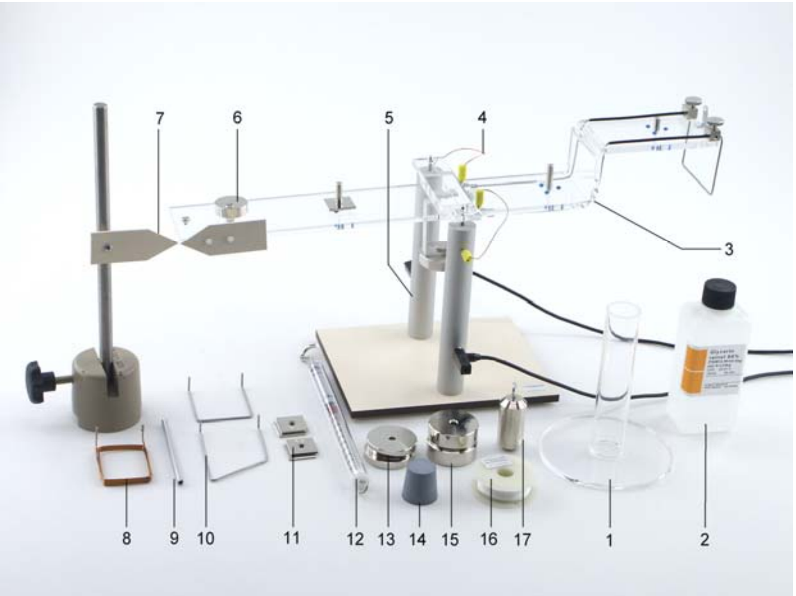
3B SCIENTIFIC® PHYSICS

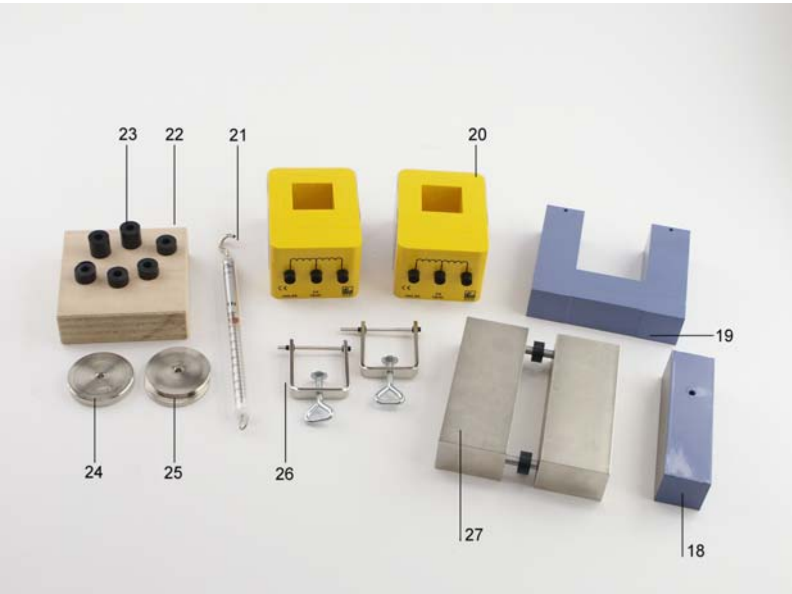
Langensiepen Current Balance U8496820

Instruction Sheet

06/09 ERL



1 Cylinder for friction brake
2 Glycerine
3 Balance beam with pointer
4 Current input terminals
5 Stand
6 Counterweight
7 Pointer for zero calibration
8 Coil, 5 turns
9 Aluminium tube
10 Conductor loop
11 10 g weight
12 Dynamometer
(from accessory set)
13 Drive weight, 100 g
14 Rubber bung
15 Drive weight ,200 g
16 Nylon thread
17 Piston for friction brake



18 Yoke
19 Transformer core
20 Coil, 600 turns
21 Dynamometer 0,1 N
22 Storage block
23 Spacer rings
24 200 g weight
25 100 g weight
26 Fixing clamp
27 Pole shoe set

1. Safety instructions

All the components of the instrument are safe to work with, provided that they are used in accordance with instructions and regulations.

The transformer core, yoke and pole shoes should be handled carefully to avoid the risk of injuries resulting from their considerable weight.
In experiments involving a strong magnetic field, do not allow any ferromagnetic materials to come near the instrument, as they would be powerfully attracted towards it with a risk of damage or injury, for example through trapping of fingers.
Equipment that is to be connected to the mains must be checked for any damage before it is used.

2. Description

The Langensiepen current balance is used for experiments on electrodynamics and Lorentz forces and involves measurements in which the force on a conductor in a magnetic field is balanced mechanically.

3. Equipment supplied

1 Stand with agate cup bearings for balance beam

1 Balance beam with pointer and terminals for current connections

1 Set of conductor loops

1 Coil, 5 turns

1 Pointer for zero calibration

1 Hydrodynamic friction brake

2 Special connecting leads

1 Bottle of glycerine (250 ml)

2 Drive weights, 100 g and 200 g

1 Counterweight weight

2 19 g weights

1 Reel of nylon thread

1 Instruction sheet

1 Transformer core with yoke and fixing clamp

1 Pole shoes set

2 100 g weights

1 200 g weight

2 Coils, 600 turns

1 Storage block

1 Dynamometer, 0.1 N

10 Spacer rings

4. Operation

4.1 Generating a strong magnetic field

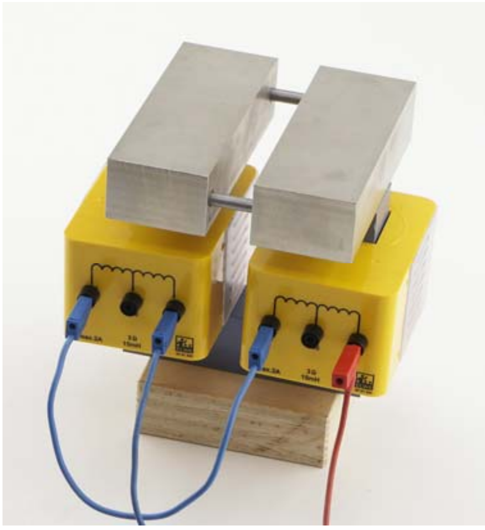


Fig. 1

The strong magnetic field generator is assembled as shown in Figure 1 using the following components from the accessories set U8496818: U-core (19), two coils (20), pole shoes (27).
The connecting leads chosen must be long enough to ensure that they do not cause any mechanical obstruction to the operation of the current balance.
The pole shoes (27) are placed on the core (19) without any special fixing. They rest in place securely enough under their own weight, and when the field is applied they are held more firmly. The distance between the pole shoes is determined by the choice of spacer rings (23), giving a separation of 10, 15 or 20 mm when used singly, or 25, 30, 35 or 40 mm by combining them. The field between the pole shoes is approximately uniform.
It is recommended that a stabilised DC power supply U33020 is used as the voltage source for excitation of the magnet (see Fig. 3). When switching the field on or off, the large inductance of the system must be taken into account by avoiding switching a large current.
The following table contains some guideline data on the magnetic flux density *B* that can be generated with different values of the coil current and spacing of the pole shoes. The magnet set-up consists of the U-core with two 600-turn coils connected in series.

Pole shoe separation	1 cm	2 cm	3 cm
Excitation current	Flux *B*	Flux *B*	Flux *B*
2 A	0.18 T	0.15 T	0.12 T
1 A	0.13 T	0.09 T	0.07 T
0.5 A	0.06 T	0.04 T	0.03 T

4.2 Current balance

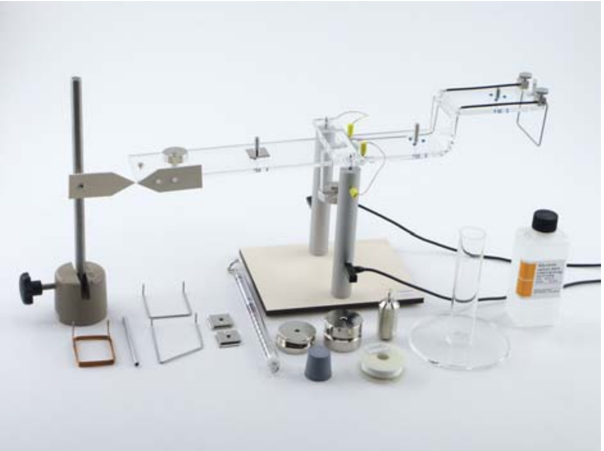


Fig. 2

The current balance (Fig. 2) consists of a stand (5), the balance beam (3), a pointer for zero calibration (7), three interchangeable conductor loops (10) and a coil with 5 turns (8).
The current in the loop or coil is applied via the stand (maximum continuous current 2 A, or up to 4 A for short periods).
The conductor loops are of different lengths. An aluminium tube (9) can be clipped into the 10 cm loop to increase the conductor cross-section.
After fitting one of the loops in place, the instrument must first be mechanically balanced. The zero position is marked by setting a pointer. Coarse adjustment is carried out using 10g weights (11), which are placed on the pegs provided on the beam. That is followed by a fine adjustment using the counterweight on the beam.

4.3 Induction set-up

Fig. 3

The induction set-up (Fig. 3) consists of a current balance and a strong magnetic field, to which a drive for moving the current loop (10) into or out of the near-uniform magnetic field between the pole shoes is added. The drive provided by the weights (13, 15, 24, 25) in combination with the friction brake produces a steady upward or downward movement of the cobductor loop (10) or the coil (8).
A choice of different spacer rings (23) between the pole shoes gives a range of magnetic flux densities with the same excitation current.
The induced voltage during the movement of the loop or coil, as measured by a microvoltmeter (U8530501), can remain constant over a period of up to 30 seconds.

4.4 Force on a current-carrying conductor

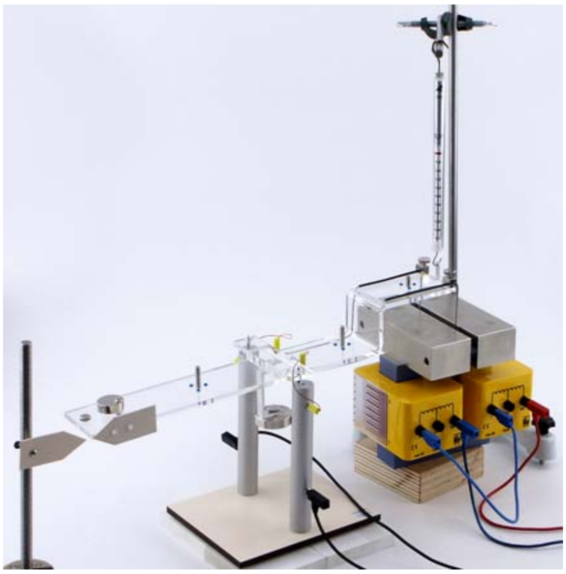


Fig. 4

Initially the distance between the pole shoes should be set at 10 mm. The current loop (length l = 5 cm) is connected in position and the current balance is adjusted for equilibrium.

The strong magnetic field is switched on and a DC current (I = 2 A) is passed through the current loop (using a second meter to measure the current).

The balance is restored to the equilibrium condition by raising the dynamometer.

If the magnetic field generator is then shifted slightly (without disturbing the current loop), the adjustment of the current balance remains unaltered, showing that the magnetic field between the pole shoes is uniform.

When the length l of the loop and the current I passing through it are changed, the following can be observed:

$F \sim l$ and $F \sim I$, also $F \sim I \cdot l$

Varying the magnetic field excitation current or the separation between the pole shoes also changes the measured force.

Therefore the coefficient of proportionality in the relationship where $F \sim I \cdot l$ can also be changed as a result changing the field arrangement. This is one appropriate way of characterising the field set-up.

Definition: $F = B \cdot I \cdot l$ or $B = \frac{F}{I \cdot l}$.

The measured force is independent of the cross-sectional area of the conductor loop. This can be easily shown by clipping the aluminium tube that is provided into the loop (l = 10 cm).

Elwe Didactic GmbH • Steinfelsstr. 6 • 08248 Klingenthal • Germany • www.elwedidactic.com
3B Scientific GmbH • Rudorffweg 8 • 21031 Hamburg • Germany • www.3bscientific.com