LEYBOLD DIDACTIC GMBH

7/89 — Brs —

Instruction Sheet 516 31-33/37

Current Balance
Vertically Adjustable Stand
Set of Conductors for Ampere Definition
Electrostatics Accessories for the Current Balance

The *current balance* (516 32) is made of nonmagnetizable materials and its operating principle is based on that of a difference balance.

With the current balance it is possible to measure small differences between forces as they occur in many experiments on electricity. The *conducting loops* which are included are used to measure the force acting upon current carrying conductors placed in a magnetic field.

With the *vertically adjustable stand* (516 31) it is possible to adjust the vertical position of test objects on the bench in a very accurate manner; mainly for use with the current balance (516 32) in connection with the *set of conductors for the electrodynamic ampere definition* (516 33) for measuring the forces between two current carrying conductors or with the *electrostatics accessories for the current balance* (516 37) for measurement of forces between electrically charged objects.

Literature:
Physics Experiments, Volume 2 (599 932)
New Physics Leaflets for Colleges and Universities, Volume 1 (599 952)
New Physics Leaflets for Colleges and Universities, Volume 2 (599 892)

1 Safety Notes

- Max. current through the conductors is 10 A.
- The maximum current may be only applied for a period of up to 2 minutes; otherwise excessive heating will bend the conductor loops!

2 Scale of Delivery, Description, Technical Data

2.1 Current balance (516 32)

Scale of delivery:

Support
Balance arm
Spring balance mount
Pintail

6 Conducting loops (lengths: 80, 40, 20 and 10 mm, shape of the loops: see Fig. 1.1, item ⑭)
4 Strips of aluminium foil for current supply to the loops (15 mm x 120 mm)
1 Roll of aluminium foil which can be cut to length for replacing the aluminium foils supplied with the unit
Perlon thread, approx. 10 cm long
1 Hex socket wrench

Additionally required:	Cat. No.
1 Stand base	300 01
1 Stand rod, 47 cm	300 42
or	
1 Stand rod, 25 cm	300 41
1 Dynamometer 0.01 N	314 081
or	
1 Dynamometer 0.1 N	314 111

Additional tools:

1 Cross-head screw-driver
Light-spot indicator, see 3.1.2

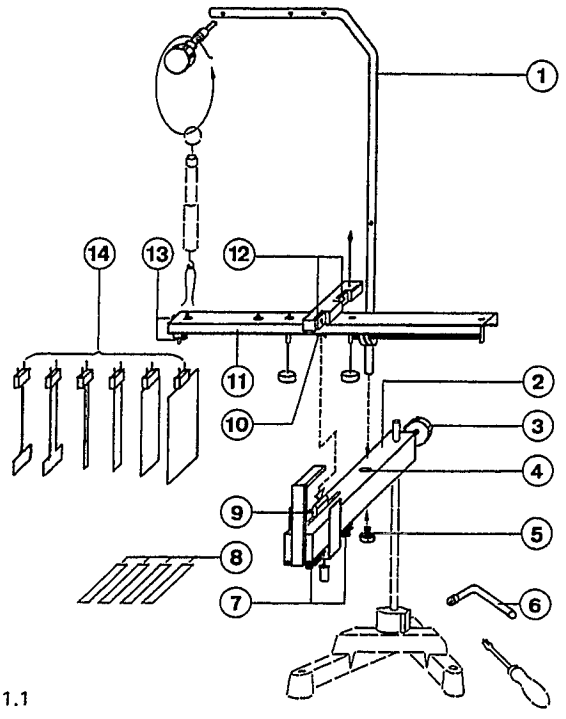

Fig. 1.1

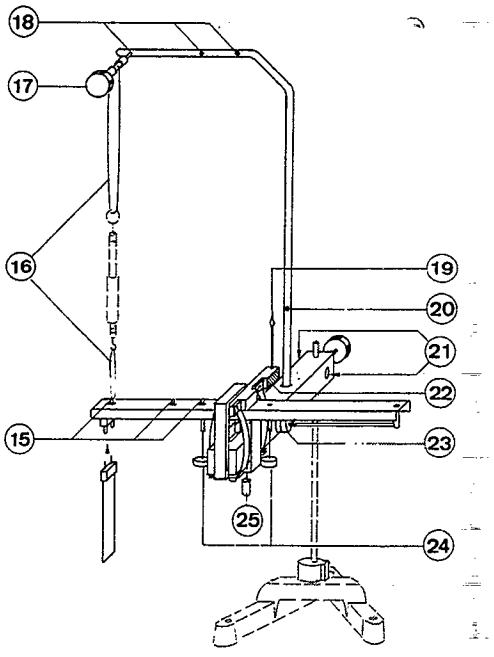

Fig. 1.2

Parts of the assemby

① Mount for dynamometer
② Support
③ Fastening screw for support ②
④ Countersunk hole for ①
⑤ Hex screw for securing ①
⑥ Hex socket wrench for ⑤
⑦ Contact plates for attaching the aluminium foils ⑧
⑧ Aluminium foils for connection between ⑦ and ⑫

⑨ Knife edge
⑩ Knife-edge bearing
⑪ Balance arm
⑫ Contact plates for attaching the aluminium strips
⑬ 1-mm socket pair resp. 4-mm socket for mounting the conductor loops ⑭ and from (516 33) as well as the test bodies from 516 37.
⑭ Plug-on wire loops
⑮ Fixing eyes with a spacing of *a*, 2 *a* and 4 *a* from the centre of rotation for attaching the dynamometer with Perlon thread ⑯
⑯ Perlon thread
⑰ Fulcrum pin with hole for attaching and vertical movement of the dynamometer with Perlon thread

For the following items refer to Fig. 1.2

⑱ Bores for ⑰
⑲ Pointer
⑳ Mark point for pointer ⑲
㉑ Sockets for current supply
㉒ Reflecting mirror for light-spot readings to obtain precise horizontal adjustment of the balance arm

㉓ Balancing weight
㉔ Displaceable weights for sensitivity adjustment
㉕ Set-screw for locking the balance arm

Technical Data:

Height of the assembled current balance: 70 cm approx.
Selectable lever lengths: *a*, 2 *a*, 4 *a*; *a* = 4.5 cm
Max. current: 10 A (for a max. period of 2 mins.)
Pin spacing of the loops: 19 mm
Effective length ℓ of the wire loops: 10, 20, 40, 80 mm
Sensitivity: 0.1 mN

2.2 Vertically adjustable stand (516 31)

Scale of delivery:

1 Vertically adjustable stand
1 Compensation weight (approx. 60 g)

㉖ Levelling screws
㉗ Knurled-head screw for indicator ㉘
㉘ Indicator
㉙ Angled scale
㉚ Clamp with bore
㉛ Clamping screw
㉜ Height adjustment screw
㉝ Compensation weight for additional experiments with the current balance (weight 60 g approx.)

Technical Data:

Lowest height:	130 mm approx.
Lift:	max. 30 mm
Scale divisions:	2/10 mm
Weight:	0.4 kg

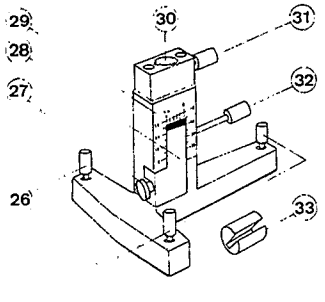

Fig. 2

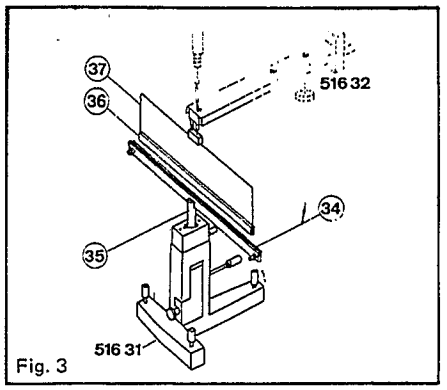

Fig. 3

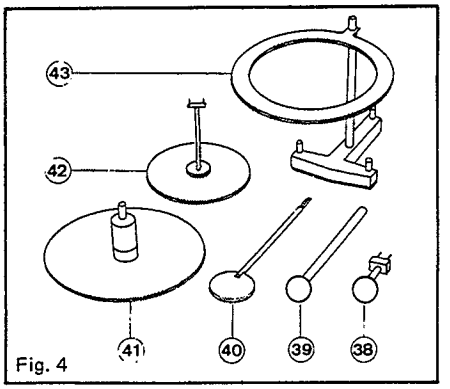

Fig. 4

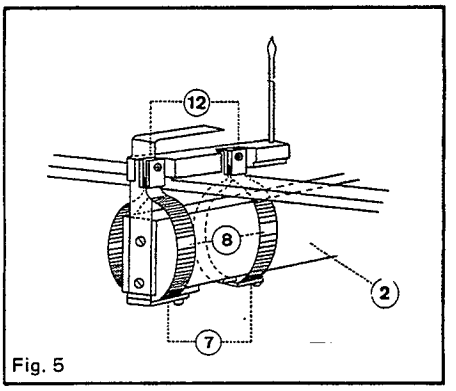

Fig. 5

2.3 Set of conductors for ampere definition (516 33)

㉞ Aluminium conductor (length 340 mm) with
㉟ Mounting pin (dia. 12 mm)
㊱ Aluminium conductor (length 300 mm ±2 mm) with
㊲ Pair of plugs (plug spacing 19 mm),
max. current I_{max} = 10 A

2.4 Electrostatics accessories for the current balance (516 37)

㊳ Sphere (dia. 30 mm) on insulator (material: PET; length 20 mm) with pair of plugs which fit into the pair of sockets ⑫ on the current balance
㊴ Sphere (dia. 30 mm) on insulated rod (material: PET, length 90 mm)
㊵ Spoon (dia. 45 mm) on insulated rod (material: PVC and PET; length 150 mm)
㊶ Capacitor, consisting of
capacitor plate (dia. 200 mm) on insulator (PET)
㊷ Capacitor plate (dia. 150 mm) with pair of plugs
㊸ Screening ring (outside diameter 200 mm)
on stand (height: 215 mm)

3 Operation and Experiment Assembly

3.1 516 32 – current balance

3.1.1 Assembly and first-time operation (see Figs. 1.1 and 1.2)

Attach support ② with a stand rod (300 41 or 300 42) to the stand base (300 01).

First flatten the aluminium strips ⑧, loosen the cross-head screws of the contact plates ⑫, insert the aluminium strips and then tighten the screws again (see Fig. 5).

Place the balance arm ⑪ on support ② and secure it by set screw ㉕. Attach the ends of the aluminium strips to the contact plates ⑦ on the support. Insert the mount for dynamometer ① into countersunk hole ④ so that it is in line with the balance arm ⑪. The mount is fixed with hex screw ⑤!

Attach the dynamometer to fulcrum pin ⑰ with a piece of fishing line and attach the other end of the dynamometer to the balance arm by a short piece of Perlon thread attached to the fixing eyes. Place both displaceable weights ㉔ as near as possible to the axis of rotation. (Sensitivity will then be approx. 0.1 mN).

3.1.2 Assembly of the light-spot indicator, zero position of the balance (see Fig. 7.1)

Free the balance arm (set screw ㉕) and adjust to a horizontal position by adjusting the balancing weights ㉓. To do this, the position of pointer ⑲ should coincide with the mark point ⑳

A lamp (e. g. 450 60/51) and a single-lens condenser with sliding aperture selector (460 17) to which a thread has been attached passing over the middle hole, is used to produce a sharp image on a screen (e. g. 441 53 with glued on paper) via reflection mirror ㉒, and the zero position is marked.

A small force acting upon the balance arm produces a small deflection of the arm itself which is indicated by the moving light spot and can be compensated for by suitably adjusting the dynamometer which, depending on the choise of the length of the balance arm, indicates the true value, twice value or four times the value of the measured force.

3.2 516 31 – vertically adjustable stand

Attach the test objects (e. g. ㉞ or ㊴ or ㊶) to clamp ㉚. Operate levelling screws ㉖ so that, when turning the height adjustment screw ㉜, the clamp is moved vertically, i. e. that it is possible to vertically adjust the aluminium conductor ㉞ running in parallel to the loop on the current balance.
See Fig. 8.

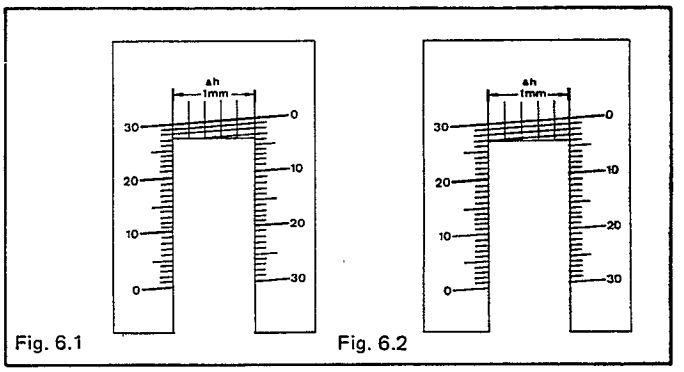

Fig. 6.1 Fig. 6.2

Reading the height markings (with reference to mark 0):

Millimeters are indicated by the top edge of the indicator ㉘ and may be read off on either vertical scale left or right.

Fractions of a millimeter can be read off on angled scale ㉙ which is graduated in steps of 0.2 mm.

Example: The indicated height difference between the settings in Figs. 6.1 and 6.2 is 0.4 mm.

3.3 Accessories for electrodynamic and electrostatic experiments with the current balance

Depending on the experiment, a test object from 516 33 or 516 37 is attached to the current balance (contact sockets ⑬) and the other object is attached to the vertically adjustable stand (see Figs. 8 to 12).

Note:

Before each experiment, all insulators should be cleaned thoroughly with alcohol and dried with warm air (ventilator 545 20).
Any static charge on the insulators may be removed by carefully passing the insulator through a bright flame (match etc.).

Note:
At least one of the d. c. currents I_H or I_I must be smoothed very well so as to avoid corrections in the measured values.

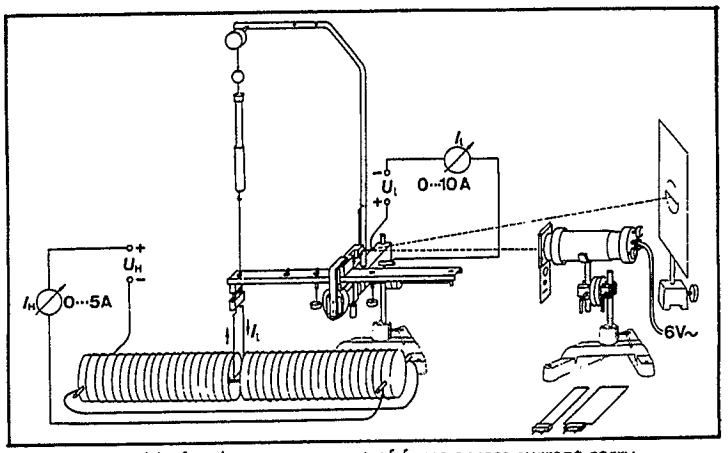

Fig. 7 Assembly for the measurement of force across current-carrying conductors in a magnetic field

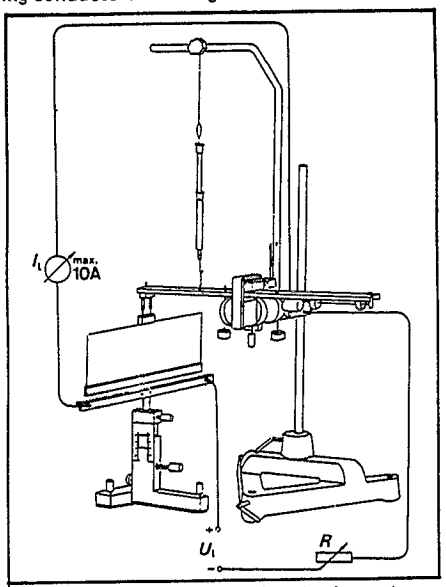

Fig. 8 Assembly for measuring the forces between to current-carrying conductors (electrodynamic ampere definition)

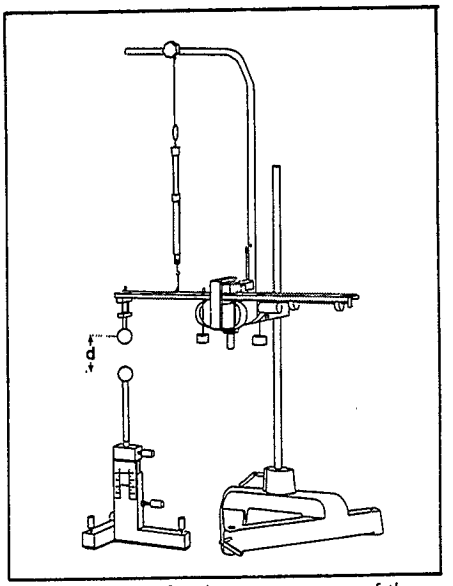

Fig. 9 Assembly for the measurement of the electric force between two charged spheres (Coulomb's law)

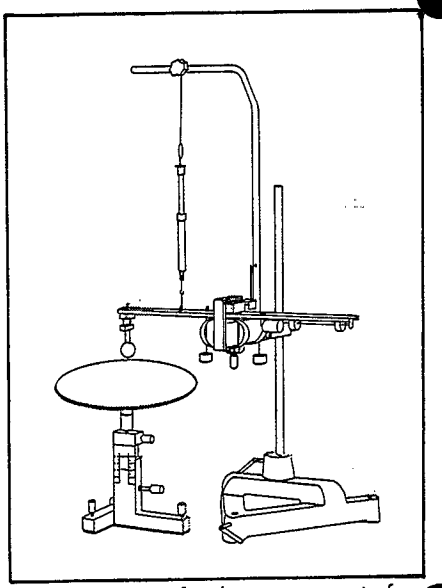

Fig. 10 Assembly for the measurement of the electric force between an earthed plate and a charged sphere ('image force')

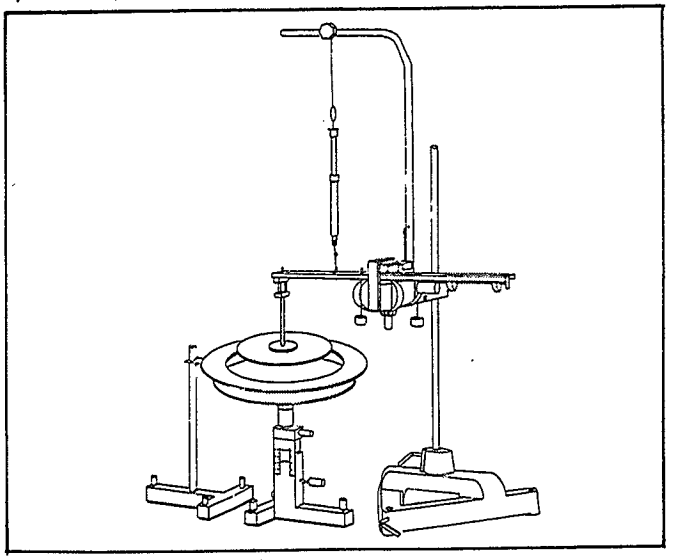

Fig. 11 Kirchhoff's voltage balance

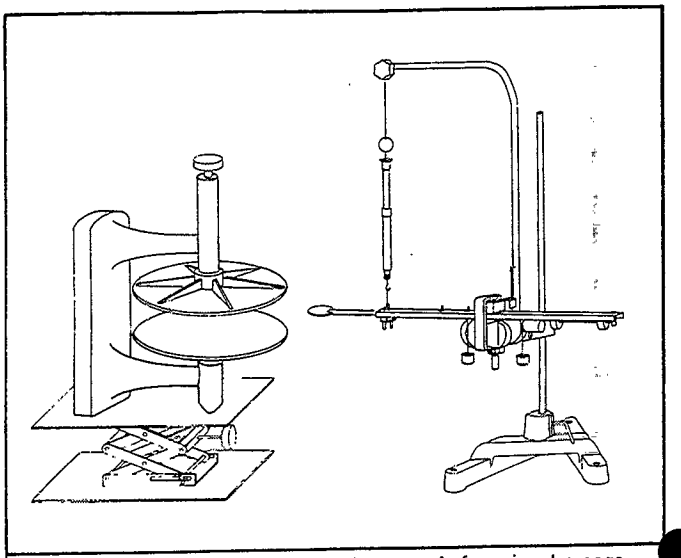

Fig. 12 Assembly for measuring the electrostatic force in a homogeneous electric field (Note: This assembly requires the compensation weight ㉝ from 516 13)

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