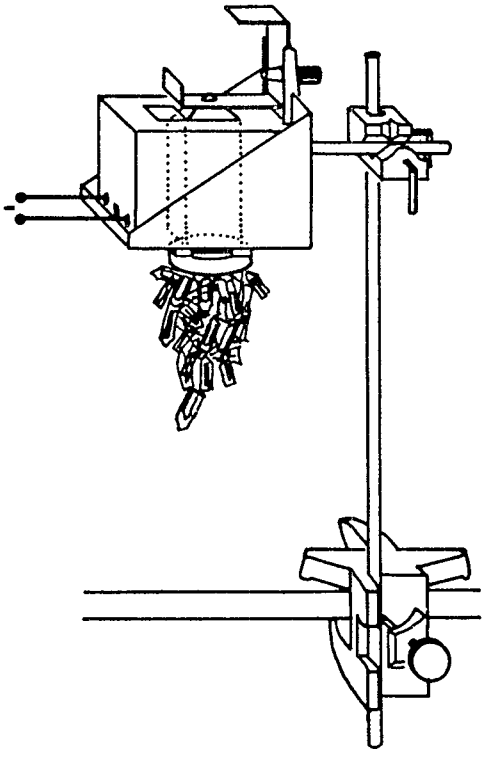

Fig. 6
Elektromagnet mit großer runder Polfläche; dient z.B. zur Demonstration der Wirkungsweise eines Elektromagneten
Electromagnet with large, round pole face; is used e.g. to demonstrate the action of an electromagnet
Electro-aimant à extrémité polaire circulaire plane; sert par ex. à montrer comme agit un électro-aimant
Electroimán con extremo polar circular plano; sirve por ej. para mostrar como funciona un electroimán

2.1.2 Verschiedene Aufbaumöglichkeiten

2.1.2 Diversas posibilidades de montaje

a)

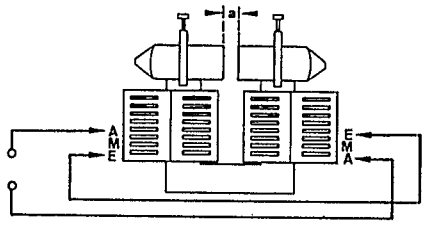

Fig.2.1
Aufbau eines Elektromagneten mit einem kräftigen, homogenen Magnetfeld
Assembly of an electromagnet with a strong, homogeneous magnetic field
Montage d'un électro-aimant à champ magnétique intense et homogène
Montaje de un electroimán con campo magnético fuerte y homogéneo

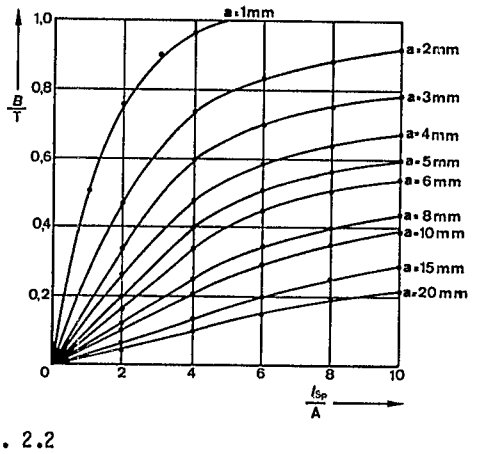

Fig. 2.2
Diagramm der zwischen den Polschuhen gemessenen Feldstärke B in Abhängigkeit vom Abstand a und dem Spulenstrom I_{Sp}*
Graph of the field strength B measured between the pole pieces as a function of distance a and coil current I_{Sp}*
Diagramme montrant la valeur mesurée de l'induction magnétique B en fonction de l'intensité I_{Sp} circulant dans la bobine, pour diverses valeurs de la distance a
Diagrama de la intensidad de campo B medida entre las piezas polares en función de la distancia a y la corriente de bobina I_{Sp}*.

b)

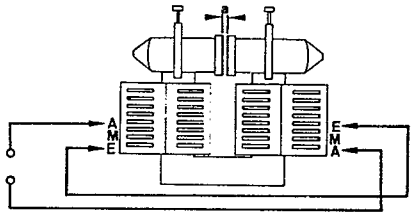

Fig. 3.1
Aufbau eines Elektromagneten mit einem ausgedehnten, homogenen Magnetfeld
Assembly of an electromagnet with an extended, homogeneous field
Montage d'un électro-aimant à champ magnétique homogène et étendu
Montaje de un electroimán con campo magnético homogéneo amplio

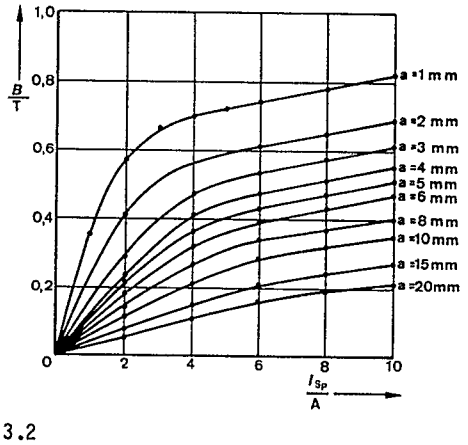

Fig. 3.2
Diagramm der zwischen den Polschuhen gemessenen Feldstärke B in Abhängigkeit vom Abstand a und dem Spulenstrom I_{Sp}*
Graph of the field strength B measured between the pole pieces as a function of distance a and coil current I_{Sp}*
Diagramme montrant la valeur mesurée de l'induction magnétique B en fonction de l'intensité I_{Sp} circulant dans la bobine, pour diverses valeurs de la distance a
Diagrama de la intensidad de campo B medida entre las piezas polares en función de la distancia a y la corriente de bobina I_{Sp}*.

*) Hinweis zu den Abbildungen 2.2; 3.2 und 4.2:

Die Diagramme wurden unter Verwendung von 2 in Reihe geschalteten Spulen mit 250 Windungen und dem Kleinspannungsstelltrafo (522 39) als Netzgerät erstellt. Bei Erstellung der Diagramme mit parallel geschalteten Spulen muß darauf geachtet werden, daß der Spulenstrom und nicht der Gesamtstrom gemessen wird.

*) Notes concerning Figs. 2.2, 3.2 and 4.2 ($I_{SP} = I_C$):

The graphs were plotted using 2 coils with 250 turns connected in series and the variable low-voltage power supply (522 39) as power supply unit. When plotting graphs using coils connected in parallel make sure to measure the coil current and not the total current.

*) Nota relativa a los diagramas 2.2; 3.2 y 4.2:
Estos diagramas fueron obtenidos empleando 2 bobinas de 250 esperiras conectadas en serie, alimentadas por el transformador de regulación para tensiones bajas (522 39). Para diagramas con las bobinas en paralelo, hay que poner atención a medir la corriente de las bobinas y no la corriente total.

*) Remarque concernant les diagrammes 2.2; 3.2 et 4.2:

Ces diagrammes ont été obtenus lors d'expériences utilisant deux bobines de 250 spires branchées en série, alimentées par le transformateur de réglage basse tension (522 39). Si l'on branche les bobines en dérivation, il faut veiller à mesurer l'intensité du courant dans la bobine, et non pas l'intensité totale, pour obtenir ces diagrammes.