

STANDARD
METEOROLOGICAL
INSTRUMENTS

NEGRETTI & ZAMBRA
LONDON

LIST M3

STANDARD METEOROLOGICAL
INSTRUMENTS.

Corrections to List M/3

Page 5	Second line - "two" should be "three".	
Page 7	M/2005	£5. 10. 0
	M/2005a	7. 0. 0
Page 29	Line 7 - for "or" read "and".	
Page 30	M/2060 and M/2061	10. 10. 0
Page 45	M/2088 and M/2089. For 21 lbs. read 7 lbs.	
	M/2090 and M/2091. For 30 lbs. read 14 lbs.	
Page 50	The Tilting Bucket Rain Gauge has a zinc cover of improved type: base plate of cast iron for M/2110 and M/2111, and of cast brass for M/2111A and M/2111B.	
Page 51	M/2110	24. 10. 0
	M/2111	24. 10. 0
Page 54	M/2117	15. 15. 0
Page 58	Seventh line - 35° to 65° should read 45° to 65°.	
Page 61	M/2133	14. 0. 0
	M/2134	11. 5. 0
Page 88	M/2220a - Thermometer as above	1. 0. 0
Page 92	20th line - "similar to above" should be "similar to page 91".	
Page 117	M/2259	54. 0. 0
	Light Filters	1. 12. 6
	M/2260	9. 5. 0
Page 128	Bottom line - "32 lb." should be "74 lb."	

16th November, 1938

NEGRETTI & ZAMBRA.



Estab^d 1850



STANDARD METEOROLOGICAL INSTRUMENTS

by

**NEGRETTI
& ZAMBRA**

SCIENTIFIC INSTRUMENT MAKERS
to
The British & Foreign Governments.

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List M.3

Catalogue of STANDARD METEOROLOGICAL INSTRUMENTS

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Dimensions and Nett Weights of the various instruments are given below the description and price.

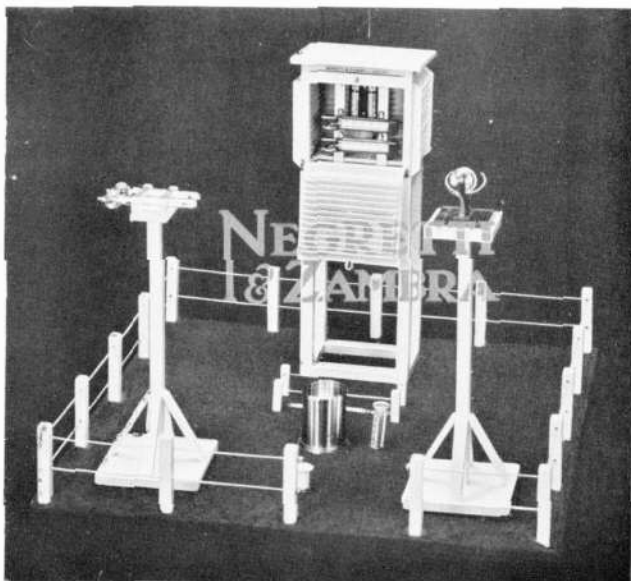
Foreword

IN endeavouring to make this catalogue of **Meteorological Instruments** as comprehensive as possible, we have considered that it will be of interest and service to our customers abroad to know the patterns and types which are specially recommended by the **Meteorological Authorities of the British Isles.**

With the permission of the **Meteorological Department of the Air Ministry,** we are able to embody extracts of the official specifications of instruments used by the **Meteorological Office,** and also to use in some instances illustrations of the particular pattern.

In addition, we have in many cases quoted the wording in the official publications—" **Observer's Handbook,**" " **Marine Observer's Handbook,**" " **British Rainfall,**" etc.

We therefore acknowledge our indebtedness to the Director of the Meteorological Office for his courtesy in granting us such permission.



ANEMOMETERS

The matter of **exposure** is of great importance to secure accurate results.

The site selected should be such that the instrument is in no way sheltered by trees or buildings : as a rough guide it is recommended that the lowest point above the roof for a wind vane is 10 feet, and the minimum height for a pressure tube anemometer head is 20 feet above the roof.

The **mast and support** described on page 21 are designed for the correct exposure of the heads on pages 10, 12 and 16, which are erected at the top, and the spindle or compo tubing connects these with the indicator or recorder fixed at the base of the mast.

Anemometers and pressure heads are **tested** in the wind channel of the National Physical Laboratory, as set out on page 5.

The **calibration** of a self-recording anemometer of the pressure tube type can be checked by an accurately-divided " U " tube water manometer, provided that the constants of the head are known : this method does not apply to check readings below 20 miles per hour ; for low velocities, a more elaborate apparatus is necessary, and on page 127 is shown an apparatus which gives pressure readings in head of water to an accuracy of .001" or .01 mm.

In setting up a wind vane, care must be taken that it is orientated to the true north and not the magnetic north. The variation between true and magnetic north is not a constant, and can be ascertained by reference to a map showing the curves of equal magnetic variation. True north can also be ascertained from the position of the Pole star, or from the sun at noon, local apparent time.

ROBINSON ANEMOMETERS



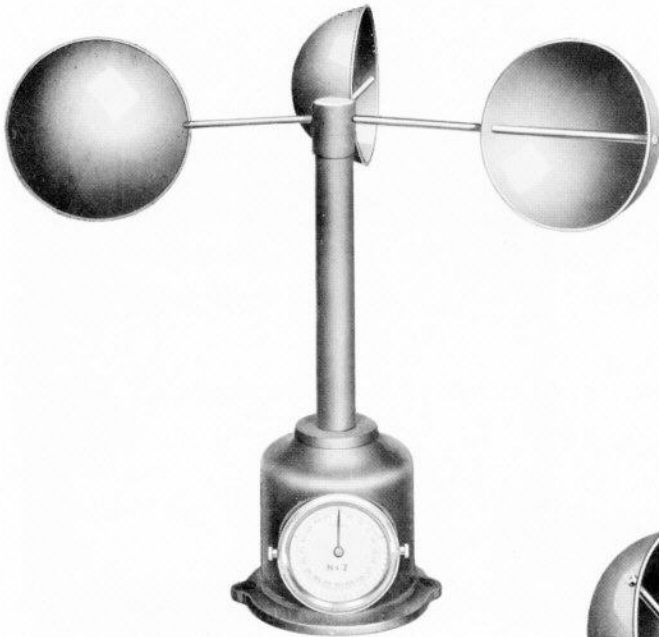
Cup Anemometer. The latest standard anemometer has three hemispherical copper cups, 5" diameter, with beaded rims, attached to two short metal arms. The movement is transmitted by a steel spindle to a counter mechanism reading up to 10,000 miles in 1/10 and 1/100. The ratio of the distance travelled by the wind to the distance travelled by the cups is known as "the factor" of the anemometer ; this factor is 2.76, and is allowed for in the calibration of the instrument.

The run of the wind during the interval between two successive readings, 12 or 24 hours as the case may be, may, therefore, be found by subtracting one from the other. If the instrument is placed in position where access cannot be readily obtained, the dial can be read at a distance with the aid of binoculars.

M 2000	Cup Anemometer, Counter Type, 10,000 miles, to .01	£10 10 0
M 2001	Ditto, up to 10,000 kilometres, to .01	£10 10 0
	National Physical Laboratory certificate giving the corrections to be applied at various speeds after test in the wind tunnel	£1 15 0

1' 4" x 1' 4" x 1' 4" 6.5-lbs.

ROBINSON ANEMOMETERS



Robinson Anemometer.

As described on page 5, with the same dimensions and factor, having a dial and two pointers, one of which registers in one-tenth divisions up to 5 miles, the other up to 500 miles.

M 2032 £9 9 0

M 2003 Ditto, up to 500 kilometres .. £9 9 0

National Physical Laboratory certificate as page 5 .. £1 15 0

1' 6" x 1' 4" x 1' 4" 8½-lbs.

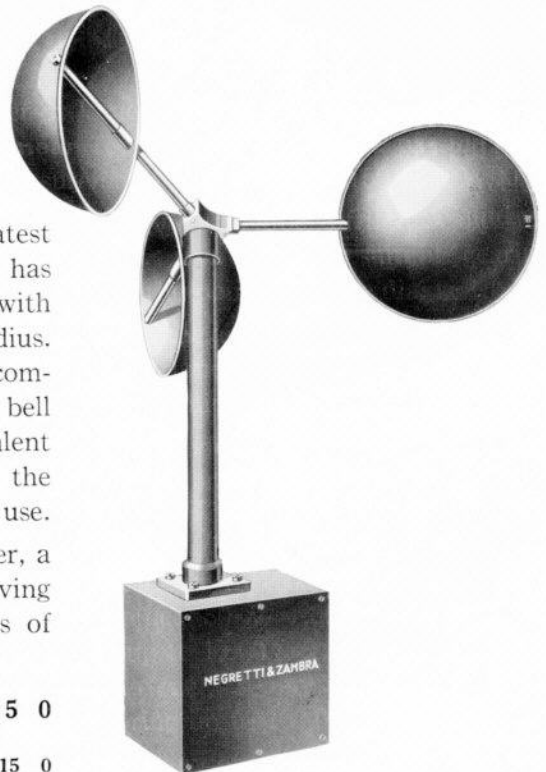
Electrical Cup Anemometer, to latest M.O. specification. This anemometer has three hemispherical cups, 5" diameter, with beaded edges, attached to arms 6½" radius. The cups turn a contact maker which completes an electrical circuit and rings a bell once in every 29 turns of the cup, equivalent to 0.05 miles. A switch is included in the circuit to cut off the current when not in use.

The outfit consists of the anemometer, a bell and battery, switch, and a chart giving the run of the wind between the times of any two signals.

M 2004 Electrical Anemometer, £11 5 0

National Physical Laboratory certificate £1 15 0

1' 4" x 1' 4" x 1' 4" 8-lbs.



AIR METERS



The Air Meter or Vane Anemometer is a portable instrument for indicating the number of **linear feet** or **metres** of air passing the instrument, and is suitable for the measurement of speeds from 50 to 10,000 feet per minute.

The instrument consists of a number of light vanes mounted on a spindle running on jewelled bearings. By means of a suitable gearing, the rotation of the spindle is communicated to the pointers. The dial is $2\frac{3}{4}$ " diameter.

The instrument is held in the air stream, preferably on a rod, and the number of feet of air passing the instrument is timed with the aid of a stop watch. A correction is usually required, which is obtained from calibration factors supplied.

A disconnector is provided for throwing the indicating mechanism out of mesh, and a setting device for bringing the hands back to zero.

M 2005	For medium speeds (i.e., 200 to 3,000 feet per minute), four dials registering up to 100,000 feet. In wood box ..	£4 10 0
M 2005a	For low speeds (i.e., 50 to 1,000 feet per minute), two dials registering up to 1,000 feet. In wood box	£6 0 0
M 2005b	For high speeds (i.e., 300 to 8,000 feet per minute), four dials registering up to 100,000 feet. In wood box ..	£7 0 0
	Metric readings to any of above air meters .. extra	£0 6 0
	National Physical Laboratory certificate up to 6,000 feet per minute ..	£1 15 0

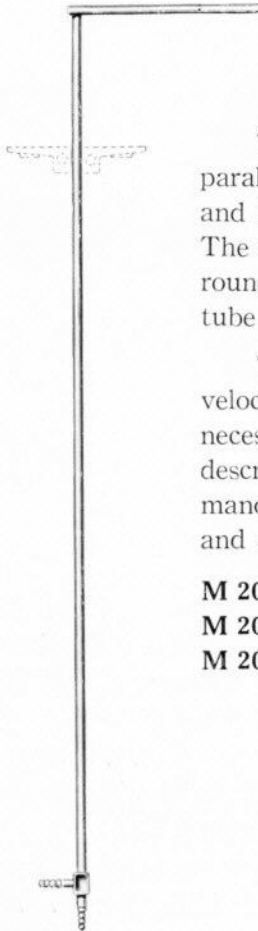
PITOT TUBES

The **Pitot Tube** method of measuring air velocities is not only one of the most convenient but probably the most accurate.

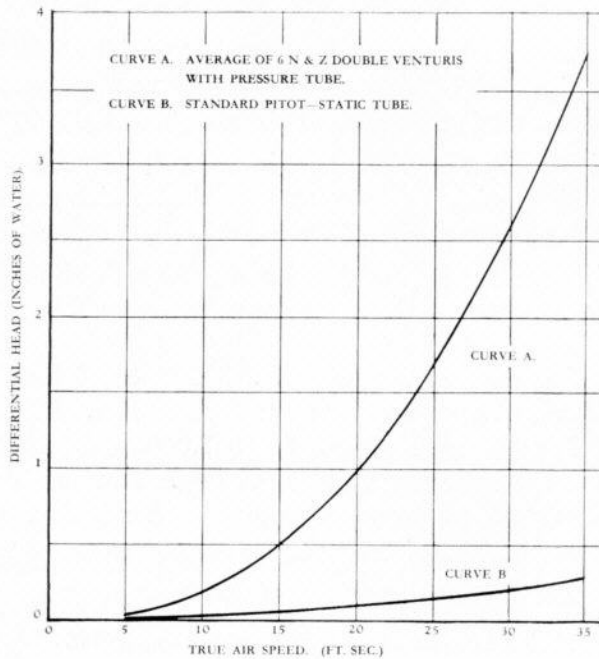
The Pitot tube consists essentially of two tubes placed parallel with the air stream. One (pressure) tube is open-ended, and is connected to the pressure side of a differential gauge. The other (static) tube has a closed end, but with holes drilled round the tube at right angles to the air stream. This static tube is connected to the "suction" side of the differential gauge.

The limitations to the use of a Pitot tube are that for low velocities the pressure differences obtained are extremely small, necessitating the use of extremely sensitive manometers, such as described on pages 126 and 127. The scale of the usual type of manometer or indicator becomes very condensed at low velocities, and accuracy is not readily obtainable.

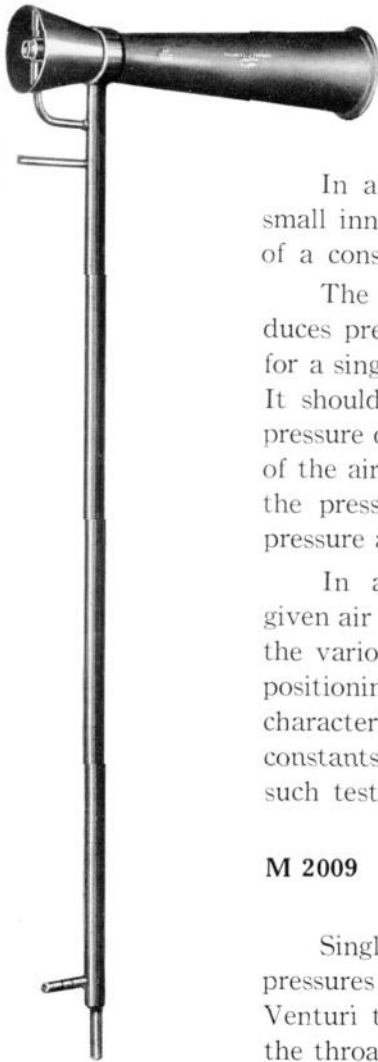
M 2006	Portable Pitot Tube, 2'	.. .. .	£1 18 0
M 2007	Ditto, 3' 6"	.. .. .	£2 2 0
M 2008	Ditto, 5'	.. .. .	£2 15 0



The diagram shows the performances of a typical Double Throat Venturi Type compared with the ordinary Pitot Tube.



VENTURI TUBES



A considerably larger differential pressure can be obtained from a double Venturi head, which, in air flows between 5 and 20 feet per second, will produce a differential pressure from 4 to 10 times that given by a Pitot tube.

In a double Venturi the down-stream open end of a small inner Venturi is situated concentrically at the throat of a considerably larger outer Venturi, as shown.

The resulting air flow through the inner Venturi produces pressure differences which considerably exceed those for a single Venturi tube, at the same external air velocity. It should be noted that with a Pitot tube the available pressure difference is the pressure due to the actual velocity of the air, whereas with a Venturi tube the greater part of the pressure difference is due to the suction or reduced pressure at the throat of the inner Venturi.

In a Venturi tube, the suction produced by a given air flow depends upon the exact shape and location of the various portions of the tube, and a slight variation in positioning or size results in a considerable variation in its characteristics. It is necessary, therefore, to determine the constants for each tube by actual tests in a wind channel, such tests being carried out by the N.P.L.

M 2009 Double Throat Venturi Tube .. £3 15 0
National Physical Laboratory certificate .. £1 15 0

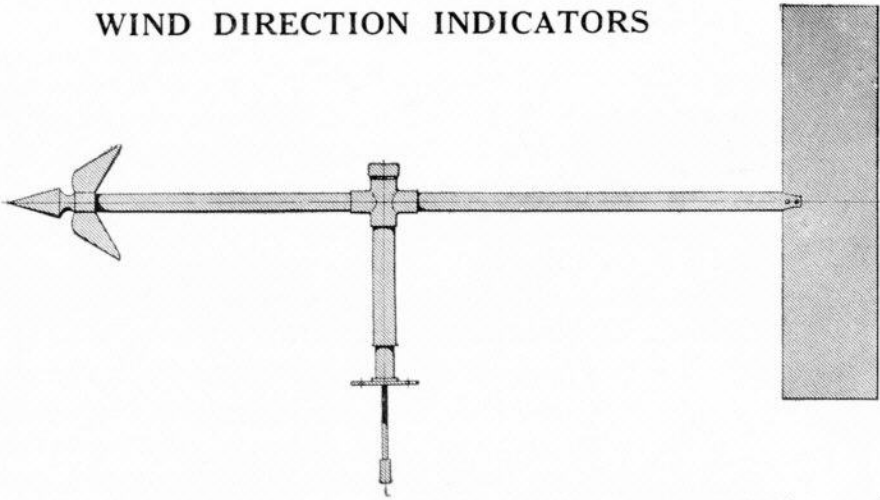
Single-throated Venturi-pitot tube giving differential pressures about two-thirds of those indicated for the double Venturi tube can be supplied if required. Dust lodged in the throat, which can cause appreciable errors, can be more readily removed in this type.

M 2009a Single Throat Venturi Tube .. £3 15 0

Treatises dealing with this subject are:—

- "Fluid Velocity and Pressure" J. R. Panell, A.M.I.Mech.E.
- "Engineering Instruments and Meters" Edgar A. Griffiths.
- "Measurement of Air Flow" E. Ower, B.Sc.
- "Chemical Engineering applied to the Flow of Gases,
Steam, Water, etc." Geoffrey Martin, D.Sc.

WIND DIRECTION INDICATORS



Wind Direction Head. This head is for use with the indicator below and recorder M 2014 (page 11); it consists of a brass tubular standard and flange, at the top of which a vane rotates on ball bearings.

The vane is constructed of brass tubing, and is furnished with a cast-iron arrow point and a streamlined shaped tail of light copper sheet.

M 2010 Wind Direction Head £9 15 0

M 2011 Spindle in lengths of 5 feet of $\frac{5}{8}$ " steel tubing with brass joints screwed and pinned. Length of 5 feet £0 15 0

M 2010, 4' x 2' 6" 11½-lbs.

Wind Direction Indicator.

The mechanism consists of a set of accurately-machined bevel wheels transferring the motion of the spindle and vane to the index hand; the dial is painted with the compass points.

The case is of cast iron with 8" or 16" aperture bezel and flange mounting at back.

M 2012 Wind Direction Indicator.

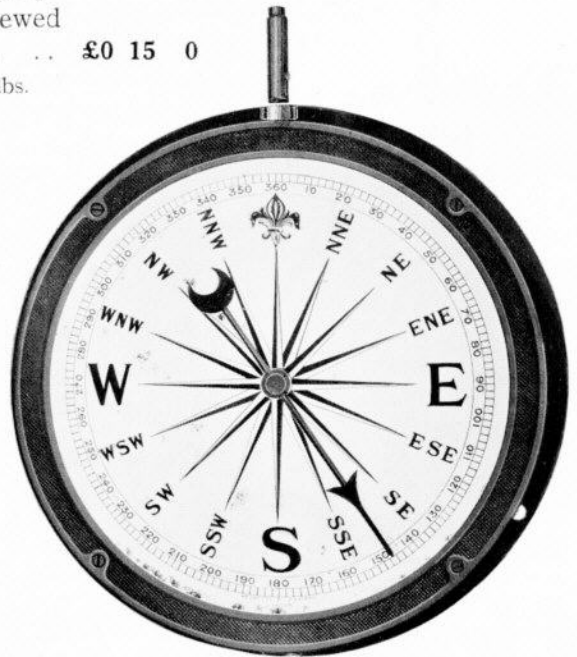
8" size £10 10 0

M 2013 Ditto, 16" size £18 0 0

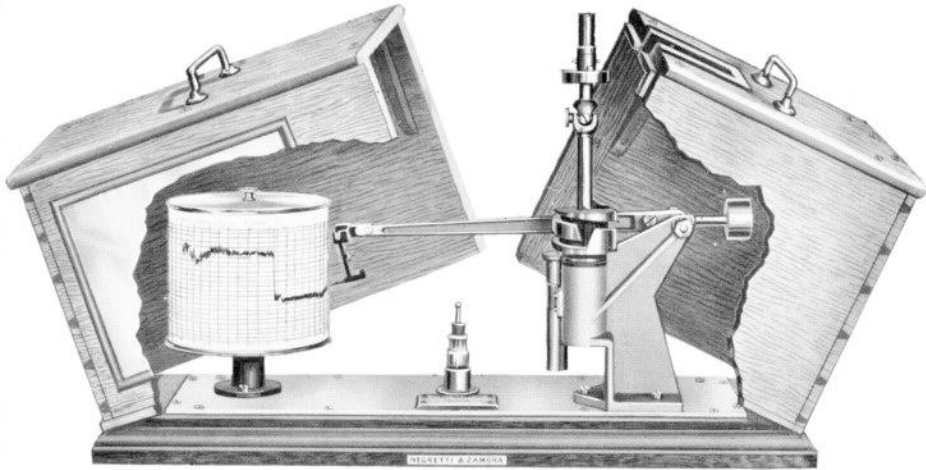
Head and Spindle, above.

M 2012, 1' x 10" x 3½" 14-lbs.

M 2013, 1' 9" x 1' 8" x 4" 39-lbs.



WIND DIRECTION RECORDERS



Wind Direction Recorder. This instrument is used with the head described on the preceding page. A feature of the instrument is the special pen-operating cam device, which enables a full record to be obtained of wind direction either side of the N and S points. To enable such a record to be obtained, the chart is marked N, E, S, W, N, E, S, and on reaching the highest or lowest part of the chart, the record is automatically brought either to the "inside" N or S position.

At the point where the instrument is coupled up to the direction shafting there is provided a Hook's joint to compensate for any error in alignment, also a key-way for taking up expansion of the shaft due to changes of temperature; and a clamping device for setting the recorder in correct orientation.

Daily drum (8-day clock)	.. . . . .	5" dia. × 4.5" high.
Pen travel	.. . . . . 1 revolution of vane	.. . . . . 2.3"
Chart	.. . . . .	4.2" high × 16.2"
Time scale	.. . . . .	0.6" per hour

The case is of polished mahogany, with glass front and two folding covers.

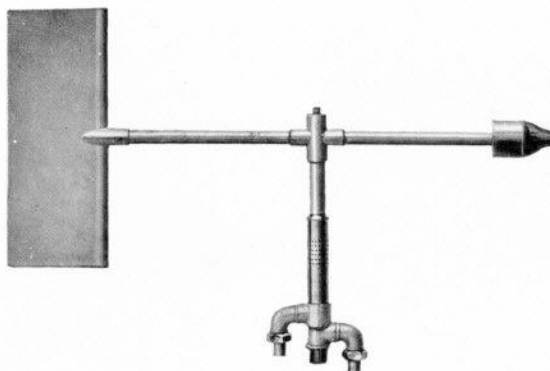
M 2014 Wind Direction Recorder, with pen, ink and 100 charts.. £32 0 0

Charts per 100 **£0 12 0**

Head and Spindle, see page 10.

11" × 1' 9½" × 8½" 24-lbs.

WIND VELOCITY HEAD



Wind Velocity Head, used in conjunction with Dial Anemometers M 2018, M 2019 (page 13), "Anemo-Biograph" M 2020 (page 14), and Recording Anemometer M 2024 (page 19), instruments on the principle developed by the late Mr. W. H. Dines.

It consists of an open-ended tube set into the wind by means of the vane, and a suction tube exposed on all sides to the wind. The effect of the wind is to produce a pressure in the former and a suction in the latter, both dependent on the wind velocity.

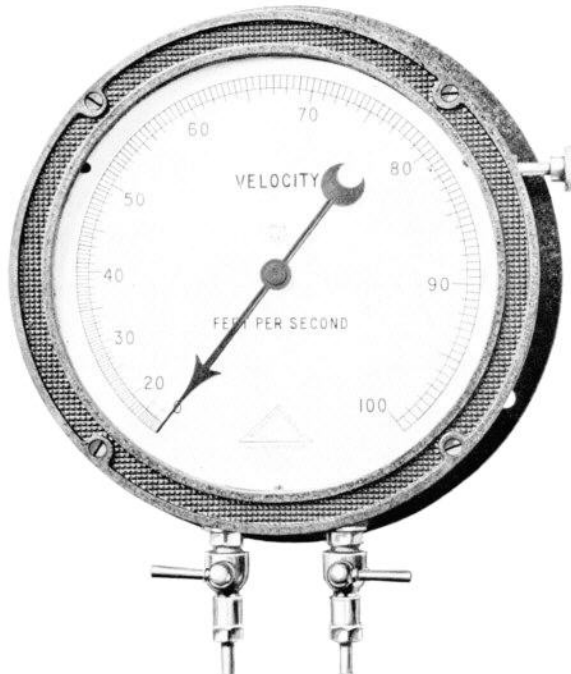
The supporting stem of the head consists of two vertical concentric brass tubes with a clearance between them. The outer tube is drilled with a number of small holes of standardised size and position, forming the "suction" side.

The horizontal tube is of brass, with the open end facing the wind, formed to balance the tail, which is of streamline section and is constructed of light sheet metal. The head is supported by a hardened steel pivot which bears in a fixed cup filled with lubricating oil. At the base of the supporting tube two threaded connections with unions are provided for attaching composition tubing $\frac{3}{8}$ " bore. The "pressure" and "suction" sides are thus connected to the indicator or recorder.

M 2015	Wind Velocity Head	.. .. .	£7 10 0
M 2016	Composition tubing, $\frac{3}{8}$ " bore	.. .. . per foot	£0 0 5
M 2017	Two water traps, brass tubular type, fitted with brass cocks	.. .. . per pair	£2 2 0
	Determination of the constants of head in the wind tunnel of the National Physical Laboratory	.. .. .	£2 0 0

(For Head with 1" bore, see page 15).
 M 2015, 2' x 1' 10" 15-lbs.

WIND VELOCITY INDICATORS



Dial Anemometer. A precision differential pressure gauge, calibrated in velocity, and suitable for use with the head and vane on page 12. The construction is similar to a low-reading pressure gauge, and has a specially balanced movement. Pressure is led to the inside of the diaphragms, which are enclosed in an air-tight case, with static connection. The unevenness of the scale, due to pressure increasing as the square of the air velocity, is reduced by a special form of control spring which comes into operation at the higher velocities.

The case is of cast iron, with an 8" or 16" aperture bezel ; flange mounting at back. An external zero adjustment is provided, and two cocks to open to vent.

M 2018 Dial Anemometer, with 8" aperture dial **£10 10 0**

M 2019 Ditto, with 16" aperture dial **£18 0 0**

RANGES

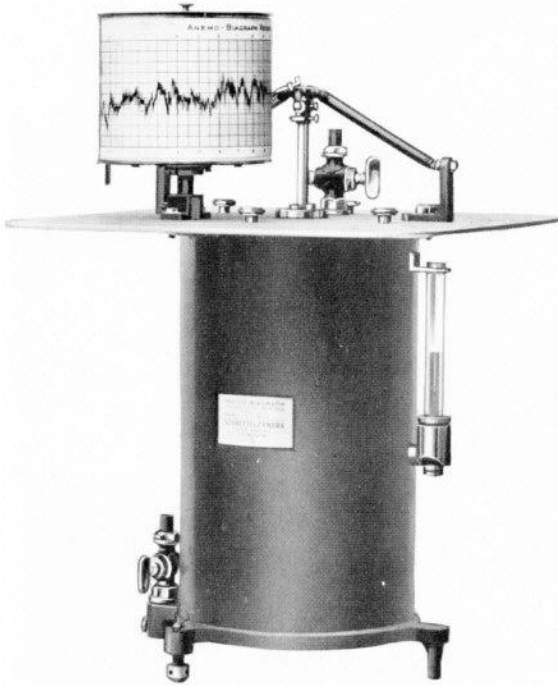
Miles per Hour.	Kilos per Hour.	Feet per Second.	Metres per Second.
0 to 70	0 to 100	0 to 100	0 to 30
0 „ 140	0 „ 220	0 „ 200	0 „ 60

For Connecting Pipes, Water Traps, etc., see page 12.

M 2018, 1' x 10" x 3 1/4" 12-lbs.

M 2019, 1' 9" x 1' 8" x 4" 35-lbs.

WIND VELOCITY RECORDERS



The "Anemo-Biograph." This wind velocity recorder, which is used with the head described on page 12, consists of a cylindrical brass chamber partly filled with liquid. A floating "bell" is partially immersed in the liquid, and a rod from its domed top passes upwards through a close-fitting ebonite bush in the air-tight cover plate and carries the recording pen.

Pressure from the head is led inside the bell above the liquid level, causing it to rise until constrained by two helical springs attached to the top of the vertical pen rod.

The suction side of the head is connected to the top of the chamber, that is, outside the bell, and thus augments the movement of the bell. The springs, which are of hardened and tempered steel treated to resist corrosion, are so arranged that a practically uniform velocity scale is obtained.

The liquid used, which acts as a seal, is a mixture of pure glycerine and water, having a specific gravity of 1.16.

Daily drum (8-day clock)	.. .. .	5" dia. × 4.5" high
Pen travel, 100 m.p.h. (160 k.p.h.)	.. .. .	3"
Chart	.. .. .	4.2" × 16.2"
Time scale	.. .. .	0.6" per hour

The mechanism is protected by a glass-domed cover.

M 2020 "Anemo-Biograph," with glass cover, liquid, pen, ink and 100 charts	.. .. .	£42 10 0
Charts	.. .. . per 100	£0 12 0
Can of liquid	.. .. .	£1 7 6

(For Head, Connecting Pipes, Water Traps, etc., see page 12.)

2' × 1' 1" × 1' 3" 25-lbs.

WIND VELOCITY RECORDERS

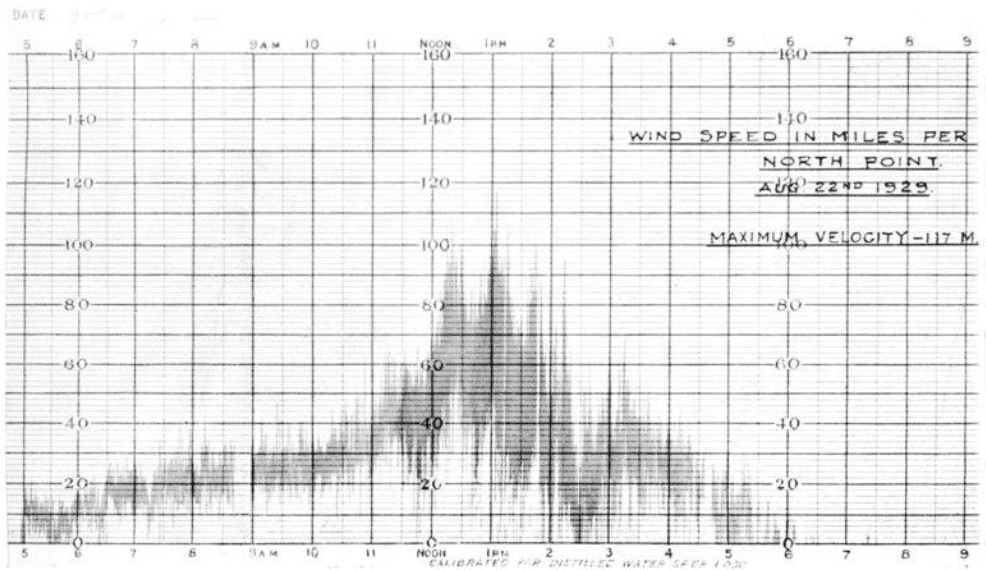
“**Anemo-Biograph**” for high velocities. A wind velocity recorder on the principle and design of the foregoing, but with 1" passages. The head and vane are of the type on page 12 but are of larger dimensions. All fittings are of 1" bore ; the clock drum is taller ; the composition tubing is also 1" bore, but it is recommended that 1" gas barrel should be used on the mast, and short lengths of composition tubing from the mast to the recorder.

Daily drum (8-day clock)	5" dia. × 6" high
Pen travel, 0/70 metres per second, or 0/160 miles per hour	5"
Chart	5.8" × 16.2"
Time scale	0.6" per hour

M 2021 “Anemo-Biograph,” with 1" connections, with head, vane and recorder, metal cover with glass front, two water traps, liquid, pen, ink and 100 charts **£93 0 0**

Charts per 100 **£0 15 0**

M 2022 Composition tubing, 1" bore per foot **£0 1 0**
 2' 2" × 1' 1" × 1' 3" 45-lbs.

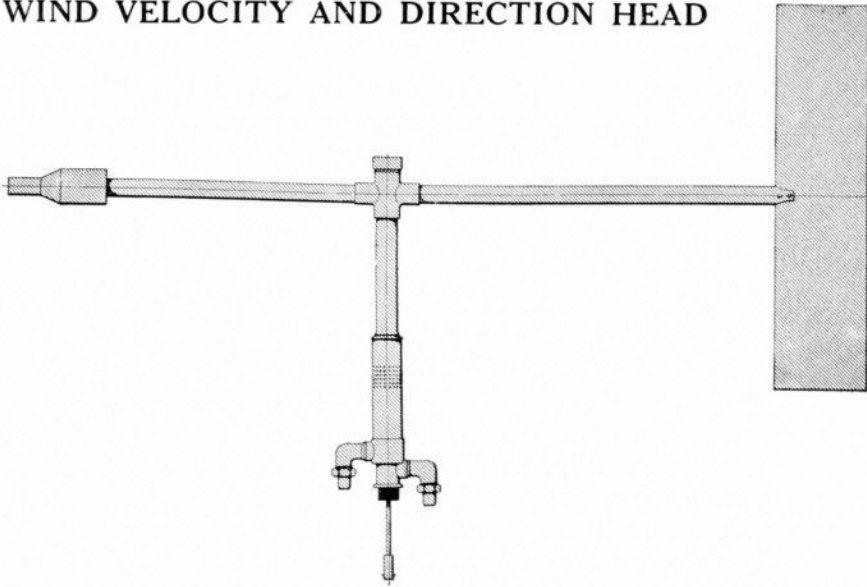


Record from a high-velocity pattern “Anemo-Biograph” at North Point, China, August 22nd, 1929, showing a gust of 116 m.p.h
(Reduced scale). By courtesy of Mr. W. H. Wickham, A.M.Inst.C.E.



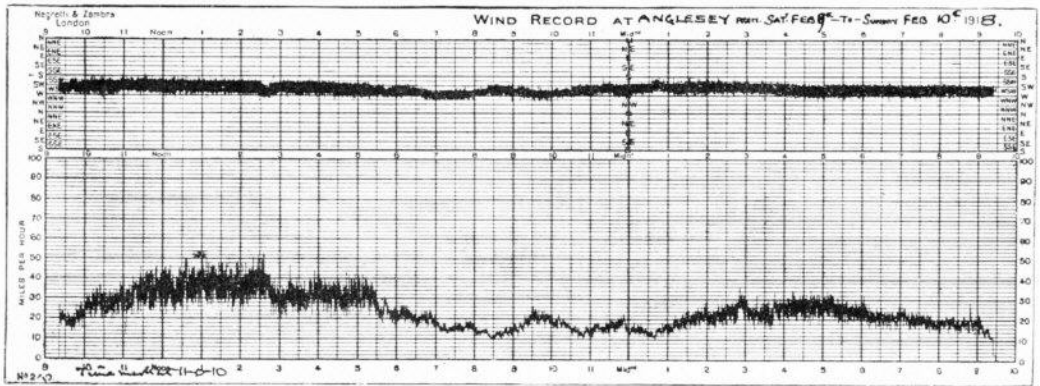


WIND VELOCITY AND DIRECTION HEAD



Wind Velocity and Direction Head. This head on the Dines' principle is used in connection with the combined wind velocity and direction recorders described on pages 17 to 19. It consists of a wind direction head which actuates the transmitting spindle to the recorder, combined with a velocity head, as described on page 12, which gives the required differential air pressure for operating the recorder. The horizontal tube is 3' 6" long and the stream-lined tail 2' 0" x 6". The head rotates on ball bearings.

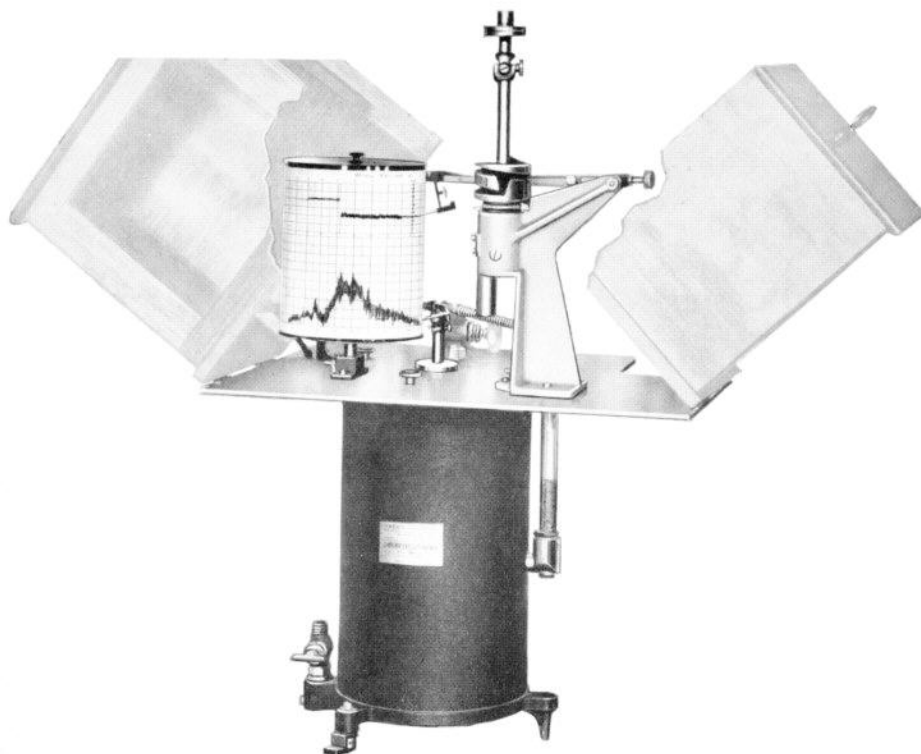
M 2026	Wind Velocity and Direction Head	.. .. .	£11	5	0
	National Physical Laboratory certificate	.. .. .	£2	0	0
	3' 6" x 3'				16-lbs.



Record from a Combined "Anemo-Biograph" and Wind Direction Recorder.
(Reduced scale.)



WIND VELOCITY AND DIRECTION RECORDER



Combined "Anemo-Biograph" and Wind Direction Recorder.—The direction recorder is mounted on the baseplate of the instrument (see page 14) so that the record of the direction is directly above that of the velocity, the two records of the chart, therefore, being synchronised.

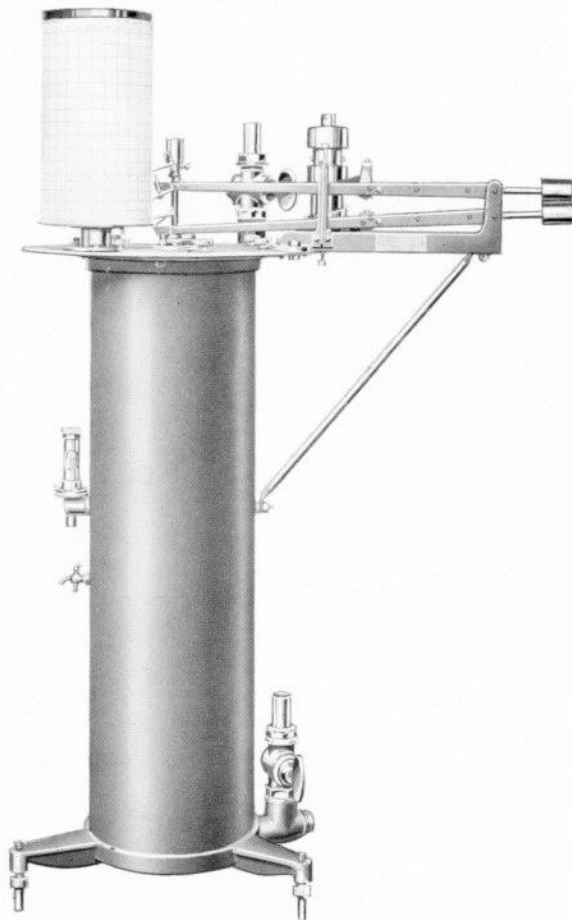
Daily drum (8-day Clock)	.. .. .	5" dia. × 6" high.
Chart	.. .. .	5.8" × 16.2"
Time scale	.. .. .	0.6" per hour.
Pen travel, 0 to 100 m.p.h. (160 k.p.h.)	.. .. .	3.1"
" " North to South	.. .. .	1.1"

M 2027 Combined "Anemo-Biograph" and Wind Direction Recorder, with 20-ft. of steel spindle, 2 lengths of 25 feet composition tubing, two water traps, liquid, two pens, ink and 100 charts	.. .. .	£76 5 0
Charts	.. .. . per 100	£0 15 0

For Head and Vane, see page 16; extra Composition tube, Spindle, etc., see pages 10 and 12.

1' 11" × 1' 5" × 1' 3" 81-lbs.

WIND VELOCITY AND DIRECTION RECORDERS



M 2023

Dines' Wind Velocity Recorder, with Direction Recorder. This instrument consists of two independent parts—the head, which is exposed to the wind, and the recording apparatus; these two parts are connected with each other by composition tubing and tubular shafting. The principle is that described on the preceding pages.

The latest type of head is furnished with a stream-lined shaped vane, has passages of 1" bore, and a cylindro-conical shroud over the elbows; this has been found to give results to a nearer approximation of the Dines' factor.

The head is given a free exposure to the wind by erection at the top of a mast as shown on page 21. For the velocity recorder, a head may be supplied for fitting to a flagstaff or pole.

The velocity recorder contains a float, which is a specially-shaped copper vessel closed at one end, placed with its open end downwards in a vessel partially filled with water and sealed from the air in the room in which it is placed.

To the top of the float is fixed a rod which passes through what is practically an airtight collar in the cover of the water vessel; this rod carries a pen of the swinging gate type. The shape of the float is calculated mathematically according to the law governing the relation of pressure to wind velocity, so that an even velocity scale is obtained.

WIND VELOCITY AND DIRECTION RECORDERS

The direction recorder is of the Meteorological Office Twin Pen, Mark II type. The arms carrying the pen are actuated by a cam mechanism attached to a spindle, which is coupled up to the head by tubular shafting.

At the lower end of the direction shaft is a sliding sleeve for disconnection of the recorder, if necessary, without altering the orientation. A sliding key-way guards against stress from expansion of the direction shaft.

Standard charts employ the following ranges :—

For Combined Velocity and Direction Recorder—M 2023 :—

110 m.p.h. and direction record.

50 metres per second and direction record.

For Velocity Recorder only—M 2024 :—

100 m.p.h., and equivalent pressure to lbs. per sq. ft.

120 " " " " " "

180 km.p.h. " " " " kgs. per sq. metre.

Daily drum (8-day clock)	.. .. .	5" dia. × 9.15" high
Chart	.. .. .	9" × 16½"
Time scale	.. .. .	0.6" per hour
Pen travel, 0 to 100 m.p.h.	.. .. .	6"
" " North to North	.. .. .	1.8"

M 2023 Dines' Anemometer with Direction Recorder, Mark II., with head and vane, 40 feet of direction shaft, 15 feet of 1" bore composition tubing, 12 pens, 2-oz. bottle of ink, 400 charts, and full set of accessories **£110 15 0**

Dust-proof metal cover with glass doors and lid **£11 5 0**

M 2024 Dines' Anemometer Velocity Recorder, with head and vane, glass shade, two coils of 50 feet composition tubing, 12 pens, ink, 400 charts, and full set of accessories **£72 0 0**

M 2025 Composition tubing, 1" bore extra per foot **£0 1 0**

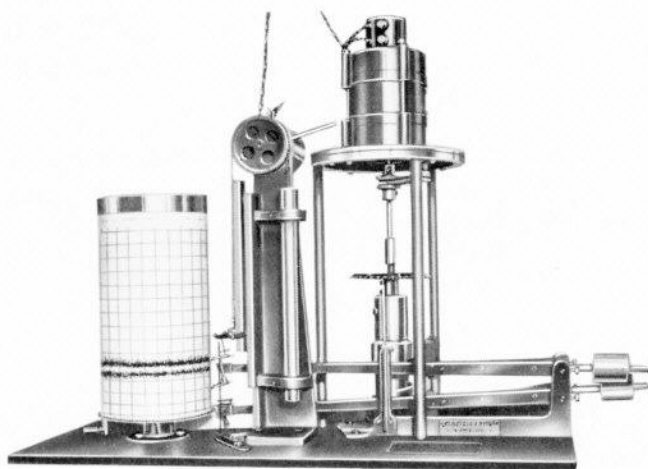
Charts extra per 100 **£1 0 0**

National Physical Laboratory certificate for the head (see page 12) **£2 2 0**

3' 3" × 2' M 2023, 126-lbs. M 2024, 103-lbs.



DISTANT RECORDING ANEMOMETER



Reproduced from the Meteorological Magazine by courtesy of the Controller of H.M. Stationery Office.

The M.O. Pattern Distant Wind Velocity and Direction Recorder is a modification of the recording anemometer shown on page 18, and overcomes the necessity for the recording mechanism to be situated directly below the vane or head. The movements are transmitted electrically to a recording unit, as illustrated, which may be situated at a considerable distance away.

“Selsyn” and “Autosyn” transmitting motors are driven by the wind vane and anemometer float respectively, and the rotation imparted to their armatures is repeated exactly at the recording unit by two similar motors, which in turn are arranged to operate the normal type of recording mechanism and pens.

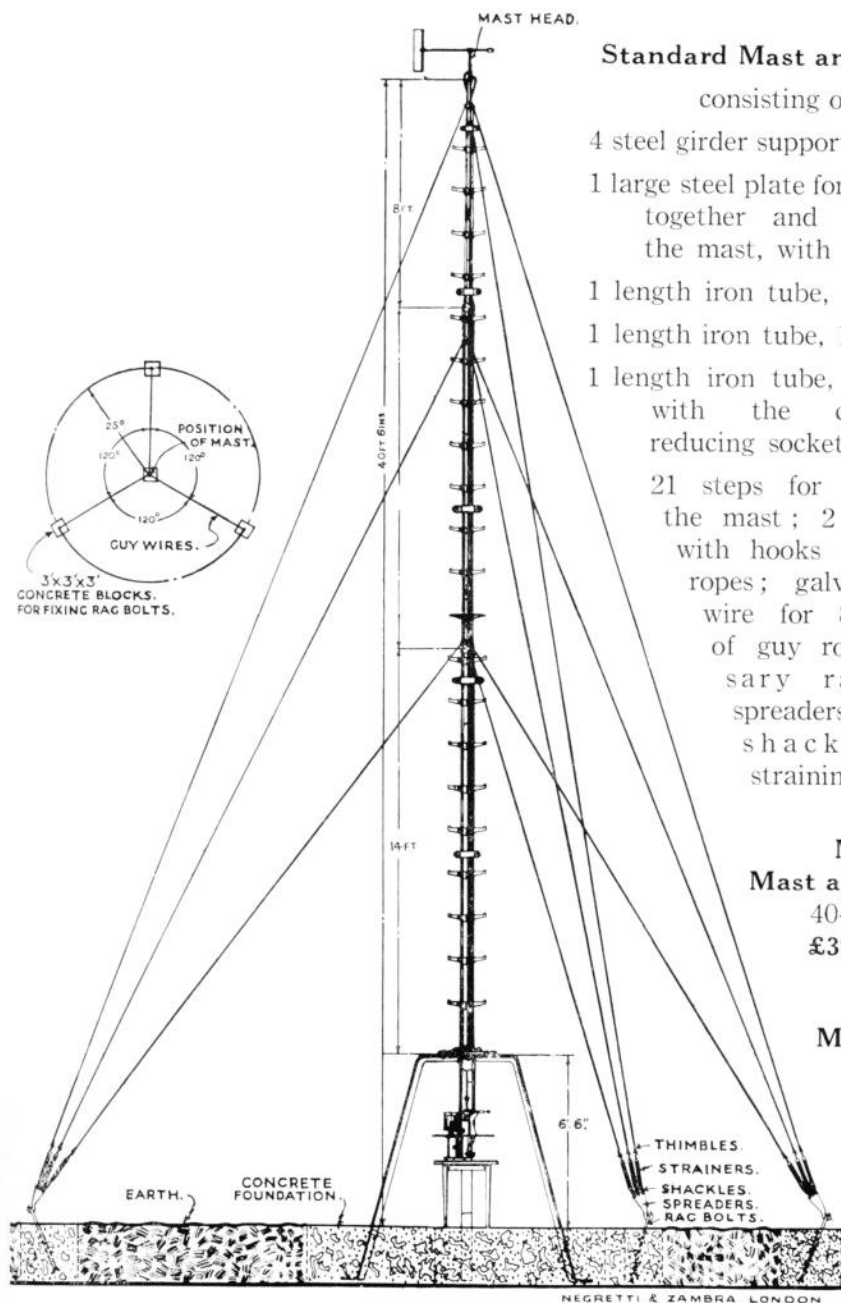
A supply of single-phase alternating current is required to energise these motors.

The transmitting “Selsyn” motor, which is larger and more powerful than the “Autosyn” motor, is situated immediately below the head, which is similar to that shown on page 16, and is protected by an extended conical housing. The anemometer float unit is situated at or close to the bottom of the mast or other structure on which the head is mounted. In addition to operating the transmitting “Autosyn” motor, the anemometer unit can be arranged so that a wind velocity record only is obtained at this point as well as at the distant recording unit.

A six, eight, or ten-core cable is required between the transmitting and recording points, according to whether alternating current is available at both, and whether telephonic communication is required in connection with checking and setting the instrument.

M 2031A Distant Recording Anemometer, M.O. pattern.
Price on application.

STANDARD MAST



Standard Mast and Support,

consisting of :—

- 4 steel girder supports, 7' 6" high.
 - 1 large steel plate for bolting these together and for carrying the mast, with
 - 1 length iron tube, 14' × 3" dia.
 - 1 length iron tube, 12' × 2½" dia.
 - 1 length iron tube, 8' × 2" dia.
- with the corresponding reducing sockets.

21 steps for clamping to the mast ; 2 or 3 collars with hooks for the guy ropes ; galvanised steel wire for 8 or 9 sets of guy ropes ; necessary rag bolts, spreaders, thimbles, shackles and straining bolts.

M 2032
Mast and Support,
 40-ft. high
 £39 0 0

M 2033
Mast without
Supports
 £32 0 0

M 2032,
 980-lbs.

M 2033,
 470-lbs.



WIND VANES

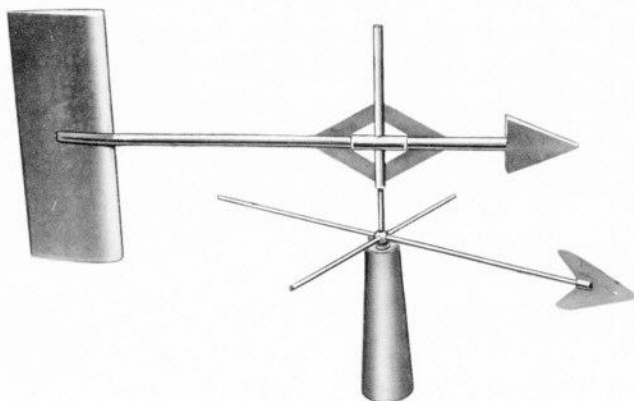


M 2028

Wind Vane. Small size, for attaching to a pole or standard, with brass flange fitting. All parts enamelled and stoved white. The fittings unscrew and take to pieces for convenience in packing.

M 2028 Wind Vane .. £2 12 6

1' 4" x 1' 3" 2½-lbs.



M 2029

Wind Vane. British Meteorological Office pattern. Copper streamlined vane, with lead arrow accurately balanced and fitted with hardened steel bearing. The bearing spindle is hardened steel carried in a brass base, which is arranged with screwed fitting for attachment either to a steel mast or to a flange for fitting on a wooden post. All parts heavily enamelled and stoved grey.

M 2029 Wind Vane,
M.O. Pattern £3 10 0

2' 8" x 1' 8" 7-lbs.

Direction Indicator. The compass point letters are made of sheet steel, 4" high, riveted to the ends of the direction arms, which are of steel rod and screw into the brass boss which fits on the brass base fitting. The arms of the brass boss are all detachable for transport purposes, and are supplied with steel set screws for rigidly fixing in position.

M 2030 Direction Indicator £2 15 0

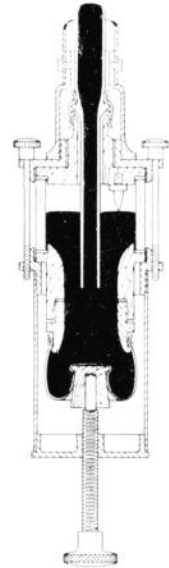


STANDARD BAROMETERS

There are two main types of standard mercurial barometers, viz., the Fortin and Kew patterns.

The **Fortin Barometer** measures the actual head of mercury from a fixed datum point in the cistern. Before readings are taken, it is necessary to adjust the level of mercury in the cistern to the fixed datum, consisting of an ivory point. This adjustment serves the double purpose of raising the mercury until it is in contact with the ivory point, and of rendering the instrument portable by entirely filling the tube and cistern with mercury.

The illustration shows the construction of a Fortin cistern, where the mercury is contained in a boxwood cylinder with a leather bag at its lower end and a glass cylinder at its upper end. The adjustment screw raises or lowers the level of mercury in the cistern, and the level of mercury can be adjusted with precision to the ivory point.



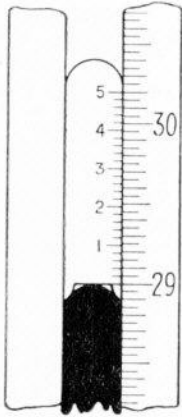
Fortin Cistern.

The **Kew Barometer** measures the head of mercury direct, without any adjustment of the cistern level. The cistern is of cast iron, and in the calibration of this Barometer, allowance is made for the rise and fall of mercury in the cistern.

Both types of barometers require corrections for index or scale errors, temperature, latitude and reduction to sea level.

National Physical Laboratory Certificates provide the corrections for index or scale errors, and the corrections for temperature, latitude and reductions to sea level can be found in various meteorological text books (see page 133).

STANDARD BAROMETERS



The **Vernier** consists of a short scale, the distance between the divisions of which is slightly less than that between those of the barometer scale.

In the case of English scales divided in inches, 25 vernier divisions are equal to 24 divisions on the barometer scale. As each of the latter is equivalent to 0.050", each vernier division is thus shorter by 0.002".

To bring successive vernier divisions in coincidence with scale divisions, a movement of the vernier of 0.002" per division is therefore required. Thus, for instance, the coincidence of the fifth vernier division above the bottom datum line or reading edge of the vernier, indicates that the latter is $5 \times 0.002"$, *i.e.*, 0.010" above the next lower barometer scale division, and 0.010" must be added to the reading represented by this scale division to obtain the exact barometric height (to the nearest 0.002"). For metric scales, each vernier division usually represents 0.05 mm. to be added to the barometer scale reading immediately below the datum.

In handling and erection, a standard barometer requires great care. If it has to be moved it should be sloped very carefully so that the mercury slowly fills the upper part of the tube. When the tube is full, the adjustment screw should be screwed up, but not forced in any way. The barometer may now be handled, but with care ; it can be carried in a horizontal position, or, preferably, vertically with the **cistern uppermost**.

For export the barometer is packed in a special case ; this case is taken to the docks by one of our staff and stowed specially in a safe position on board a ship sailing direct to the port nearest its destination. The consignee, having been warned of the date of sailing, meets the ship on its arrival, and personally removes the case.

For delivery inland, the barometer is given into the charge of the guard of a through train, and met by the consignee upon arrival at destination.

STANDARD FORTIN BAROMETERS

Standard Fortin Barometer, Type A, with tube 0.4" internal diameter, filled with pure distilled mercury boiled in the tube. The cistern is built up of brass, glass and boxwood with adjustment screw. The scale is engine engraved and silvered, and fitted with glass protecting sheath, and the vernier is operated by a milled-head screw with a rack and pinion movement. The thermometer is mounted in a brass frame, and the tube is graduated and figured on the scale. The barometer is mounted on an oak panel (or mahogany if specially required) with opal glass reflectors; strong metal support at top, and ring at the bottom fitted with three clamping screws. Standard ranges as follows:—

	Range.	Divided to	Thermometer.
Inches	26 to 31	0.002	5° to 120° F.
Millimetres ..	660 .. 790	0.05	-15° .. 50° C.
Millibars	880 .. 1050	0.1	250° .. 320° A.

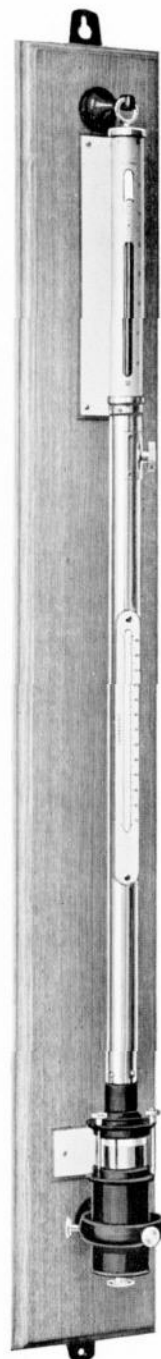
STANDARD FORTIN BAROMETERS, Type A

Single Scale

M 2034	Inches	£16 10 0
M 2035	Millimetres	£16 10 0
M 2036	Millibars	£16 10 0
	National Physical Laboratory certificate ..	£1 10 0

Double Scale

M 2037	Inches and Millimetres	£18 5 0
M 2038	Inches and Millibars	£18 5 0
	National Physical Laboratory certificate ..	£1 15 0
	4' 4" × 6" × 5½"	33-lbs.





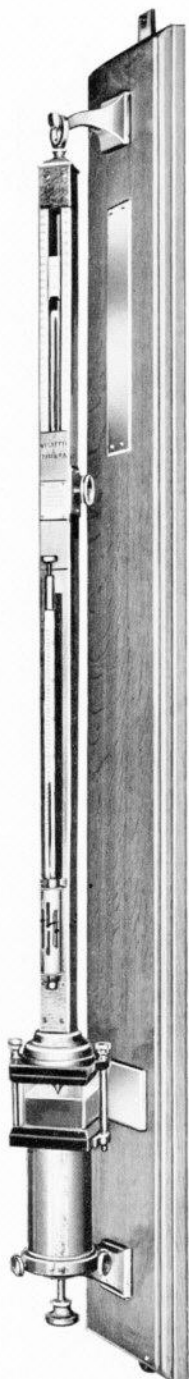
STANDARD FORTIN BAROMETERS

Type B, with tube 0.5" diameter.
 „ **C** „ 0.6" „

These instruments are similar to Type A but of heavier construction and larger cisterns. The large bore tubes give greater accuracy and precision of reading.

Standard Fortin Barometer, Type D, with tube 0.6" diameter ; square frame and cistern suitable for an Observatory, Public Institution, etc., where an imposing barometer of high precision is required.

The cistern is built up of cast iron, and enclosed in a highly-finished brass case ; the scale is engine engraved and silvered on a square brass tube. The vernier is operated by a milled-head screw with a rack and pinion movement. The attached thermometer is exceptionally bold, and mounted in a highly-finished brass frame. The barometer can be supplied mounted on a polished mahogany panel with bevelled opal glass reflectors, but usually it is enclosed in a glass-panelled case (see page 27).



M 2041

STANDARD RANGES

	Scale Range.	Divided to	Thermometer.
Inches	26 to 31	0.002	5° to 120° F.
Millimetres ..	660 „ 790	0.05	-15° „ 50° C.
Millibars	880 „ 1050	0.1	250° „ 320° A.

Standard Fortin Barometer, complete as described above, mounted on a panel with any two of the above scales.

- M 2039 Type B £22 10 0
- M 2040 Type C £28 10 0
- M 2041 Type D £52 10 0

National Physical Laboratory certificate .. £2 5 0
 4' [4" x 6" x 6½" 40-lbs.



STANDARD KEW BAROMETERS

Standard Kew Type Barometer. This barometer requires only one setting, and is universally used for general observations of barometric pressure ; it is constructed on similar lines to the Fortin previously described (except for the cistern), and is supplied on a polished wood panel with reflectors and brackets.

M 2043	Standard Kew Barometer, 0.3" tube, range 26 to 31" reading to .002".	£14 0 0
M 2044	Ditto, 660 to 790 mm. to 0.05 mm. . .	£14 0 0
M 2045	Ditto, 880 to 1050 mb. to 0.1 mb. . .	£14 0 0
	National Physical Laboratory certificate . .	£1 10 0

Double Scales

M 2046	Ditto, range 26 to 31" and 660 to 790 mm.	£15 10 0
M 2047	Ditto, range 26 to 31" and 880 to 1050 mb.	£15 10 0
	National Physical Laboratory certificate . .	£1 15 0
	3' 2" x 6" x 5½"	19-lbs.

Glass-panelled Cases for Standard Barometers

The foregoing Fortin and Kew Barometers can be supplied mounted in glass-panelled, dust-proof fumed oak cases (or polished mahogany, if specially required) fitted with two locks and keys at the following additional prices.

With plate-glass door and sheet-glass sides.

M 2048	For Fortin Barometer, Type A	£6 10 6
M 2049	" " " " B	£6 18 0
M 2050	" " " " C	£6 18 0
M 2051	" " " " D	£7 5 0
M 2052	" " " " E	£5 10 0
M 2053	" Kew Barometers	£5 10 0
	With bevelled-glass fronts and sides . . extra	£1 5 6
	4' 3" x 8" x 7½"	30-lbs.



M 2043

STANDARD KEW BAROMETERS

Standard Kew Type Barometer. This barometer is intended for use as a bench standard and has a 0.5" diameter tube.

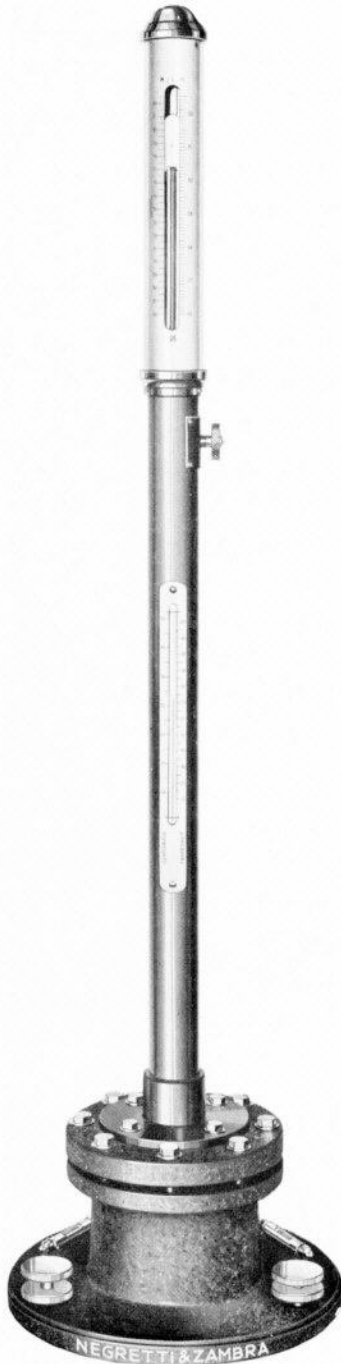
The base carries two levelling screws and spirit levels and is integral with the cistern, which has an internal diameter of 4".

A substantial cover plate carries the scale tube, the scale itself being silvered and engraved from 26" to 31", with a corresponding scale in millimetres or millibars engraved on the opposite side of the slot.

The portion of the tube on which the scales are marked is protected by a cylindrical glass cover.

Adjustment of the vernier is by a milled thumb screw. A thermometer divided from 10° to 120° F. and -10° to 50° C. is attached to the scale-tube column, with its bulb projecting into the latter.

For transportation the barometer is inverted and mounted in a special carrying crate. A vent plug, which carries internally a chamois leather cover, permits equalisation of the cistern and the external pressures, but prevents escape of mercury when the barometer is in an inverted position.



M 2042 Standard Kew Barometer, 0.5" tube, range 26" to 31", reading to 31" by vernier to .002", with millimetre scale from 660 to 790 reading to .05 mm. or millibar scale from 880 to 1050 reading to .1 mb. **£54 0 0**
 National Physical Laboratory certificate for one scale **£2 15 0**
 3' 4" x 10" 76-lbs.

NOTE.—Standard barometers can be graduated down to 20" (508 mm.) for use in stations at **high altitudes**—India, South Africa, Argentine, Mexico, etc.—including extra charge for National Physical Laboratory certificate extra **£2 0 0**

STANDARD KEW BAROMETERS

Kew Pattern Station Barometer, British Meteorological Office Specification. Tube, bore of the visible part 8 mm. filled with pure distilled mercury ; fitted with air trap in the form of an inverted pipette 2" to 2½" long. Cistern made of Firth's "Staybrite" steel, 3 to 4 mm. thick, left bright. Scale silvered, protected by a glass tube, graduated 870 to 1100 millibars or 25.7" to 32.6", readable by vernier to 1060 mb. and 31.4". Vernier operated by milled-head screw working with a rack and pinion, and reading to 0.1 mb. or 0.002". Thermometer mounted in a brass frame, tube graduated 260 320° A. or 5 120° F. Gymbal ring with suspension arm 60 mm. long, and bracket for wall attachment. Box of varnished deal ½-in. thick, with lock and key and rope handles ; box fitted with india-rubber packings.

M 2054 Kew Station Barometer to M.O. Specification, graduated millibars and inches, and with National Physical Laboratory certificate **£21 15 0**

M 2054A "Gold" Slide. For attachment to a Kew pattern barometer in place of the ordinary attached thermometer for computing the corrections to be applied to the readings **£6 0 0**

Kew Pattern Marine Barometer, similar to M 2043 Kew Station barometer except that the bore of the tube is contracted above the air trap so that the movement of the mercury is damped, the falling time for 1.5" to 0.5" (50 mb. to 18 mb.) above actual reading being between 4 and 5 minutes. The suspension arm is 12" long.

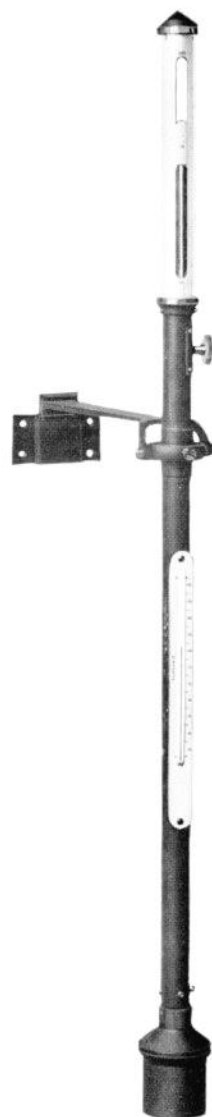
M 2055 Kew Type Marine Barometer, scale 26.5" to 31", reading to .002" **£14 0 0**

M 2056 Ditto, 670 to 790 mm. to .05 mm. **£14 0 0**

M 2057 Ditto, 890 to 1050 mb. to .1 mb. **£14 0 0**

National Physical Laboratory certificate **£1 10 0**

Box, 3' 2" x 4½" x 4½" 20-lbs.



M 2055





STANDARD BAROMETERS



M 2058

Mountain Barometer. A standard barometer of the Fortin type for determining altitudes.

The tube is of 0.2" bore filled with pure distilled mercury ; the cistern is constructed on the Fortin principle as described on page 23. The scales are graduated from 15 to 31", or 380 to 790 mm., and reading by vernier to 0.002" or 0.05 mm.

Thermometer mounted in brass case, graduated on the stem 1° F., or 0.5° C. Tripod of brass tubes, folding into three parts.

Solid leather case built up on a light metal frame shaped to take the barometer and tripod ; it has a leather cap and long strap.

- | | | |
|--------|--|----------|
| M 2058 | Mountain Barometer, scale 15 to 31", reading to .002" | £22 10 0 |
| M 2059 | Ditto, scale 380 to 790 mm., reading to 0.05 mm. | £22 10 0 |
| | National Physical Laboratory certificate | £2 5 0 |
| | Leather case, 3' 4" × 3" | 8-lbs. |

Student Barometer (Type E). This is a simpler form of the Fortin barometer described on page 25. The tube is of 0.25" bore, the frame and cistern bronzed ; the board is of stained oak, fitted with reflectors and brackets.

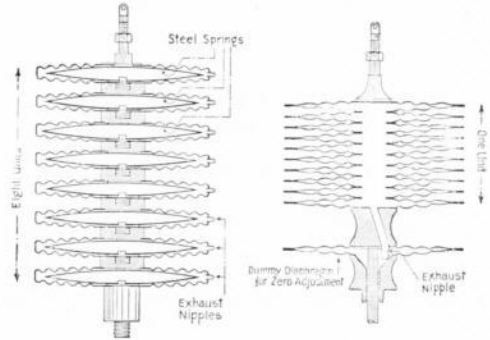
- | | | |
|--------|---|---------|
| M 2060 | Student Barometer, range 26.5" to 31", reading to 0.002" | £8 10 0 |
| M 2061 | Ditto, range 670 to 790 mm., reading to .05 mm. | £8 10 0 |
| | National Physical Laboratory certificate | £1 10 0 |
| | 3' 9" × 4" × 4" | 11-lbs. |



ANEROID BAROMETERS

The quality and performance of diaphragms used in aneroid barometers has a very important bearing on the accuracy of the instrument.

Negretti & Zambra's method of stamping diaphragms, instead of spinning them in the usual way, produces diaphragms of very high consistency in their performance and of considerably higher quality than has hitherto been possible.



Hardened and tempered steel or nickel silver alloy is used, and the diaphragms are formed—without the use of any springs—into one complete unit, as shown in the illustration on the right.

As the result of prolonged investigations and research, Negretti & Zambra have established an entirely new design of aneroid barometer, which is probably the most notable advance made in aneroid design. The inherent errors have been reduced to such small proportions that this aneroid barometer might well replace the mercurial barometer for scientific observations, since it requires no corrections for temperature or latitude.

In a letter from the Director, Rijks Studietienst Voor de Luchtvaart, Amsterdam, dated 2 12/1935, he wrote :—

“The two Precision Aneroids, recently despatched, have reached me in good order.

“I have had the occasion already of making a number of tests at different temperatures, the results of which are enclosed herewith. As far as can be seen from so short a period of observation the errors of both instruments are **by far within the tolerances**. I think it's a very good thing that the indications of both instruments under different conditions are so much alike. **This makes me sure that the good qualities do not belong to a single instrument but to the type with which I have already got so much satisfaction.**”

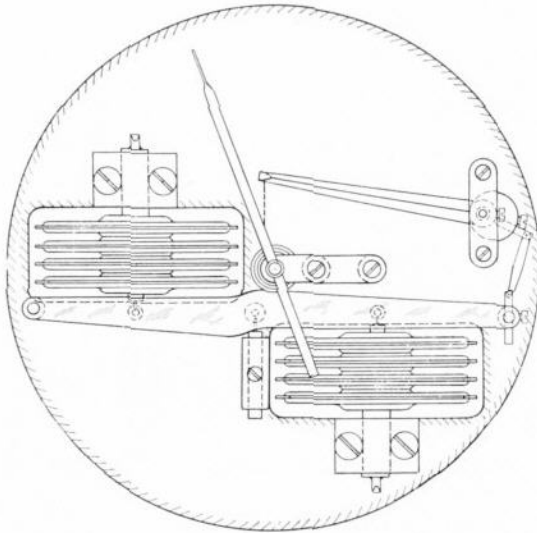
The use of the improved diaphragms eliminates the use of the U-shaped spring and its anchorage, obviating **hysteresis and creep**.

PRECISION ANEROID BAROMETERS

Errors due to **temperature** changes occur only in a minor degree from the thermal expansion of the various members, and are mainly due to the physical property that materials have of a change of elasticity modulus with temperature.

By suitably proportioning the volume of the space inside the boxes when closed to that when open, and by leaving a certain definite amount of dry air in the boxes, a compensation, that varies with the deflection, is effected.

This method of compensation, together with the improved method of construction of the diaphragms and their connections, ensures practically perfect **compensation for temperature** over the whole range of the instrument.



The movement employs two sets of four exhausted diaphragm capsules ; each set consists of eight nickel-plated hardened and tempered steel diaphragms. The two sets are fixed to the frame of the instrument, and the free ends are connected to a magnifying lever in such a manner that the two sets are balanced. The magnifying lever is of girder construction, and the fulcrum is formed by a flexing strip of stainless steel. The diaphragms are also connected to the balancing lever by flexing strips. At the end of the

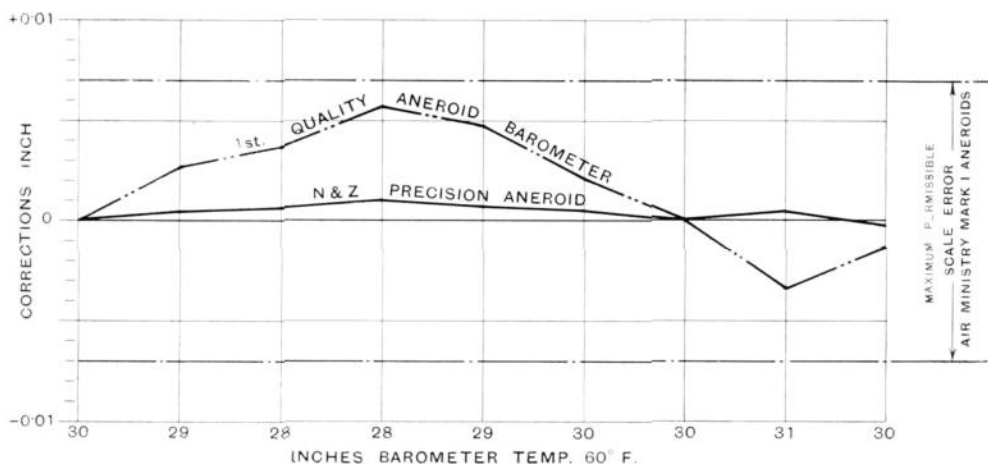
magnifying lever the movement is magnified, and at this point the movement is unaffected by position and balance, and is free from friction or backlash. The control at this point is considerable, due to the number of diaphragms used. The end of the magnifying lever is then linked to a second lever mounted on a practically frictionless spindle with point bearings. Attached to this spindle is a third lever which operates a chain and pulley mechanism. The pulley is of large diameter and operates on a spindle with a thrust bearing. A hair spring is used to give the required tension on the chain.

PRECISION ANEROID BAROMETERS

The **standard ranges** are as follows. In the case of the range 28 to 31", divided to 0.01", estimation of pressure may be obtained to 0.002", and possibly 0.001", by subdividing with the eye.

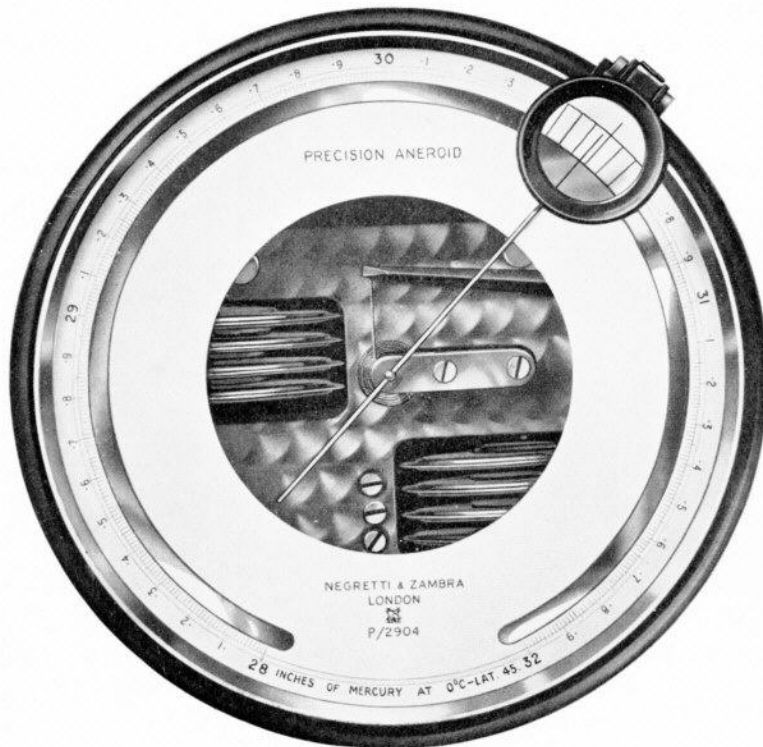
INCH.	Divided to	MILLIMETRES.	Divided to	MILLIBARS.	Divided to
28 to 34	0.02	710 to 860	0.50	950 to 1150	0.50
28 .. 32	0.01	710 .. 810	0.20	950 .. 1080	0.50
28 .. 31	0.01	710 .. 790	0.20	950 .. 1050	0.20
25 .. 31 5	0.02	640 .. 800	0.50	850 .. 1060	1.00
21 .. 31	0.02	540 .. 790	0.50	710 .. 1050	1.00

The precision aneroid is usually **calibrated** in pressure units only. A height scale in feet or metres can be added, however, and derived from the I.C.A.N. Law, Isothermal Law, or from Airy's Tables, with zero height at a pressure of 31, 30, or 29.90". Unless otherwise required, the height scale will be derived from the I.C.A.N. Law, which assumes that the air temperature falls uniformly at the rate of 1.98° C. per 1,000 feet from 15° C. on the ground.



The above graph of the performance of an N. & Z. Precision Aneroid under various tests for Hysteresis, Temperature, etc., shows the marked superiority when compared with the usual type of first class Aneroid, and with the limits of the Air Ministry specification.

PRECISION ANEROID BAROMETERS



The pointer is of tubular form, extremely light and rigid in construction, and is formed into a knife edge for reading purposes.

The frame carrying the diaphragms and movement is of special construction to avoid effects of strain or distortion.

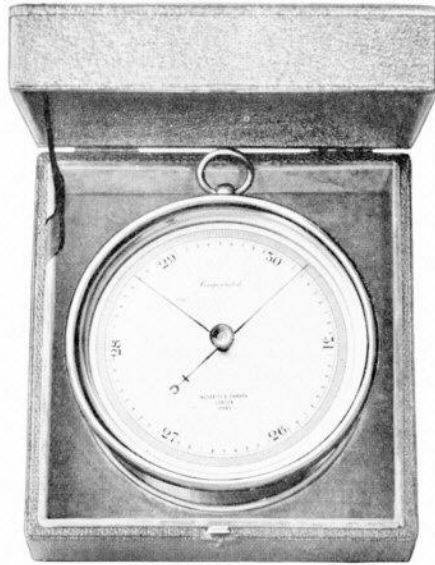
The setting adjustment consists of a quadrant and pinion which, in effect, rotates the whole movement and eliminates any possibility of characteristic errors being introduced when a setting is made. This is operated from the back of the case.

The dial is of brass, $4\frac{1}{2}$ " diameter, engine divided and silvered. An anti-parallax mirror is fitted behind the knife edge of the pointer.

A magnifying lens is also provided, which is attached to the rotating bezel.

M 2062 Precision Aneroid Barometer, in teak box. Price on application.

ANEROID BAROMETERS



Aneroid Barometer, British Meteorological Office Specification, Mark II.

Movement compensated for temperature, mounted in a brass case with suspension bow and bevelled-glass front. An index hand is provided on the cover glass and is set by a knurled button. The dial measures 4" diameter, scale 855 to 1055 mbs., engine divided and figured, and the instrument is complete in leatherette case with hinged lid.

M 2063	Aneroid Barometer , M.O. pattern, Mark I., as specified above, graduated in millibars.. .. .	£5 10 0
M 2064	Ditto, 26" to 31"	£5 10 0
M 2065	Ditto, 600 to 800 mm.	£5 10 0
	National Physical Laboratory certificate for above	£1 0 0
M 2063A	Ditto, M.O. pattern, Mark II., a simpler type ; graduated in millibars	£2 10 0
M 2064A	Ditto, 26" to 31"	£2 10 0
M 2065A	Ditto, 600 to 800 mm.	£2 10 0

RECORDING BAROMETERS



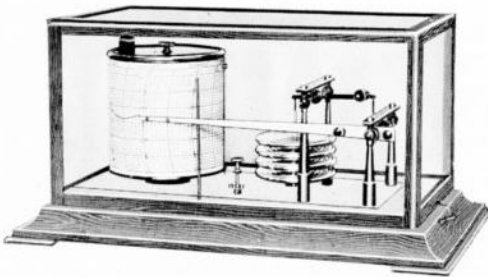
Barograph (Recording Barometer), British Meteorological Office Specification. Movement 7 to 8 chambers of spun diaphragms with inside springs.

Case of mahogany, french polished, dovetailed corners, front and left-hand side of case glazed; a stout handle is secured to lid. For time marking a spring push is fitted into the cover for depressing the recorder arm at the right-hand end, the push-knob being flush with the

mahogany. A drawer is fitted to the bottom of the case to hold a spare pen arm. A stoppered bottle for ink is sunk into a socket in the baseplate, with a brass dipper. The range is from 950/1050 mb. Weekly drum.

Clock drum	93 mm. high.
Time scale (12 hours)	2.0 cm.
Pressure scale (10 centibars)	7.5 cm.

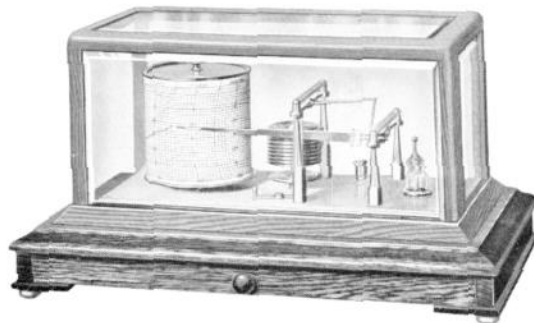
M 2067 Barograph, M.O. pattern, with pen, ink, and 100 charts £10 10 0
 Charts per 100 **£0 12 0**
 1' x 8½" x 6¼" 9-lbs.



Recording Barometer, of the simplest type. Movement consisting of four sets of spun diaphragms mounted on brass baseplate, and fitted in plain oak case with removable cover, glass all sides and top. Range 28/31" or 720/800 mm.; clock, daily or weekly as M 2069.

M 2068 Recording Barometer, English or Metric scale, with pen, ink, and 100 charts £7 10 0
 Charts per 100 **£0 12 0**
 1' 1" x 6½" x 7½" 8-lbs.

RECORDING BAROMETERS

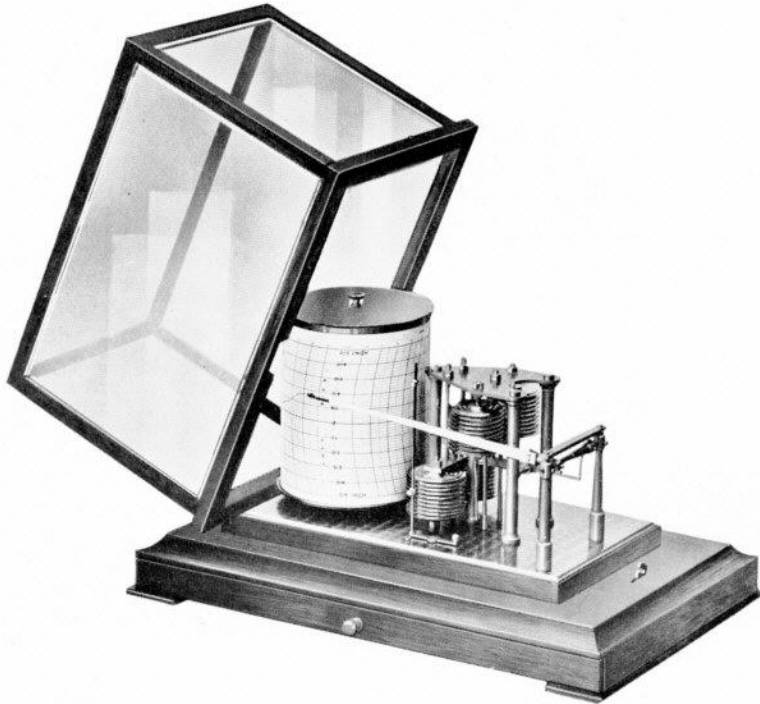


Recording Barometer of the highest quality workmanship and finish. Movement consisting of a specially-formed set of diaphragms (see page 31), fully compensated, operating lever mechanism to the pen-arm spindle. Jewelled pivots are provided to reduce friction to a minimum. A special form of zero adjustment is fitted, by which the diaphragms are raised or lowered in a truly vertical plane. The pen arm is hinged in order to ensure an even pressure of the pen on the chart. The whole movement is mounted on a polished brass plate, and all brass parts are highly polished and stove-lacquered with the best possible finish. The instrument is mounted in an oak or polished mahogany case, with bevelled glass panels and drawer for charts.

Daily (8-day clock) or weekly drum	..	3.6" dia. × 3.6" high
Pen travel	..	3"
Chart	..	3.6" × 11.8"
Time scale (daily)	..	0.45" per hour.
" " (weekly)	..	1.54" per day.
Pressure scale	..	1" per 1" barometric pressure.

- M 2069 Recording Barometer**, range 28/31" or 720/800 mm., with pen, ink and 100 charts **£12 10 0**
- M 2070** Ditto, range as above, with sector dial graduated in 1/10ths of an inch or 2 mm., with pen, ink and 100 charts **£15 0 0**
- M 2069A** Barograph as M 2069 in oak case, but **without drawer** ; with pen, ink and 100 charts **£10 10 0**
- Charts per 100 **£0 12 0**
- Barographs fitted with chart and clock making one revolution in **one month** extra **£2 2 0**
- Presentation Plates in brass or silver, extra.
- M 2069, 1' 4" × 9" × 8½" 12-lbs.

PRECISION RECORDING BAROMETERS



Precision Recording Barometer, or Micro-Barograph. A recording barometer with a greatly magnified scale, showing that fluctuations of pressure of the order of 0.02" may be faithfully recorded, is required in the investigations of various meteorological phenomena, and in the tropics where the movements of the barometer are practically only those of diurnal variation of the order of a few tenths of an inch. Further, such an instrument is indispensable in air surveys for recording the barometric changes at the base.

A magnification of five times normal scale cannot be effected by the ordinary type of barograph, for the reason that there is not sufficient control to overcome the friction of the moving parts of the pen on the chart, etc., nor can temperature corrections be arranged to the necessary fine degree. Therefore, in this precision barometer, four sets of the special diaphragms described on page 31 are used in two pairs, which achieves the desired end in giving adequate control on the pen arm. Their movement is transmitted to the main lever through flexing strips, thus avoiding the use of pivots, then by a crank slotted link to the pen arm.

PRECISION RECORDING BAROMETERS

The pen arm is adjustable to the middle position of the chart by a spring-controlled thumbscrew on the main lever ; when the pen reaches the top of the chart, further movement of the diaphragm and main lever is unrestrained, but the pen movement is restricted by stops on the pen lift rod.

A spring lever device prevents any strain on the mechanism.

The charts may be overprinted for actual barometric pressures, such as 25/26", 30/31", 700/725 mm., or $\pm 0.5"$, ± 12.5 mm.

Daily (8-day clock) or weekly drum	.. 5" dia. \times 6" high.
Pen travel	.. .. . 5"
Chart	.. .. . 5.8" \times 16.2"
Time scale (daily)	.. .. . 0.6" per hour.
" " (weekly)	.. .. . 2.06" per day.
Scale	.. .. . 1" per 0.2" pressure.

Case polished oak or mahogany, with drawer for charts, hinged glazed cover.

M 2071 Precision Recording Barometer , with pen, ink and 100 charts	.. .. . £52 10 0
Charts	.. .. . per 100 £0 15 0
National Physical Laboratory certificate..	.. .. . £6 0 0

Recording Barometer, Large Size. This instrument is designed to give a more open scale than that described on page 37. The scale value is nearly twice that of the usual pattern, and to obtain this open scale the instrument is provided with a balanced movement described in the foregoing, where the movement of the four sets of diaphragms is transmitted through link and flexing strips.

Daily (8-day clock) or weekly drum	.. 5" dia. \times 6" high.
Pen travel	.. .. . 5"
Chart	.. .. . 5.8" \times 16.2"
Time scale (daily)	.. .. . 0.6" per hour.
" " (weekly)	.. .. . 2.06" per day.
Scale	.. .. . 1" per 0.6" pressure.

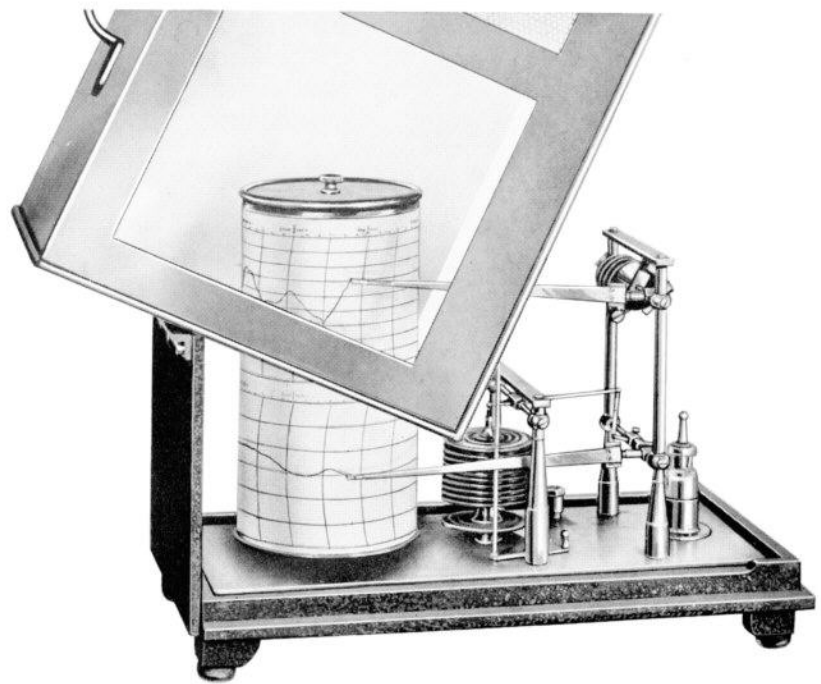
Case, polished oak or mahogany, with drawer for charts, hinged glazed cover.

M 2072 Recording Barometer , ranged 28" to 31" or 720 mm. to 800 mm., with pen, ink and 100 charts	.. .. . £44 5 0
Charts	.. .. . per 100 £0 15 0

1' 6½" \times 12" \times 10½" 39-lbs.



BARO-THERMOGRAPH



Baro-Thermograph. An instrument for recording on one chart the traces of barometric pressure and temperature.

The barometer mechanism consists of a set of aneroid diaphragms operating the pen arm on the usual link and lever principle.

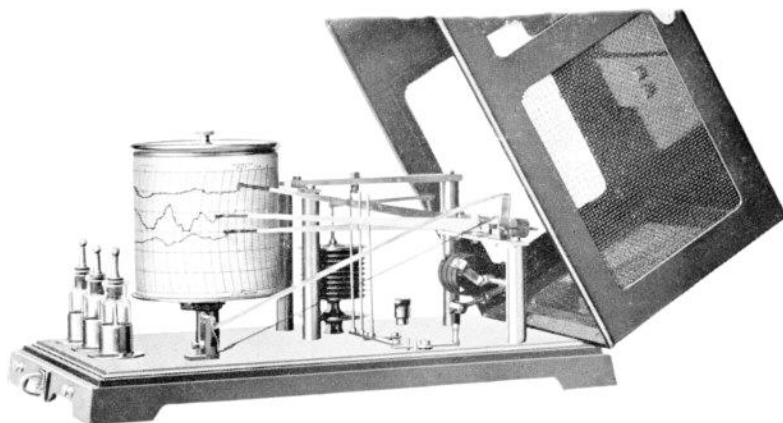
The thermometer mechanism comprises a bimetallic spiral coil mounted on brackets in such a way that the centre is above that of the barometer. The two records are, therefore, one above the other, and the traces are synchronised on the chart. Ranges are as follows :—

Barometer scale	28.31"
Thermometer	0/100° F., or 30/130° F.
Daily (8-day clock) or weekly drum	3.6" dia.
Chart	7" × 11.8"
Time scale (daily)	0.45" per hour.
" (weekly)	1.54" per day.
Scales .. .. .	.1" pressure per inch and 33.3° F. (18.3° C.) per inch.

The movements are mounted on a cast-iron base, with well-ventilated glass-pannelled metal cover.

M 2073 Baro-Thermograph, with 2 pens, 2 bottles of different coloured ink, and 100 charts **£21 0 0**
 Charts per 100 **£0 15 0**
1' 1" × 1' × 7" 15-lbs.

BARO-THERMO-HYGROGRAPH



Baro-Thermo-Hygrograph. The instrument records on one chart the three separate traces of barometric pressure, temperature, and humidity.

The passing of the pens on the chart is arranged by setting them a fixed amount, say, one hour, in advance of each other ; this enables the clock drum to be of standard height and not three times as high as usual.

The barometer mechanism consists of a set of diaphragms of the special type described on page 31 ; the movement is transmitted to the pen arm through a link and lever mechanism ; a setting screw for adjustment is provided.

The thermometer mechanism consists of a bimetallic spiral coil, the movements of which are transmitted through a crank and link to the second pen arm.

The hygrometer mechanism consists of a bundle of about 15 strands of human hair suitably treated, and their movement is transmitted directly by a crank to the third pen arm. Ranges are :—Barometer, 28 to 31" ; Thermometer, 0/120° F. ; Hygrometer, 10/100%.

Daily (8-day clock) or weekly drum	3.6" dia. × 3.6" high.
Chart	3.6" × 11.8"
Time scale (daily)	0.45" per hour.
" " (weekly)	1.54" per day.
Scales	1" pressure per inch and 40° F. per inch. 90% humidity for 3"

The brass plate carrying these three movements is mounted on a cast-iron base with a hinged, well-ventilated, glass-panelled metal cover.

M 2074 Baro-Thermo-Hygrograph, with 3 pens, 3 bottles of different coloured ink, and 100 charts	£22 0 0
Charts per 100	£0 12 0
1' 2" × 7½" × 8½" 9-lbs.	

RAIN GAUGES

Rainfall is measured in terms of the depth of water which would be collected upon a level area of any size, supposing the rain to fall uniformly over the area at the rate at which it falls into the gauge.

The Rain Gauge is used to measure the precipitation of rain, snow, hail and sleet, and in its simplest form consists of a funnel to collect the rain, and a glass or metal receiver to collect the rain which falls into the funnel. The important considerations of a satisfactory gauge are the proportion of the funnel to prevent splashing out of heavy rain ; the collection of snow, etc. ; the height of the rim of the funnel above the ground level ; the minimising of evaporation errors, and the prevention of damage by frost or corrosion.

It has been proved that the amount of rain measured in a gauge with a rim of 5" diameter is practically identical with that of a gauge with an 8" rim. Rain Gauges are almost invariably of 5" or 8" diameter (metric equivalent 125 mm. and 200 mm.).

The measurement of rain may be in terms of decimals of an inch, usually .01" (with an exceptional .005") or decimals of a millimetre usually .1 mm., the former being employed by the average observer in the British Isles—the latter by the British Meteorological Office and countries using the metric system.

The Recording Rain Gauge is not a labour-saving device but is an adjunct to an eye-read instrument, and provides information which is not apparent in a 12 or 24 hours' reading, viz., INTENSITY, RATE AND DURATION. Both gauges should be set up on the same site.

When no rain has fallen for some time, a recording rain gauge should be **tested** by pouring into the funnel quantities of rain corresponding to definite intervals on the chart.

In cold weather, a night-light placed inside below the funnel of the gauge will **prevent freezing**.

RAIN GAUGES



Rain Gauge, British Meteorological Office Specification. Constructed of stout copper, funnel surmounted with turned brass rim 8" diameter ; outer case fitted with splayed base ; inner can with wire rim and lip and brass drop handle ; glass bottle. Taper Measure as shown under Fig. M 2094, page 46.

M 2080	Rain Gauge, 8" size, with measure graduated in inches	..	£3	12	6
M 2081	Ditto, with measure graduated in millimetres	.. .. .	£3	12	6

Rain Gauge, 8" "Snowdon" Pattern. Specification as above but the outer case is parallel without a splayed base.

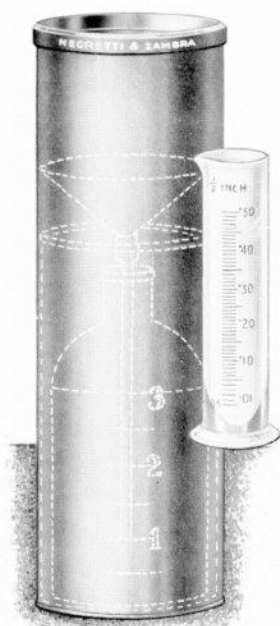
M 2082	Rain Gauge, with measure as Fig. M 2102 on page 46	..	£3	5	0
	1' 9½" × 1' 1½"				9-lbs.

Rain Gauge, British Meteorological Office Specification. Constructed of stout copper, funnel surmounted with a turned brass rim 5" diameter. Outer case with splayed base ; inner can with wire rim, lip, and brass drop handle ; glass bottle ; graduated measure, taper form, as shown on page 46.

M 2083	Rain Gauge, 5" size, with measure graduated in inches	..	£2	2	0
M 2084	Ditto, with measure graduated in millimetres	.. .. .	£2	2	0
	Meteorological Office certificate	.. .. .	£0	3	0
	1' 7½" × 8½"				8-lbs.



RAIN GAUGES



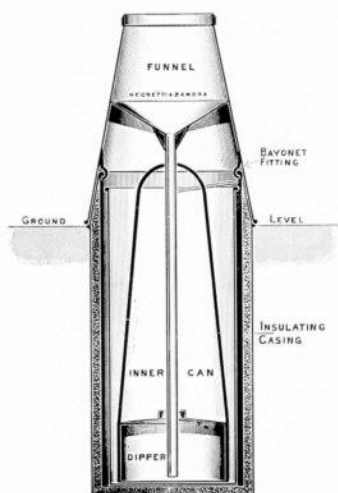
Rain Gauge, 5" "Snowdon" Pattern.
The specification of the "Snowdon" rain gauge is similar to the foregoing, except that the outer case is parallel without a splayed base. There is provided a glass bottle graduated in $\frac{1}{2}$ " of rainfall. The graduated measure is of the "Camden" type shown under Fig. M 2097 on page 46, with lip and foot.

- M 2085** Rain Gauge, 5" "Snowdon" Pattern, in copper, with measure **£1 17 6**
- M 2086** Ditto, in galvanized iron, with measure **£1 7 6**
Meteorological Office certificate .. **£0 3 0**
- 1' 4 $\frac{1}{2}$ " × 5 $\frac{1}{4}$ " 4-lbs.

Rain Gauge, "Seathwaite" Pattern.

A gauge of large capacity for outlying districts. The funnel is of the "Snowdon" type made of galvanized iron, brass rim 5" diameter; outer case of galvanized iron with secret catch for securing the funnel; annular space filled with pitch to guard against frost. Inner can of galvanized iron with wire rim, dished cover, and brass drop handle. Dipper of copper to hold exactly 5" of rainfall with brass wire handle.

Dip rod of cedar, graduated 30" in subdivisions of .1". A stout wooden case, with hinged lid and strap handle, carries the dip rod, dipper and graduated measure.



- M 2087** Rain Gauge "Seathwaite" Pattern, with accessories as above **£6 13 6**
Meteorological Office certificate .. **£0 9 0**
- 2' 3" × 10" 66-lbs.



RAIN GAUGES

Rain Gauge, "Bradford" Pattern.
Capacity 18" ; funnel of the "Snowdon" type, made of galvanized iron with turned brass rim 5" diameter ; outer case of galvanized iron, inner can of zinc with wire rim, dished cover and brass drop handle. Dip rod of cedar, graduated 18" in .1".

Measure graduated 1" in sub-divisions of .01".

- | | | | |
|---------------|------------------------|-------|----------------|
| M 2088 | Bradford Gauge | .. .. | £2 15 0 |
| M 2089 | Ditto, in stout copper | .. .. | £3 12 6 |
| | 2' 6" × 5¼" | | 21-lbs. |

Rain Gauge, "Mountain" Pattern.
Capacity 27". Specification as above. Graduated measure to 1½" in sub-divisions of .05".

- | | | | |
|---------------|-----------------------------------|-------|----------------|
| M 2090 | Mountain Rain Gauge | | |
| | as above | .. .. | £3 12 6 |
| M 2091 | Ditto, in copper | .. .. | £4 10 0 |
| | Meteorological Office certificate | .. .. | £0 9 0 |
| | 3' 6" × 5¼" | | 30-lbs. |



RAIN GAUGE MEASURES

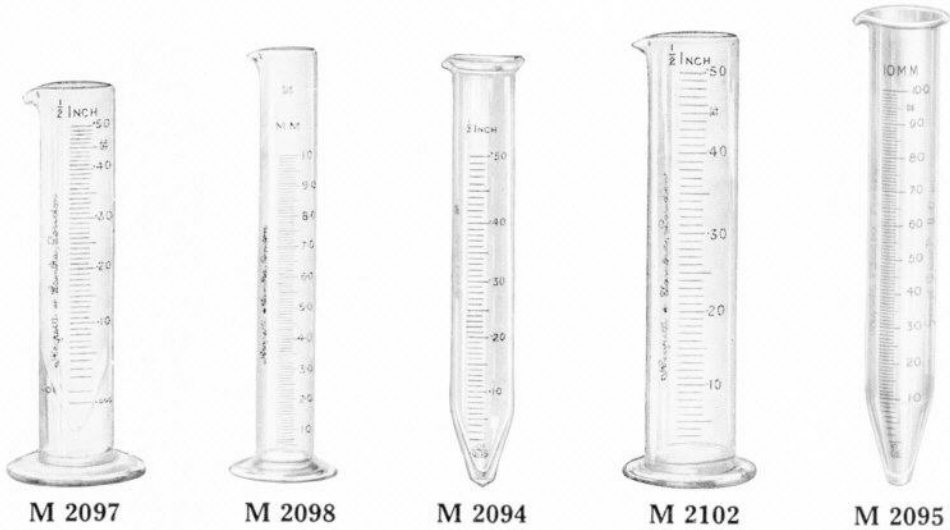
Rain Gauge Measuring Glasses hold ½" or 10 mm. of rainfall. Entries should be made to the nearest hundredth of an inch or to the nearest tenth of a mm.

Quantities below .005" or 0.05 mm. are entered as "trace" ; above these figures, and below .01" and 0.1 mm., the total is recorded as .01" or 0.1 mm.

A method of dealing with snow or frozen rainwater will be found on page 42; further particulars are given in the Meteorological Text Books.



RAIN GAUGE MEASURES



Made of good, stout flint glass thoroughly annealed, conforming to the specification of the Meteorological Office. Accuracy as follows :—

Millimetre Measures.	Maximum error below 1 mm.	±0.01 mm.	of rainfall.
	“ “ above 1 mm.	±0.05 mm.	“
Inch Measures.	Maximum error below 0.05"	±0.001"	of rainfall.
	“ “ above 0.05"	±0.005"	“

The “Taper” and “Camden” patterns show the sub-division .005" or .05 mm.

Rain Gauge Measure, Meteorological Office pattern, with long taper at the lower end and stout rim for pouring and holding.

M 2093	For 5" gauge, graduated in millimetres	.. .. .	£0 8 6
M 2094	For 5" " " " inches	.. .. .	£0 8 0
M 2095	For 8" " " " millimetres	.. .. .	£0 11 6
M 2096	For 8" " " " inches	.. .. .	£0 10 0

Rain Gauge Measures, with foot and lip.

M 2097	For 5" gauge, graduated in inches, “Camden” pattern, taper showing the first .005"	.. .. .	£0 7 0
M 2098	For 5" gauge, graduated in millimetres	.. .. .	£0 7 0
M 2099	For 5" " " to hold 1"	.. .. .	£0 8 0
M 2100	For 5" " " 1 1/2"	.. .. .	£0 9 0
M 2101	For 12.5 cm. gauge, graduated in millimetres	.. .. .	£0 8 0
M 2102	For 8" " " inches	.. .. .	£0 8 0
M 2103	For 8" " " millimetres	.. .. .	£0 8 0
M 2104	For 20 cm. " " "	.. .. .	£0 8 6
	Meteorological Office certificate	.. .. .	£0 1 3
	Excepting Nos. 2099, 2100	.. .. .	£0 1 9

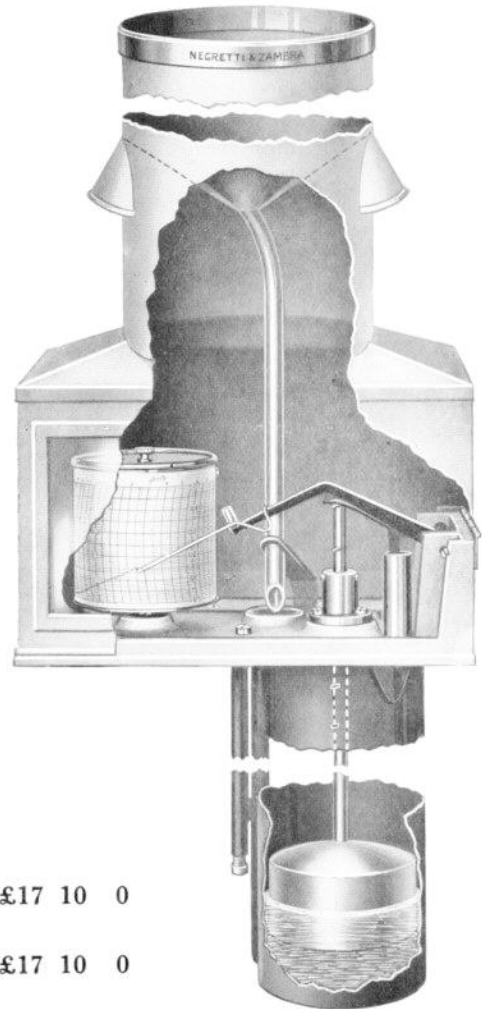


RECORDING RAIN GAUGES

The "Hyetograph" gives a record of duration and intensity of rainfall.

From a 6" diameter funnel the rain is led through a pipe to a float chamber. A rod attached to the float lifts the pen arm through a stud and pallet device. When the pen arm reaches the top of the chart, viz., 0.5" rainfall, the pallet disengages with the stud and the pen arm falls to the bottom of the chart. The pallet then engages with the next stud, and this operation is continuous until the container is full, viz., 4" of rainfall. When the float rod is depressed by hand, a syphon tube rapidly empties the gauge.

The baseplate is of cast iron, aluminium painted to prevent corrosion; cover of galvanized iron with glass front; funnel with turned brass ring; float chamber and float of copper.



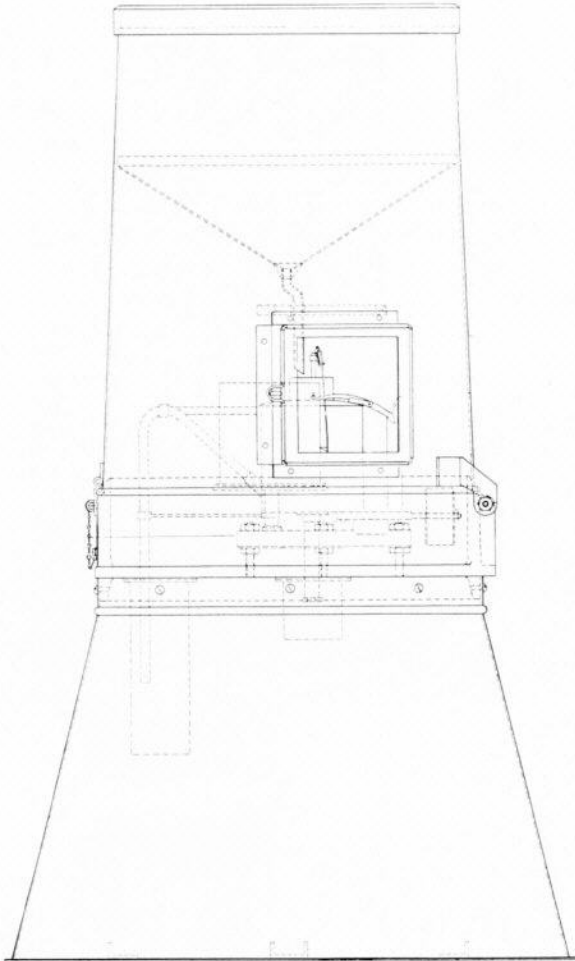
- | | | |
|---------------|--|-----------------|
| M 2105 | "Hyetograph," English scale, with pen, ink and 100 special charts | £17 10 0 |
| M 2106 | Ditto, metric scale, with pen, ink and 100 charts . . | £17 10 0 |
| | Charts, on waterproof paper . . . extra per 100 | £0 11 0 |

- | | |
|--|------------------------|
| Maximum capacity | 4" of rainfall. |
| Funnel | 6" in diameter. |
| Float | 4" " |
| Pen travel | 3" = 1/2" of rainfall. |
| Daily drum (8-day clock). Time scale . . | 0.45" per hour. |
| Depth in the ground | 12" |
| Height above ground | 18" |

57-lbs.



RECORDING RAIN GAUGES



Dines Tilting Syphon Rain Gauge to British Meteorological Office Specification. This instrument is designed to give a continuous record of the amount of rain falling in a rain gauge funnel 11.31" diameter and of the usual form.

Rain-water is led from the funnel into a float chamber, which is in the form of a tilting container, held in its normal position by means of a trigger and catch.

The rain-water entering the chamber lifts the float which also carries the recording pen.

When 5 mm. (or 0.20") of rain has been recorded, the trigger is released from the catch and the float chamber tilts, causing the water to syphon out.

The pen is automatically held off the chart until the syphoning is completed, and the chamber has been returned to its normal position by a counter-balance weight.

The instrument is strongly constructed throughout and is supported on a splayed base built up on a circular gun-metal casting, which is sunk into the ground.

M 2106A Dines Tilting Syphon Rain Gauge. British Meteorological Office pattern. Price on application.

Capacity	Unlimited.
Funnel	11.31" diameter.
Pen travel	10 mm. = 1 mm. of rainfall.
Daily drum (8-day clock). Time scale	11.4 mm. per hour.
Overall height	33 1/4"

62-lbs.

RECORDING RAIN GAUGES

“ Natural Syphon ” Gauge. This is a type of gauge which automatically syphons after each 0.5" of rainfall, and does not require hand operation of the syphon. The rain is collected in a 6" diameter funnel and is led through a pipe to a float chamber, where it is recorded by a float mechanism. As the float rises, the pen attached to the float rod traces the record on a clock-driven chart. When the pen reaches the top of the chart for 0.5" of rainfall, the syphon automatically comes into action and discharges the gauge rapidly. The pen falls to the bottom of the chart and the cycle is repeated.

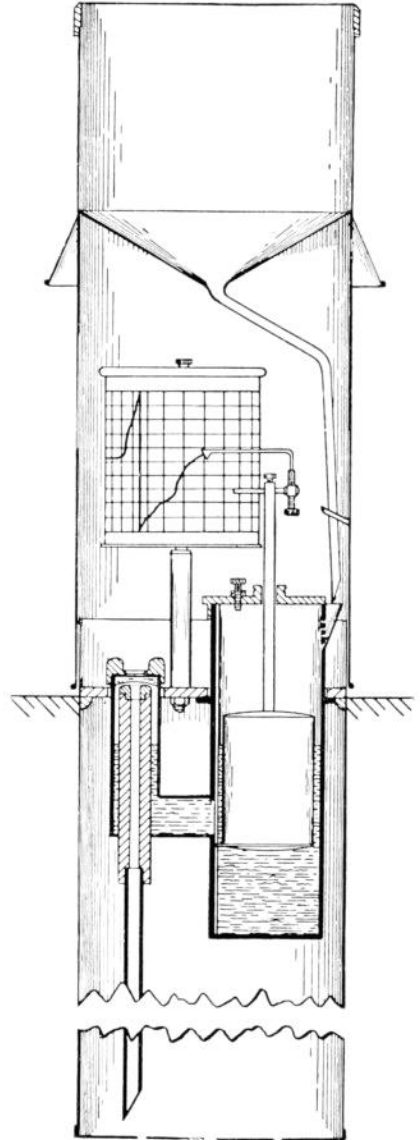
The gauge is constructed of galvanized metal, aluminium painted to prevent corrosion. The cover is surmounted by a funnel of the "Snowdon" type, with 6" diameter turned brass ring.

The charts are printed on waterproof paper to prevent buckling and stretching.

M 2107 “ Natural Syphon ” Rain Gauge,
with pen, ink, and 100 charts on
special waterproof paper, **£17 10 0**

M 2108 Ditto, metric scale .. **£17 10 0**
Charts. waterproof, per 100,
£0 11 0

Capacity	Unlimited.
Funnel	6" diameter.
Float	2" diameter.
Pen travel	3" = $\frac{1}{2}$ " of rainfall.
Daily drum (8 - day clock). Time scale	0.45" per hour.
Depth in the ground ..	15"
Height above ground ..	15"



40-lbs.



RECORDING RAIN GAUGES

M 2109 "Natural Syphon" Rain Gauge to British Meteorological Office Specification, with pen, ink, and 100 charts on special waterproof paper **£20 0 0**

Cover and cylinder of sheet copper. Syphon discharges at 10 mm. rainfall. Time of discharge not more than 10 seconds.

Pen travel 6 mm. = 1 mm. rainfall.

Daily drum (8-day clock). Time scale . . . 11.4 mm. per hour.

Template for reading rate and duration of rainfall **£0 4 0**

Meteorological Office certificate **£0 12 6**

40-lbs.

THE "TILTING BUCKET" RAIN GAUGES

This gauge records on the chart the amount of rainfall in increments of 1/100".

The rain is collected in an 8" diameter funnel and is led through a pipe to a bucket with open ends, divided into two compartments, and pivoted about its central point ; it tilts over when .01" of rainfall has been collected.

An escapement advances a toothed wheel, to which is attached a profile cam ; resting on this cam is a brass roller attached to the pen arm, which is thus raised step by step for each .01" of rainfall up to 1" ; the roller then trips off the cam and the pen returns to zero of the chart ; an oil-filled dashpot damps the fall. Attached to the escapement wheel is a dial graduated to 1" in subdivisions of .01".

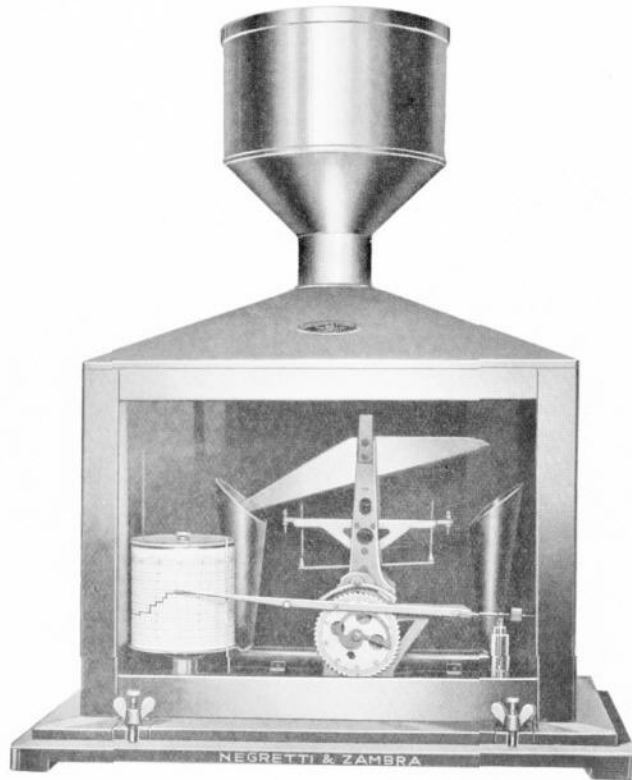
The gauge is constructed with a metal base and a sheet-metal cover with glass-panelled front clamped to the brass baseplate by four wing nuts. The cover is surmounted by a funnel of the "Snowdon" type, with 8" diameter brass ring detachable for convenience in packing.

Base, cover and funnel stoved and enamelled green or white.

NOTE.—As the record from this instrument is "step by step," it is not suitable for measuring the duration of gentle rain, and the records are, therefore, not accepted by the British Rainfall Authorities. However, on account of the capacity being unlimited and no syphon being necessary, it is suitable for tropical countries, and where a gauge has to be left for some considerable time unattended.

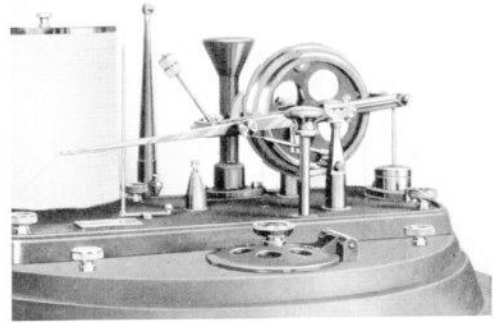
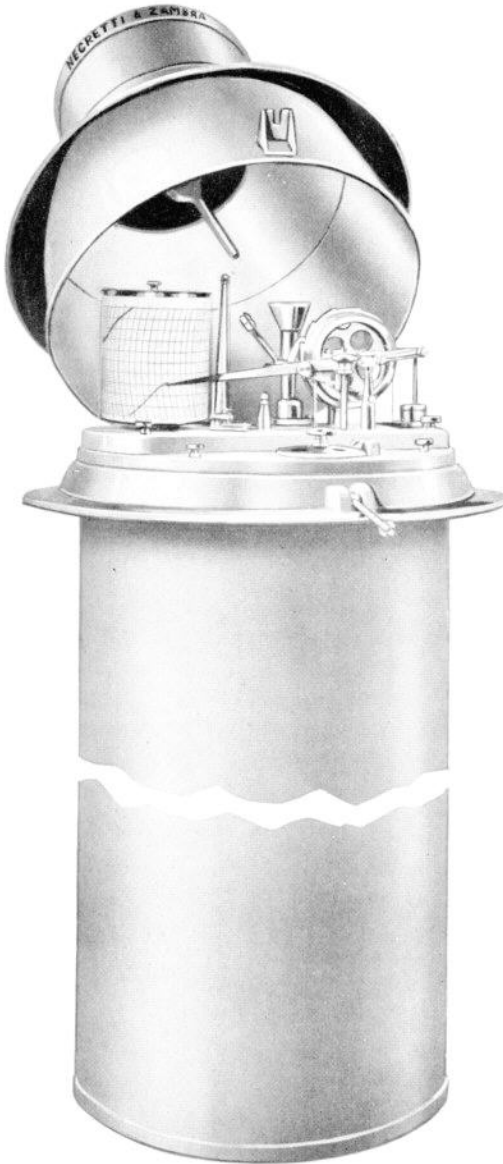


RECORDING RAIN GAUGES



- | | | |
|---------|--|----------------------|
| M 2110 | Recording Rain Gauge as described on page 50, with pen, ink, and 100 charts | £20 0 0 |
| M 2111 | Ditto, metric scale to 25 mm. | £20 0 0 |
| M 2111A | Ditto, Tropical Pattern , with cover and funnel of copper, polished or enamelled; various parts of the mechanism sand-blasted and lacquered and windows sand-blasted inside | £28 10 0 |
| M 2111B | Ditto, metric scale to 25 mm. | £28 10 0 |
| | Charts per 100 | £0 12 0 |
| | Capacity | Unlimited. |
| | Funnel | 8" diameter. |
| | Pen travel | 3" = 1" of rainfall. |
| | Daily drum (8-day clock). Time scale | 0.45" per hour. |
| | Weekly drum " " | 1.54" per day. |
| | Overall height | 28" |
| | 2' 4" × 1' 9" × 1' 2" | 33-lbs. |

RECORDING RAIN GAUGES



Enlarged view of mechanism.

Recording Rain Gauge, "Float" Pattern. This instrument is designed to give a record of rainfall of great accuracy over an open reading chart (0.5" of rainfall = 5" pen travel), and to contain a large volume of rain before any hand syphoning is necessary.

RECORDING RAIN GAUGES

The rain is collected in a 10" diameter funnel and is led through a pipe to the float chamber. The float operates the pen arm through a chain and pulley mechanism. As the float rises, the pulley rotates and lifts the pen arm through a ratchet device ; immediately the pen reaches the top of the chart, a pawl, operating on a ratchet, is tripped and the pen falls to the bottom of the chart. An oil-filled dashpot damps the fall. This cycle is repeated until the float chamber is partially or entirely full, when a knob is pressed by hand, and all accumulated water in the gauge is rapidly syphoned out.

The cover is surmounted by a funnel of the "Snowdon" type, with 10" diameter turned brass ring.

Stainless steel, gun metal, phosphor bronze and copper are largely used in the construction of this gauge to avoid any possibility of corrosion or deterioration after years of exposure to adverse conditions.

Charts printed on waterproof paper to avoid buckling and stretching.

M 2112	Recording Rain Gauge , with pen, ink, and 100 charts. . .	£97 0 0
	Charts on waterproof paper per 100 . . .	£0 15 0
	Maximum capacity	12" of rainfall.
	Funnel diameter	10"
	Float diameter	5½"
	Pen travel	5" = 0.5" of rainfall.
	Daily drum (8-day clock). Time scale . . .	0.6" per hour
	or	
	6-hour drum (2-day clock). Time scale . . .	2.55" per hour.
	Height above ground	1' 8"
	Depth below ground	3' 4"
	5' × 1' 11" 130-lbs.	



EVAPORATION GAUGES



M 2113

Piche's Evaporimeter. A glass tube about 9" long × 0.6" diameter is graduated in ccm. A metal clip holds a disc of porous paper, from which the water in the tube evaporates, and the alteration of level indicates the degree of evaporation.

- M 2113 Piche Evaporimeter £0 12 6
- M 2114 Box of 150 Discs £0 1 6

Evaporimeter. A copper vessel with 8" or 20 cm. diameter turned brass rim is fitted with a wire guard to prevent animals from interfering with the water.

A glass measure is graduated in .01" or .1 mm. in relation to the brass rim, and is used for measuring the water in the gauge.

- M 2115 Evaporation Gauge £2 5 0

INDEX TYPE

Evaporation Gauge. A copper float rises and falls in a copper cylinder, which acts as a still water chamber. A brass chain attached to the float operates a brass wheel and turns an index hand attached to the axis; the float is correctly counterpoised. The index hand moves over an arc $9\frac{1}{2}$ " radius; the scale of 0 to 4.00" subdivided to .02" engraved on a brass strip attached to the iron frame. The wrought-iron frame is designed to fit on the corner of the recognised tank.



M 2116

- M 2116 Index Evaporation Gauge £12 0 0

- M 2117 Tank, of galvanized iron, $\frac{1}{8}$ " thick, measuring 6-ft. × 6-ft. × 2-ft., with braced ends and still water chamber £13 0 0

(Price dependent upon market price of material).

- M 2116. 1' 8 $\frac{1}{2}$ " × 1' 8" × 8 $\frac{1}{2}$ " 10-lbs.

RECORDING PERCOLATION GAUGE

This gauge is used in conjunction with the investigation of percolation of rainfall through the earth.

A specimen piece of ground of known area is selected, under which is installed a large trough. The gauge is installed in a tunnel and the trough collects the water and records on the clock-driven chart the amount of percolation.

The gauge consists of a copper tank 18" in diameter \times 3 feet high; a gauge glass is provided for measuring accurately the volume of water in the tank.

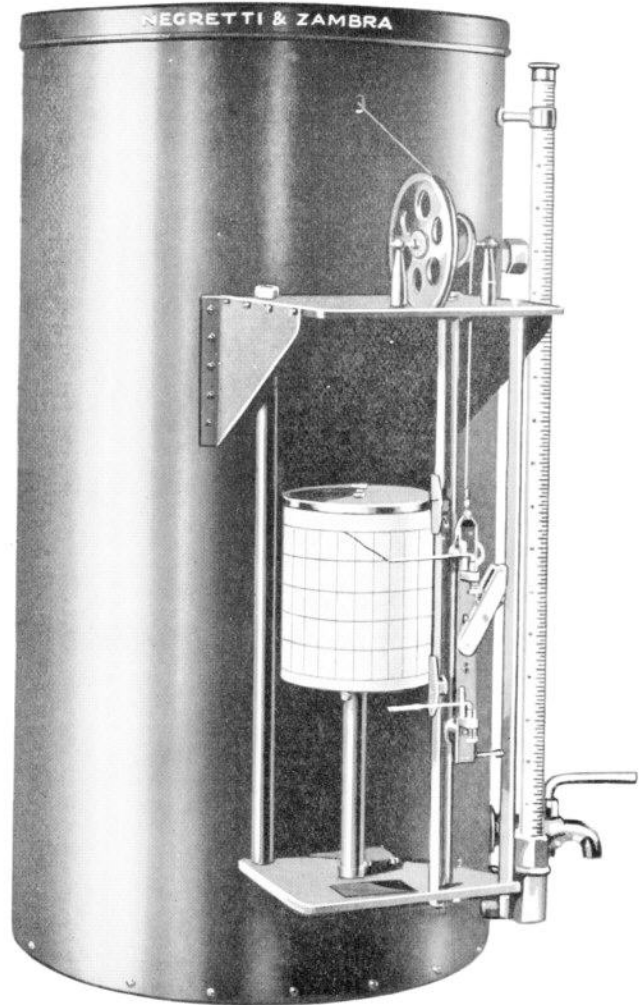
A copper float, 8" diameter, moving in the tank, operates one or more pen arms by means of a cable and pulley device. Friction or corrosion in the mechanism is avoided by the careful design and selection of materials. The

travel of the float is approximately 24" for 1" of percolation: the first pen travels on the chart 5" for 0.5" of percolation, and the second pen comes into operation at 0.5" to 1". A cock is provided for emptying the tank.

The clock makes one revolution in 24 hours. Time scale, 0.6" per hour.

M 2118 Percolation Gauge, with pens, ink, and 100 charts £67 10 0

3' \times 1' 6 $\frac{1}{2}$ " \times 2' 3 $\frac{1}{2}$ " 35-lbs.



SUNSHINE RECORDERS

The instruments for recording bright Sunshine are :—

“ **Campbell-Stokes** ” **Recorder**, where the sun’s rays are focussed by means of a glass sphere upon prepared and printed cardboard strips.

“ **Jordan** ” **Recorder**, where the sunlight enters a hole in a light-tight circular box, and leaves a trace on a specially-prepared sensitised chart.

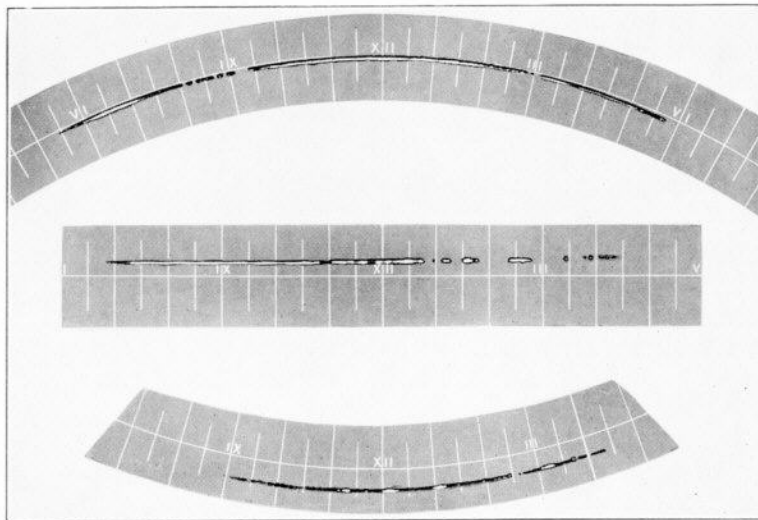
Electrical Recorder, where the intensity of the sun’s rays is measured by a thermopile and a millivoltmeter.

In order that all returns of sunshine should be absolutely comparable, the Campbell-Stokes recorder has been adopted as Standard by such authorities as the British Meteorological Office, the Canadian Meteorological Service, the Union of South Africa, and most of the British Colonies.

The setting up of a sunshine recorder is all-important for accurate records :—

- (a) The base must be perfectly level.
- (b) The frame carrying the charts must be tilted and clamped to the correct latitude of the place of observation.
- (c) The instrument must be correctly in the meridian of the station.

Instructions for setting either by compass (making due allowance for magnetic deviation) or by the clock (allowing for the equation of time) are published in most text-books.



Specimen traces of Cards of Campbell-Stokes Recorder.

“CAMPBELL-STOKES” SUNSHINE RECORDERS



Campbell-Stokes Pattern, “Universal” Type. The instrument consists of baseplate, standard, semi-circular arc, brass casting for holding the recording cards generally known as the bowl, and a glass sphere.

The base is a heavy polished slate slab.

The standard is a brass upright, with plate and clamp for fixing the arc at the correct latitude.

The semi-circular arc, which carries a graduated scale of latitudes, has bosses at each end accurately drilled and tapped to take the securing bolts and locking nuts for the sphere.

The bowl is machined with three concentric grooves to take the three patterns of cards as follows:—

Equinoctial (Straight)	.. ..	width 1.56"
Summer (Long Curve)	.. ..	.. 1.26"
Winter (Short Curve)	.. ..	.. 1.26"

The edge of the bowl should be cut so that when it is adjusted for its mean latitude, the plane of the cut shall be approximately horizontal.

The sphere is of well-annealed glass, refractive index 1.512. Focal length 2.95". Diameter 4".

M 2119 Campbell-Stokes Sunshine Recorder, “Universal”

Type £15 15 0

(Supply of cards for one year, see M 2122.) 26-lbs.





“ CAMPBELL-STOKES ” SUNSHINE RECORDERS



Campbell-Stokes Pattern for Temperate Latitudes. British Meteorological Office Specification.

This instrument is designed for use in latitudes 35° to 65°, and is provided with a scale and an adjustment enabling it to be set correctly for any latitude between these limits.

The glass sphere is supported on a pillar with a cupped top and capable of such adjustment as may

be required to bring the sphere truly central with respect to the bowl.

The instrument is built up on a brass sub-base fitted with three levelling screws, which are in turn located on a substantial gun-metal casting.

In other respects the recorder is similar to M 2119.

M 2120 Sunshine Recorder, M.O. Pattern, for temperate latitudes £16 0 0

Tropical Pattern : British Meteorological Office Specification.

This recorder is suitable for use in latitudes between 5° North and 45° South, or 5° South and 45° North.

It is similar in construction to that described above except with respect to the mounting of the sphere.

Two brass caps are screwed in holes accurately drilled diametrically opposite to each other in the glass sphere, and two adjustable pivots, fitted at the ends of the semi-circular supporting frame, engage in tapered holes in the caps.

M 2121 Sunshine Recorder, M.O. Pattern, for tropical latitudes £18 10 0

M 2122 A supply of Cards lasting one year consists of 150 Long, 150 Short Curve, and 100 Straight **£1 10 0**

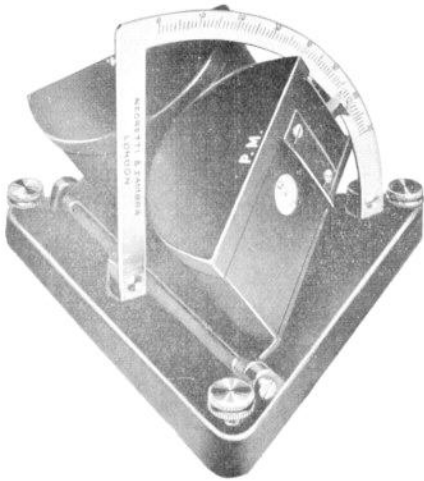
M 2123 A Template of celluloid for totalling the trace **£0 2 0**

M 2124 Glass Sphere to standard specification (drilling, extra 17/6) .. **£5 12 6**

Meteorological Office certificate **£0 3 0**



“JORDAN” SUNSHINE RECORDERS



M 2125



M 2127

Jordan's Photographic Pattern. This instrument consists of two brass half cylinders with detachable covers, with a pinhole on the east and on the west, the sunlight entering the holes and leaving the trace on the sensitised chart fitted in each cylinder.

The two cylinders are mounted upon a brass baseplate, which is adjustable for latitude and is clamped to a brass arc graduated 0° to 70°. The plate and arc are bolted on to a cast-iron baseplate provided with three levelling screws.

The charts are coated with a special solution of sensitivity sufficient to record the sun's rays but not to fog the rest of the chart. The record is a narrow band of dark blue, and is fixed by rinsing the chart in water ; the trace is tabulated after the chart is rinsed.

M 2125	Sunshine Recorder, Twin-cylinder pattern	£7 10 0
M 2126	Charts, per packet of 100 each A.M. and P.M. 8½" × 7½" × 7" 8-lbs.	£0 9 6

Jordan Sunshine Recorder. This is a simple model with single cylinder, having two pinholes and detachable cover.

Mounted on a cast-iron base, with pivot and clamp for latitude. Brass scale plate and index from 20 / 70°, and spanner for clamping.

The single sensitised chart is printed for A.M. and P.M. records.

M 2127	Jordan Recorder, Single-cylinder type	£2 5 0
M 2128	Charts, sensitised 4½" × 4½" × 7" 3-lbs.	per 100 £0 6 0



SOLARIMETERS

Instruments for measuring solar radiation, comprising the solarimeter and pyrhelimeter, consist of a sensitive thermopile connected with a millivoltmeter of either the indicating or the recording type.

The Solarimeter uses a thermopile of the Moll pattern modified by Gorczynski, with its sensitive surface located horizontally and hermetically enclosed in a heavy brass cylinder with hemispherical cover of special flint glass. The millivoltmeter has a scale of 100 divisions, and a statement of the value of one division, in calories per CM^2 per minute, is issued with each instrument. These two parts are fitted into a stout box, and the apparatus is kept indoors, being taken out-of-doors only when a reading is to be taken.

M 2129 Solarimeter, for Direct Reading (foreign) Price on application.

Recording Solarimeter consists of a thermopile similar to that described above, used with a recording millivoltmeter.

The thermopile, under hemispherical glass cover of 30 mm. or 50 mm. diameter, is mounted on a small holder which is fixed out-of-doors at the most convenient place ; it is connected by electric cable with the recorder.

The recording apparatus is a millivoltmeter having a drum making one revolution in 13 or 26 hours ; the chart measures 10×40 cm., and the pen arm leaves a dotted trace. A statement of the value of one division, in calories per CM^2 per minute, is issued with the recorder.

M 2130 Recording Solarimeter, with small (30 mm.) thermopile holder, 100 charts, pen, ink, etc. (foreign) Price on application.

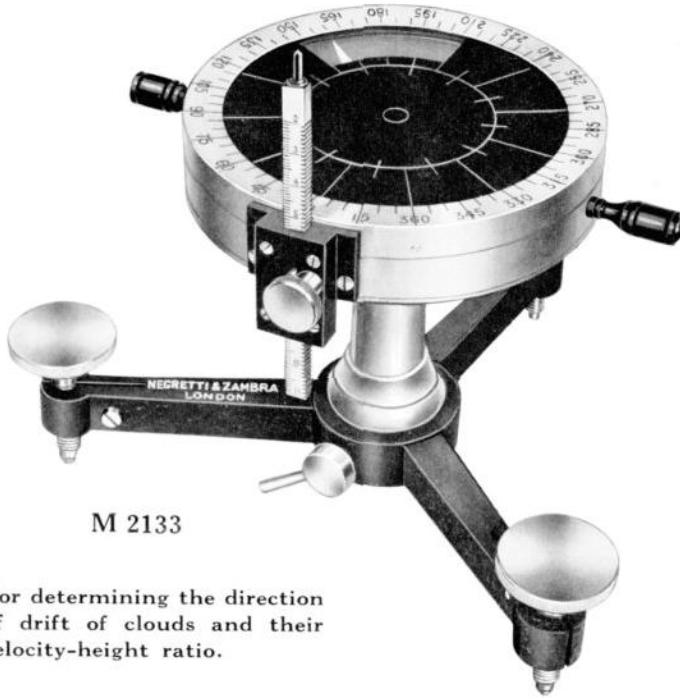
M 2131 Ditto, ditto, with large (50 mm.) thermopile holder

Pyrhelimeter consists of a Moll thermopile in a brass tube, with a series of three Langley diaphragms. The tube has a sighting device and provision for vertical adjustment. It is connected by electric cable to a millivoltmeter having 100 divisions—a statement of the value of one division in calories per CM^2 per minute is furnished.

M 2132 Pyrhelimeter (foreign) Price on application.



NEPHOSCOPES



M 2133

For determining the direction of drift of clouds and their velocity-height ratio.

The Finemann Pattern. This consists of a disc of black glass mounted on a tripod stand fitted with three levelling screws. A vertical pointer, which can be raised or lowered by rack and pinion, is attached to a collar which can be rotated independently of the mirror. A scale of millimetres engraved on the edge of the pointer gives the height of the tip above the glass surface. The black glass disc is engraved with concentric circle and radii 25 mm. apart.

The case is of stout wood with hinged cover, in which are fixed three brass plates on which the instrument can be used.

M 2133 Finemann Nephoscope £10 5 0

The Besson Pattern is for direct vision, and has a brass "comb" mounted on a tall rotatable upright.

The upright is of brass rod about 9-ft. long, mounted by means of rings and clamps to a post in such a way that it may rotate freely.

The cross-piece is about 3½-ft. long, furnished with 6 equidistant vertical spikes.

M 2134 Besson Nephoscope £8 5 0

STANDARD THERMOMETERS

The equipment of a normal station consists of the following thermometers :—

Dry Bulb Thermometer.
 Wet Bulb ,,
 Maximum ,,
 Minimum ,,

And at some stations :—

Solar Maximum Thermometer.
 Grass Minimum ,,
 Earth Thermometer.

“The accurate measurement of the temperature of the air in the open is one of the most difficult of all meteorological measurements, for it is so readily affected by effects of radiation. Radiation from the sun, the clouds, the sky, the ground and surrounding objects passes in straight lines through the air without appreciably affecting its temperature, for air is very transparent to radiant heat, especially if it is dry. But the instrument that is used to measure the temperature of the air is some kind of thermometer, and is made of material which intercepts radiant heat to an appreciable extent. In consequence, the reading of the instrument may differ from that corresponding with true air temperature by any amount up to 50° F., or even more. Such differences depend partly upon the nature of the thermometer, partly upon the amounts of the different kinds of radiation experienced, and partly upon the wind velocity and other extraneous factors. The reading of a thermometer freely exposed in the open may thus bear no determinable relation to the temperature of the particles of air in which it is placed. It is usual, therefore, to provide some form of thermometer shelter or ‘screen,’ which will serve to support the thermometers and to protect them from the weather and accidental damage, and at the same time shield them from radiation without impairing the free passage of air over the bulbs of the thermometers.”⁽¹⁾

The **Stevenson Screen** should be erected 4-ft. above the ground, preferably over a grass plot and with the door facing due north (south in Southern Hemisphere), or preferably somewhat east of north, so that the sun may no shine on the instruments.

(1) “The Dictionary of Applied Physics”
 —Meteorological Instruments—by R. Corless, O.B.E., M.A.

STANDARD THERMOMETERS

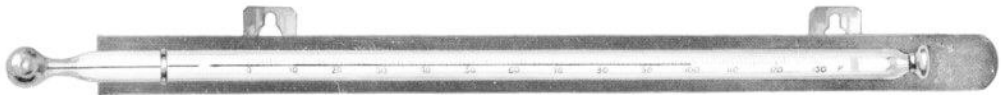


- M 2135 **Standard Maximum Thermometer**, British M.O. pattern, to B.S.I. specification 692-1936. Tube protected by an outer glass sheath. Length 13½". Bulb of normal glass; stem of British lead glass. Range 0/130° F. or 15/145° F., divided single degrees, figured every 10° .. £1 2 6
- M 2135A Ditto, Canadian pattern -40/+110° F. £1 5 0



- M 2136 **Standard Minimum Thermometer**, British M.O. pattern, to specification as above, tube filled with rectified spirits of wine, and fitted with a floating index. Range -30/+100° F. or -10/+120° F. Safety cavity to 150° F... £1 2 6
- M 2136A Ditto, Canadian pattern -80/110° F. £1 5 0

For Ordinary Thermometers of this type see page 69.
For Wet and Dry Bulb Thermometers of this type see page 82.



- M 2137 **Standard Maximum Thermometer**, specification and ranges as M 2135 above, mounted on mahogany stock with two brass hanging plates, centres 9½" apart £1 7 6

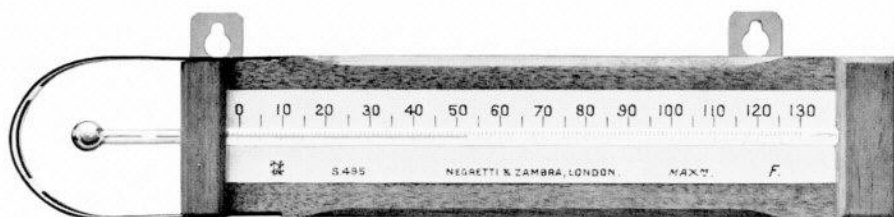


- M 2138 **Standard Minimum Thermometer**, specification and ranges as M 2136 above, mounted on mahogany stock with two brass hanging plates, centres 9½" apart £1 7 6
- (Note.—The range of M 2137,8 used in Australia is 0/140° F.).

National Physical Laboratory certificate for any of the above (excepting Nos. 2135A, 2136A) £0 3 0

Ditto for Nos. 2135A, 2136A, where the test includes one at the freezing point of mercury, £0 10 0; or 2136A with test also at -70° F. £0 15 0

STANDARD THERMOMETERS



- M 2139 Standard Maximum Registering Thermometer.** Tube 12" long, fitted with opal glass scale in mahogany mount ; bulb protected by brass guard, overall length 13½" ; bulb of normal glass, stem of British lead glass fitted with maximum constriction. Range, 0 / 130° F., divided on stem in single degrees, figured every 10° on scale. Mount fitted with two brass hanging plates 8½" apart £1 7 6
- M 2140** Ditto -15 / +55° C. £1 7 6
- M 2141** Ditto, low range -40 / +120° F. £1 10 0
- M 2142** Ditto, Tropical. Range 25 / 150° F. or -5 / +65° C. £1 7 6

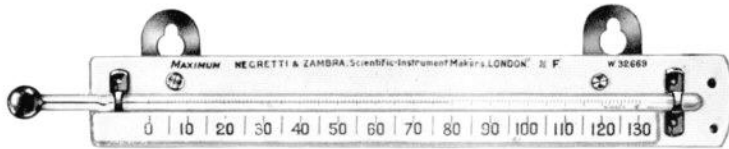


- M 2143 Standard Minimum Registering Thermometer.** Specification as above. Stem filled with rectified spirits of wine, and fitted with floating index. Range -20 / +110° F. ... £1 7 6
- M 2144** Ditto -30 / +45° C. £1 7 6
- M 2145** Ditto, low range -70 / +110° F. £1 10 0
- M 2146** Ditto, Tropical. Range -5 / +130° F. or -20 / +55° C. £1 7 6

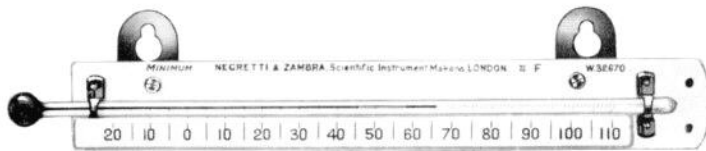
National Physical Laboratory certificate for any of the above (excepting Nos. 2141, 2145) £0 3 0

Ditto for Nos. 2141, 2145, where the test includes one at the freezing point of mercury £0 10 0

STANDARD THERMOMETERS



- M 2147 **Standard Maximum Thermometer**, Secondary or "Public School" pattern. Tube 10 $\frac{1}{4}$ " long, with porcelain scale and brass mount for suspension. Range 0/130° F. £0 17 6
- M 2148 Ditto, -15/+55° C. £0 17 6



- M 2149 **Standard Minimum Thermometer** as above. Range -20/+110° F. £0 17 6
- M 2150 Ditto, -30/+45° C. £0 17 6



Minimum Thermometer, Terrestrial Radiation (or Grass Minimum), British M.O. pattern to B.S.I. specification 692-1936. As described under M 2136 on page 63.

Range -30/+100° F. or -10/+120° F., divided on the stem in single degrees, and figured every 10°. Safety cavity to 150° F.

- M 2151 **Terrestrial Radiation Thermometer** £1 2 6
- M 2152 Ditto, -35/+40° C. £1 2 6



Minimum Thermometer, as above, with bulb blown in the shape of a link to give a larger surface of exposure.

- M 2153 **Terrestrial Radiation Thermometer** -30/+100° F. or -10/+120° F. £1 7 6
- M 2154 Ditto, -35/+40° C. £1 7 6

National Physical Laboratory certificate for any thermometer on this page £0 3 0

SOLAR THERMOMETERS



- M 2155 **Solar Radiation Thermometer.** Maximum registering thermometer, with bulb and 1" of stem coated with dull lamp black enclosed in a glass sheath completely exhausted of air. Length 15", bulb of normal glass, stem and sheath of lead glass. Range 20/200° F., divided on the stem and figured every 10° £1 15 0
- M 2156 Ditto, -5/+95° C. £1 15 0
- M 2157 Ditto, fitted with small U-tube gauge to show that the vacuum in the sheath is maintained £2 2 0

National Physical Laboratory certificate for above thermometers:—

For corrections to the thermometer before being sheathed £0 5 6

- M 2158 **Actinometer (Marie Davy).** An actinometer is used for ascertaining approximately the quantity of heat which the earth receives from the sun, and consists of a pair of thermometers mounted in a hermetically sealed sheath, one bulb being left bright and the other coated with lamp-black. Range 20/200° F., mounted on a base of polished hardwood, with holes for the thermometers, £3 17 6

- M 2159 Ditto, -5/+95° C., £3 17 6

- M 2160 **Actinometer Thermometer,** bright or black bulb as above, £1 12 6

National Physical Laboratory certificate for corrections before thermometer is sheathed.

Each £0 5 6



EARTH THERMOMETERS

Earth Thermometer, British Meteorological Office pattern. Tube fused into outer glass protecting sheath. Overall length 12" × 0.9" diameter. Range 20/100° F., divided on the stem in single degrees and figured every 10°; the bulb is embedded in paraffin wax of melting point 120° F. A stout piece of rubber tubing, with boxwood plug and brass screw-eye, is securely bound round the upper end of the sheath; two rubber rings are provided.

M 2161	Earth Thermometer , M.O. Pattern as above	£1	10	0
M 2162	Ditto, -5/+40° Centigrade	£1	10	0
	National Physical Laboratory certificate	£0	3	0

Tube for Earth Thermometer, Ordinary type. Wrought-iron tubing 1½" bore, with wooden plug at lower end. Painted one coat of black enamel. Japanned copper cover and brass chain.

	1-ft.	2-ft.	4-ft.	6-ft.	12-ft.
M 2163	£0 17 6	£1 1 0	£1 8 6	£1 16 0	£2 18 6

Tube for Earth Thermometer, British Meteorological Office pattern. Mild steel tubing 1¼" bore, with solid steel cone at lower end; rubber disc 1" diameter cemented in the steel casting. A mild steel flange 3" in diameter × ⅛" thick is brazed on the tube 12½" and 48½" respectively above the rubber disc; brass chain attached to cap of copper 3" long, provided with a brass handle and brass eye. The tube is painted two coats red lead paint and one coat of black enamel.

	1-ft.	4-ft.
M 2164	£1 15 0	£2 2 0

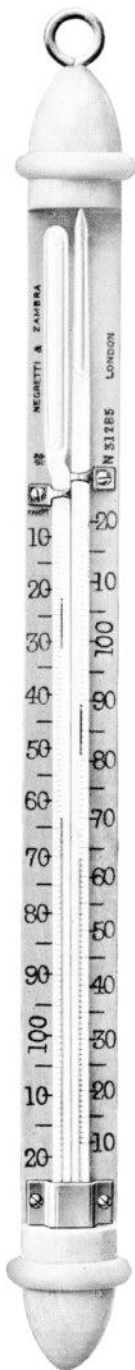
Earth Thermometer, Right-angle Form, British Meteorological Office specification. Tube of British lead glass, with 8" scale and 4" or 8" stem at right angles. Bulb of normal glass, diameter 0.5", length between 0.45" and 0.55". Range 20/100° F., divided on the stem in single degrees and figured every 10°.

M 2165	Right-angle Thermometer	£0	12	6
	National Physical Laboratory certificate	£0	3	6

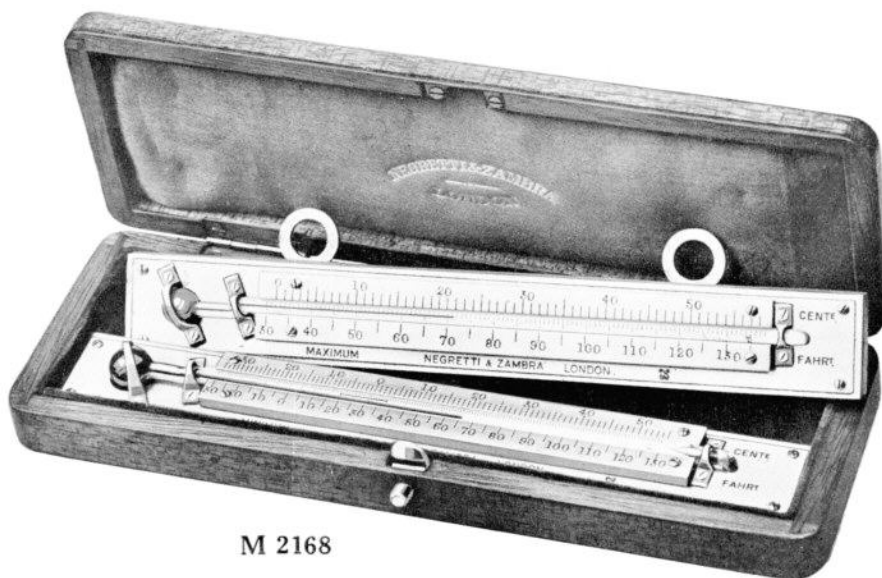


M 2161

STANDARD THERMOMETERS



M 2166



M 2168

- M 2166** Maximum and Minimum Thermometer, Six's Pattern, for letting down a tube and registering earth temperatures. The tube is divided on the stem and mounted on a turned boxwood stick with brass rings top and bottom, and rubber protecting rings. The length overall is $11\frac{1}{2}$ " , diameter $1\frac{1}{8}$ " . Range $+10/+120^{\circ}$ F. £1 2 6
- M 2167** Ditto. Range $-10/+50^{\circ}$ C. £1 2 6
National Physical Laboratory certificate £0 4 6
- M 2168** Pocket Maximum and Minimum Thermometers, in polished, velvet-lined mahogany case. Tubes divided on the stems ; divisions and figures on nickel-silver scales mounted on boxwood.
Maximum $30/130^{\circ}$ F., and $0/55^{\circ}$ C.
Minimum $-20/+110^{\circ}$ F., and $-30/+45^{\circ}$ C.
Small Size $7\frac{1}{2} \times 2\frac{3}{4} \times 1$ " £4 5 0
- M 2169** Ditto, Large Size $10\frac{1}{2} \times 3\frac{1}{4} \times 1$ " £5 10 0
National Physical Laboratory certificate £0 6 0

STANDARD THERMOMETERS

Standard Thermometer, 21" long, with finest quality tube mounted on opal glass, on which are permanently fired the divisions and figures, the tube being also divided on the stem. Fitted on polished mahogany frame, with the highest quality finish.

STANDARD RANGES

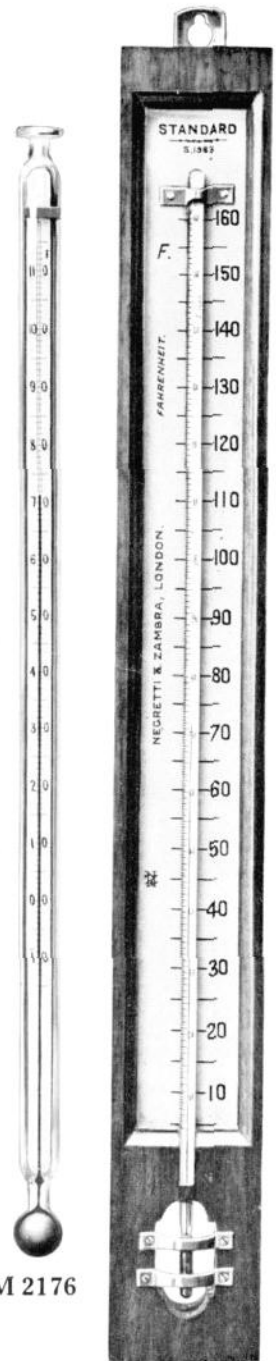
Type.	Range	Sub-divided to	Each.	With N.P.L. Cert. Extra.
M 2170	-30° to 120° F.	0.2°	£3 15 0	£0 14 0
M 2171	+10° „ 160° F.	0.2°	£3 12 6	£0 15 6
M 2172	+30° „ 250° F.	0.5°	£3 17 6	£0 11 6
M 2173	-30° „ 50° C.	0.1°	£3 15 0	£0 15 6
M 2174	-10° „ 70° C.	0.1°	£3 12 6	£0 11 0
M 2175	0° „ 120° C.	0.2°	£3 17 6	£0 11 0

Ordinary Thermometer, British Meteorological Office pattern to B.S.I. specification 692—1936. Tube protected by an outer glass sheath, and overall length 13½". Bulb of normal glass, stem of British lead glass supported inside the sheath by a ring of rubber; sheath permanently fused on to the thermometer at a point between the bulb and the lowest graduation. Range -15/+115° F., or 0/130° F., divided on the stem in single degrees and figured every 10°.

M 2176 **Standard Thermometer**, Mark I. £1 0 0

M 2176A Ditto, Canadian pattern -40/+110° F. £1 2 6

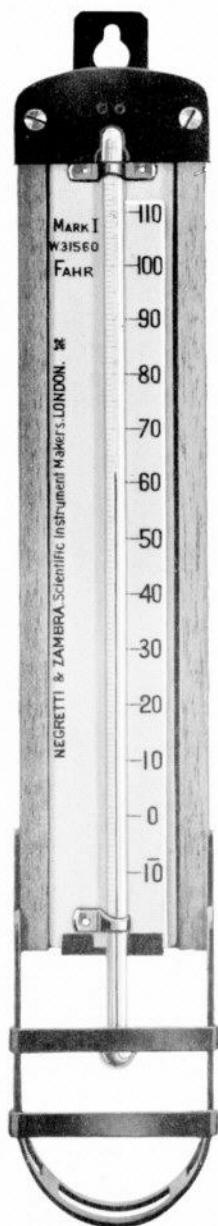
National Physical Laboratory certificate for
 M 2176 £0 3 0
 Ditto, for M 2176A £0 10 0



M 2176

M 2171

STANDARD THERMOMETERS



M 2177 with Protector
M 2180

Ordinary Thermometer, British Meteorological Office pattern, Marks I., II., and III. Tube $10\frac{3}{4}$ " long, filled with mercury, fitted on porcelain scale plate with raised side; bulb of normal glass, stem of English lead glass, divided on the stem in single degrees and marked every 5°, figured every 10° on the raised side of the porcelain scale plate.

- M 2177 **Thermometer**,
Mark I. Range -10/+110° F. £0 13 6
- M 2178 Ditto, Mark II. Range -40/+85° F. £0 15 0
- M 2179 Ditto, Mark III. Range 0/130° F. .. £0 13 6

National Physical Laboratory Certificate

Mark I.	Mark II.	Mark III.
£0 2 6	£0 10 0	£0 2 6

Note.—A pair of these thermometers, one being fitted with wick and muslin, constitute the Wet and Dry Bull Hygrometer used by various Meteorologica. Services.

Protector for Marine Screen Thermometer, British Meteorological Office Specification. This frame provides a support for Ordinary Thermometers as above, and is a mahogany stock fitted with brass guard and turned-up brass fitting to support the base of the porcelain scale; it has also a top fitting and a brass hanger.

- M 2180 £0 17 6

Protector for Sea-water Thermometer, British Meteorological Office Specification. This frame provides a protecting support to the above thermometers when used for sea-water observations. It resembles the above in all respects, except that in place of the guard there is a brass reservoir into which the bulb of the thermometer will dip.

- M 2181 £1 1 6

DEEP SEA THERMOMETERS

Deep Sea Thermometer. The Negretti & Zambra original patent "Reversing" or "Turnover" pattern indicates the temperature only **at the spot where it is reversed.**

The action is that when it descends into the sea it acts as an ordinary thermometer, the mercury rising and falling according to the temperature of the stratum through which it passes. When, however, the prearranged depth is reached, and a reverse motion given to the line to pull the apparatus to the surface, the column of mercury breaks automatically, and that which is cut off at the constriction or appendix remains to indicate the actual temperature at the moment of reversal at the prearranged depth.

The thermometer consists of a tube and bulb made of glass of known constants, such as Borosilicate, of a length suited to the range of scale and graduations as described later, and with two cavities, of which the lower is to accommodate surplus mercury if the thermometer is heated above the scale value. The upper cavity takes the surplus mercury when the thermometer, after reversal, passes through layers of water at a temperature higher than that at the reversal. This surplus must not fall and join the main column or it would falsify the reading, and therefore the tube is made so that it will hold the maximum amount which may expand during any one sounding. The latest type of cavity takes the form of a loop, which adds great strength to the thermometer where it is most needed.

Various forms of constriction have been tried, but that which has, up to now, met with the greatest success, is in the form of an appendix which is visible upon all N. & Z. deep sea thermometers. Upon reversal, the mercury starts to flow from the point of the appendix and then breaks at the point where this joins the main column. Experience shows that this form of "break" gives the most exact reproductions of readings, which is, of course, the vital point of a reversing thermometer.

The bulb and stem are protected against pressure effects up to **at least 3 tons per square inch** (470 kgms. per sq. cm.) by an outer glass sheath with mercury round the bulb to conduct changes of temperature rapidly to the thermometer.

DEEP SEA THERMOMETERS

The **auxiliary or side thermometer** is fitted to the latest pattern deep sea thermometers for the reason that a correct reading of the column of mercury trapped during reversal can only be obtained when read at the same temperature as when the thermometer was reversed.

The side thermometer shows the present temperature of the trapped mercury, and a correction must be applied which depends on :—

- (a) The difference in temperature " T " between the side thermometer and the temperature indicated by the trapped mercury.
- (b) The volume of the trapped mercury " V ."
- (c) The coefficient of apparent expansion of mercury in the glass, of which the thermometer is made " A."

With regard to (a), it is assumed that the temperature of the trapped mercury, when reversed, is as indicated by the column when read. This simplifies the calculation somewhat, and the error introduced is negligible.

(b) The volume of mercury is expressed in units of that volume which would occupy the space between two successive degree marks of the reversing thermometer. The volume which would give a reading on the reversing thermometer at 0° is stated on the thermometer, and the total volume for determining the correction is obtained by adding the reading in degrees if above zero, and subtracting it if below.

The thermometer is also marked with the coefficient of apparent cubical expansion of mercury in the glass of which it is made.

Taking the symbols given in (a), (b) and (c), the correction to be applied is : $T \times V \times A$.

EXAMPLE :—

The reversing thermometer reads 12° C.,
 the side thermometer reads 17° C.,
 the volume at 0° C. is 95 ;
 the coefficient of expansion of mercury in the glass is 1/6100 per deg. C.

$$\begin{aligned} \text{the correction is } & (17 - 12) \times (95 + 12) \times \frac{1}{6100} \\ & = \frac{5 \times 107}{6100} = 0.09^\circ \text{ approx.} \end{aligned}$$

As the reversing thermometer when read was at a higher temperature than when reversed, this correction is to be subtracted from 12°, and the temperature at reversing thus becomes 11.91° C.

DEEP SEA THERMOMETERS



M 2185



M 2182



M 2186

For specification and prices—see page 74.



DEEP SEA THERMOMETERS

	M 2182	M 2183	M 2184	M 2185
Overall Length	25 cm.	32 cm.	32 cm.	32 cm.
Range of scale	-2/+25° C.	-2/+25° C.	-2/+12° C.	-2/+30° C.
Sub-divisions . . . . .	.5°	.2°	.1°	.2°
Approx. scale value of 1° C.	4 mm.	6 mm.	10 mm.	5 mm.
Correction by N.P.L. to . .	.1°	.05°	.02°	.05°
Price	£2 10 0	£3 15 0	£4 0 0	£3 15 0
N.P.L. certificate for pressure and temperature tests	£0 13 6	£0 16 6	£1 2 6	£0 16 6
M 2185A Deep-sea Thermometer , unprotected type for depth measurements ; range 0-30° divided to 0.1° C.				£4 0 0
M 2185B Ditto	0-60°	0-2° C.		£4 0 0
National Physical Laboratory certificate for M 2185A				£4 10 0
Ditto, for M 2185B				£4 0 0
M 2185C Thermometer for Water Bottles (Nansen-Petersen), length 320 mm., range -2/+16° C. divided to 0.01° C.				£3 0 0
M 2185D Ditto, length 385 mm., range -2/+32° C. divided to 0.01° C.				£4 0 0
National Physical Laboratory certificate				£0 18 6

FRAMES

Reversing Frame constructed to take a pair of full-sized thermometers, consisting of two brass tubes attached by a chain to a spring release which is clamped on to the sounding line or wire. A heavy brass weight or messenger of stream-lined design runs down the line, impinges on a lever which, in turn, releases the clip holding the frame which causes the latter to turn completely over.

This is the simplest, most reliable, light and yet robust form of frame.

M 2186 Reversing Frame , Marine Biological pattern, to take two thermometers in stout wooden case	£4 10 0
M 2186A Ditto, improved pattern	£6 0 0
M 2187 Ditto, with a single tube	£3 10 0
M 2187A Ditto, improved pattern	£4 7 6

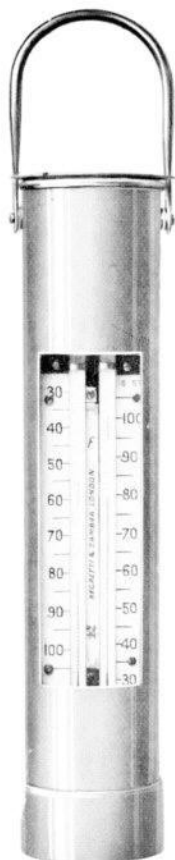
Note.—The above prices of frames do not include thermometers.

M 2187B Wooden Float Frame (loaded) which reverses on ascending, suitable for shallow depths ; for any of the above thermometers	£1 6 6
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Note.—Particulars of other Reversing Frames, such as the "Magnaghi," "Scottish" pattern, etc., in separate pamphlet.



DEEP SEA THERMOMETERS



Miller Pattern Deep Sea Thermometer, registering the maximum and minimum temperatures, bulb protected against pressures up to 3 tons per square inch. Thermometer graduated on the stem as specified below ; opal glass scales on which the figures are permanently fired mounted on vulcanite back, in stout copper case. The instrument is supplied with a magnet for resetting the indices.

M 2188 Miller Pattern Deep Sea Thermometer, ranged +30/100° F. in 1° **£3 18 6**

M 2189 Ditto, -5/+40° C. in 0.5° divisions **£3 18 6**

National Physical Laboratory certificate for scale error and pressure test **£0 16 6**
 11½" × 2¼" 1¼-lbs.

SEA-WATER BOTTLE

Fishery Type Water Bottle, constructed on the suggestions of Mr. D. J. Matthews, late of the Marine Biological Association.

It is made entirely of brass, and consists of a stout cylinder with two spring-controlled valves. These valves are set open before descent, and closed by a trip action operated by a sliding weight or messenger. The capacity is 20-ozs. = 483 c.c., and it is specially designed for the recovery of Plankton, the interior being coated to prevent any chemical action injuring the organisms.

In stout wooden case, with stream-lined shape messenger.

M 2190 Fishery Water Bottle **£13 10 0**

Case, 1' 9" × 4½" × 6" 8-lbs.



SURFACE THERMOMETERS



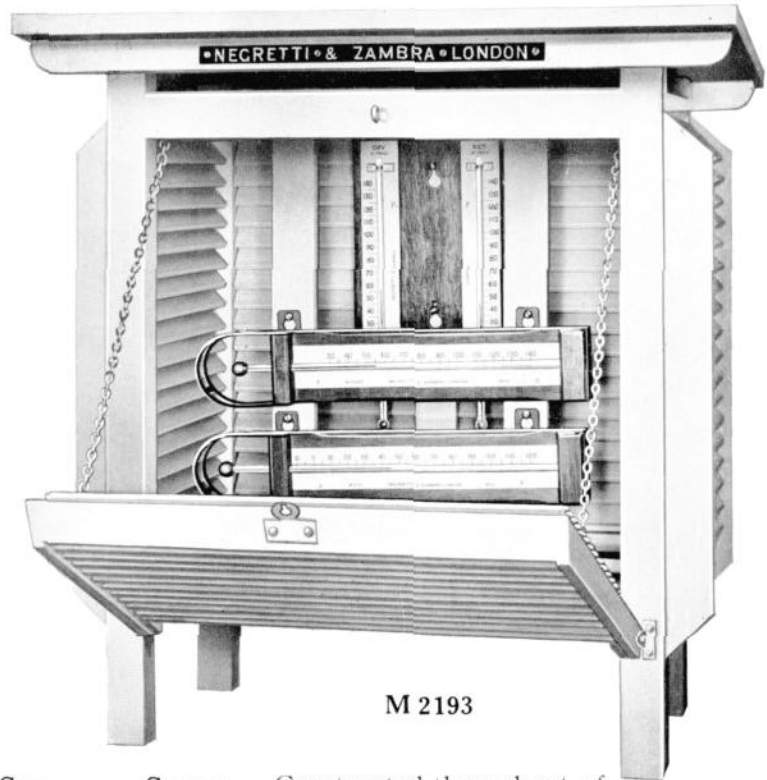
Surface Thermometer. The bulb is reduced to the smallest dimension possible with a mercury-in-glass thermometer in order to reduce the thermal lag to a minimum. On to the glass bulb a copper foot is soldered with a special alloy ; this foot offers a comparatively large surface and forms a good conductor of heat to the bulb. Surrounding the bulb and copper foot is a reflector, polished inside and outside to prevent loss of heat by radiation or by air currents ; the reflector is sprung from the glass tube to ensure the copper foot being in good contact with the surface. This thermometer was designed and is used for taking the temperature of rocks, etc.

- M 2191** **Surface Thermometer**, mercury filled, lens tube, complete in wooden box. Range 0/100° C. or equivalent F. . . £4 10 0
- M 2192** Ditto, in brass case with handle, complete in wooden box £6 15 0



THERMOMETER SCREENS

Sheathed Type instruments, British M.O. pattern. Standard maximum and minimum thermometers are shown on page 63; standard wet and dry bulb hygrometer on page 82; the screen fitting for same is mentioned below.



M 2193

- M 2193 Standard Stevenson Screen.** Constructed throughout of best yellow pine with double louvres, 18 on each side; inside dimensions 16" x 16" x 9"; hinged door with 18 double louvres, brass hasp, staple and padlock. The bottom consists of three boards with ventilation spaces between them; the roof is made in two parts, the inner of plain board drilled with ten holes; the outer roof of selected timber, jointed and tenoned. Three uprights for the thermometers are fitted in the correct positions inside the screen. All parts are finished two coats of paint before assembly, and one coat of white enamel after completion **£5 10 0**
- M 2194** Four Posts 5-ft. x 3" x 3", to serve as a stand **£2 0 0**
- M 2193A Stevenson Screen.** British Meteorological Office Pattern **£9 15 0**
 M 2193, 2' x 2' 1" x 1' 5" 31-lbs. M 2193A, 2' 3" x 1' 11" x 1' 8" 60-lbs.
- M 2193B Screen Fitting** to take sheathed thermometers. **£0 12 6**
- M 2193C Galvanised Stand for Stevenson Screen,** British Meteorological Office specification, as described on page 78 **£3 5 0**
 63-lbs.

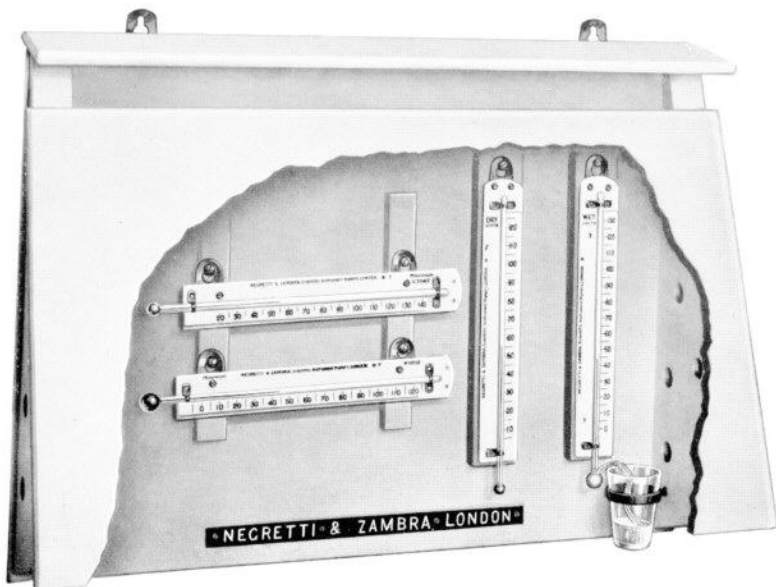
THERMOMETER SCREENS



- M 2194A Stevenson Screen**, British Meteorological Office specification, for sheathed thermometers. This screen, smaller and lighter in construction, has been specially designed for the maximum, minimum, dry bulb and wet bulb sheathed thermometers, all of which are used horizontally with the bulb ends in a slightly lower position. The screen is double louvred, and measures internally 16½" wide, 12" high and 6" deep ; brass clips are fitted to support the thermometers. For thermometers, see 2135/2136A, page 63, and 2199B, page 82 **£5 10 0**
 20-lbs.
- M 2194B Galvanised Stand** for above. Constructed of angle steel, 4' 6½" high with cross bracing of mild steel strip and a 5" square footplate at base of each upright. Complete with bolts and nuts and spanner for assembly **£2 17 6**
 50-lbs.
- M 2195 Large Stevenson Screen**, British Meteorological Office specification ; to accommodate two recording instruments and the usual thermometers. The construction and dimensions are similar to M 2193, page 77, except in regard to the length. Two doors to the front. Measurements inside the posts, 3' 5" × 1' 4" × 9" **£20 5 0**
 80-lbs.
- M 2195A Galvanised Stand** for above large screen **£3 15 0**
 84-lbs.
- M 2196 Shipboard Portable Screen**. Inside dimensions 13" × 11" × 15¾". Made of best yellow pine with single louvres **£3 12 6**
 25-lbs.



METEOROLOGICAL SETS



“ Public School ” Set. This installation comprises a set of secondary standard thermometers mounted on a screen of the Glaisher type.

- The maximum thermometer is that described under M 2147, page 65
- The minimum “ “ “ “ M 2149, “ 65
- The hygrometer “ “ “ “ M 2203, “ 84

The screen is of hard wood, painted white and suitably battened to avoid warping, with hinged front, ledge for rain drainage, ventilated sides, and two stout brass back plates.

- The complete set** comprises the above, and
 - 5" Snowdon rain gauge and measure.
 - Meteorological pocket book.
 - “ Hints to Observers.”

M 2198 “ Public School ” Set of Instruments £7 7 0

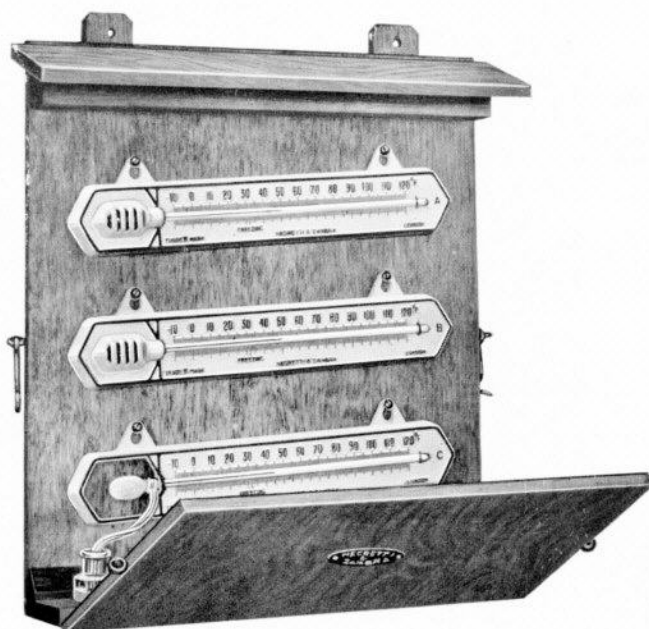
National Physical Laboratory certificates and Meteorological Office certificate for rain gauge **£0 15 0**

Note.—As the readings of thermometers exposed in a Glaisher type differ from those in a Stevenson’s screen, the British Meteorological Authorities do not accept readings from the above.

2' x 1' 6½" x 7" 30-lbs.



METEOROLOGICAL SETS



A simple outfit for educational purposes, consisting of three thermometers mounted on a screen of the Glaisher type.

The maximum thermometer is of the usual mercury-filled constricted type mounted on a die-cast metal frame, with figures and divisions in bold relief.

The minimum thermometer is of the usual red-coloured, spirit-filled type, with floating index. Mounted on a frame as above. The reading of this thermometer is also that of the dry bulb.

The wet bulb thermometer has also a spirit-filled tube mounted on frame as above.

The scales of all the thermometers are identical, avoiding confusion of differing scale values.

The screen is of three-ply wood, varnished for protection against weather, provided with strong hinges and clips at side, and hinged cover. Printed instructions for manipulation, use, and relative humidities pasted inside the cover.

M 2199 Complete Temperature Station as above **£2 2 0**

1' 4" x 1' 2" x 3" 9-lbs.

HYGROMETERS

Hygrometers used for meteorological observations may be classified under the following main headings :—

- (a) Wet and dry bulb hygrometers without means for ventilating the wet bulb.
- (b) Wet and dry bulb hygrometers, ventilated type where the air is in motion relative to the bulbs, such as the whirling hygrometer, Assmann psychrometer, etc.
- (c) Dew point hygrometers such as the Daniells', Régnaults', etc.
- (d) Hair hygrometers, indicating or recording types.

The tables commonly used with the wet and dry bulb hygrometer to obtain relative percentage humidity, vapour pressures, dew point, etc., are as follows :—

Wet and Dry Bulb Thermometer exposed in a Stevenson screen.

Fahrenheit. Hygrometric Tables, Meteorological Office publication M.O.265.

Hygrometrical Tables—Glaisher.

Centigrade. Instructions Meteorologiques—Angot.

Wet and Dry Bulb Thermometer in moving air.

Fahrenheit. Psychrometric Tables, U.S. Department of Agriculture—W.B.235.

Ditto, abbreviated form, on celluloid plate—N. & Z.

Centigrade. Aspirations Psychrometer-Tafeln—Assmann.

Ditto, abbreviated form, on celluloid plate—N. & Z.

(For Prices of above Tables, see page 133).

A full discussion on Hygrometers will be found in :—

The Proceedings of the Physical Society of London, Vol. XXXIV., Part II.

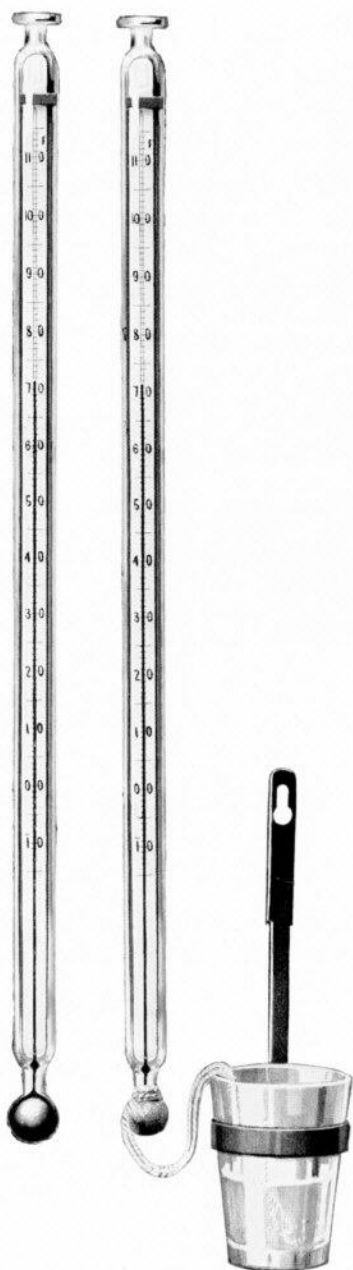
The Dictionary of Applied Physics, Vol. II.

Some Modified Forms of Hygrometers by Ezer Griffiths, F.R.S.

The Rationale of Glaisher's System of Hygrometry

by F. J. W. Whipple, M.A., F.Inst.P.

STANDARD HYGROMETERS



Standard Hygrometer, British Meteorological Office pattern to B.S.I. specification 692-1936. Tubes protected by outer glass sheaths ; overall length $12\frac{1}{2}$ ". Bulbs of normal glass, stems of British lead glass supported inside the sheaths by rings of rubber ; sheaths permanently fused on to the thermometers at a point between the bulbs and the lowest graduations. Range $0/130^{\circ}$ F. or $-15/+115^{\circ}$ F. divided on the stems in single degrees and figured every 10° . Wet bulb with muslin and wick. Glass water reservoir with bronzed brass bracket.

M 2199A Standard Hygrometer,

Mark I. £2 5 0

National Physical Laboratory
certificate £0 6 0

M 2199B Ditto, arranged for horizontal use in the screen

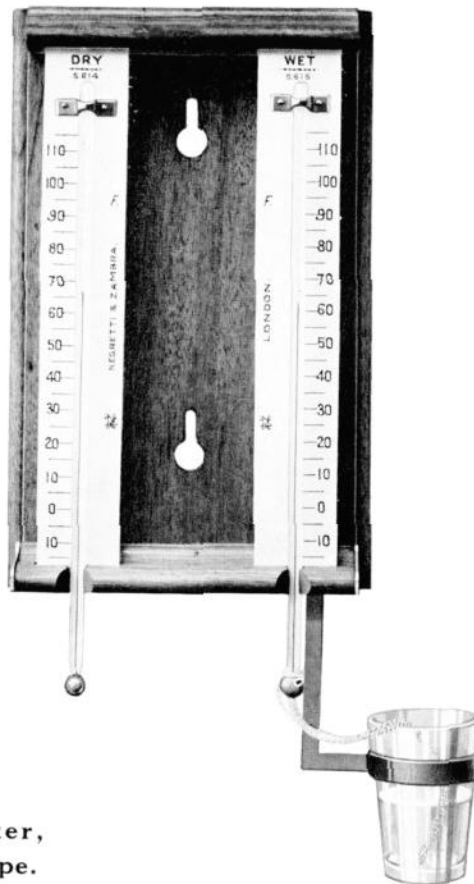
M 2194A, page 78 . . . £2 5 0

National Physical Laboratory
certificate, verifying the
thermometers in a horizontal
position £0 6 0

Note.—In the use of wet and dry bulb hygrometers, the muslin must be clean, and should therefore be changed before it becomes dirty. The water used must be soft, either distilled or rain water.

Full particulars regarding the management of these instruments during frosty weather will be found in the text-books.

STANDARD HYGROMETERS



**Standard Hygrometer,
Wet and Dry Bulb Type.**

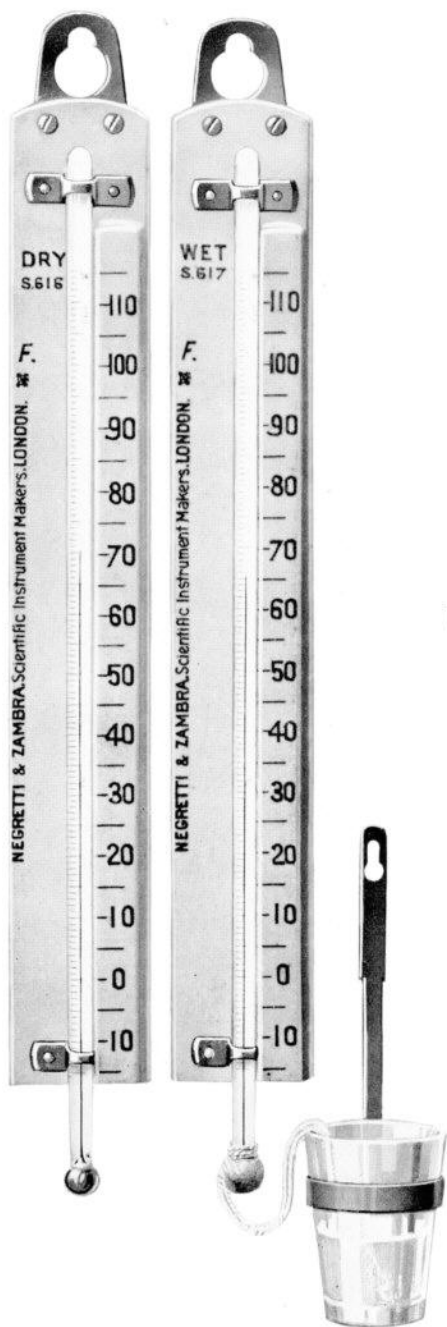
This instrument consists of a pair of thermometers mounted on a board, the bulb of one thermometer being covered with muslin kept moist by means of a wick dipping into a water reservoir.

Tubes 10¹/₄" long, with bulbs of normal glass and English lead capillary, fitted on opal glass scale plates on a mahogany mount with two holes for suspension.

Range -15/+115° F., divided on the stem in single degrees and figured on the scale every 10°. Glass water cup carried on bronzed brass bracket.

M 2200	Standard Hygrometer	£2 10 0
M 2201	Ditto, -25/+45° C.	£2 10 0
M 2202	Ditto, tropical ranges 10/140° F. or -10/+60° C.	£2 10 0
	National Physical Laboratory certificate	£0 6 0

STANDARD HYGROMETERS



M2203 Standard Hygrometer, secondary or "Public School" Pattern. Tubes 10¼" long, bulbs of normal glass and English lead capillary, each fitted on a porcelain scale plate with brass hanging back-plate. Range 20/130° F., divided on the stem in single degrees and figured every 10° on raised edge of scale plate. Glass water reservoir with bronzed brass bracket,

£1 11 6

M 2204 Ditto, -5/+55° C. . . £1 11 6

The above with tropical ranges.
10/140° F.

-10/+60° C.

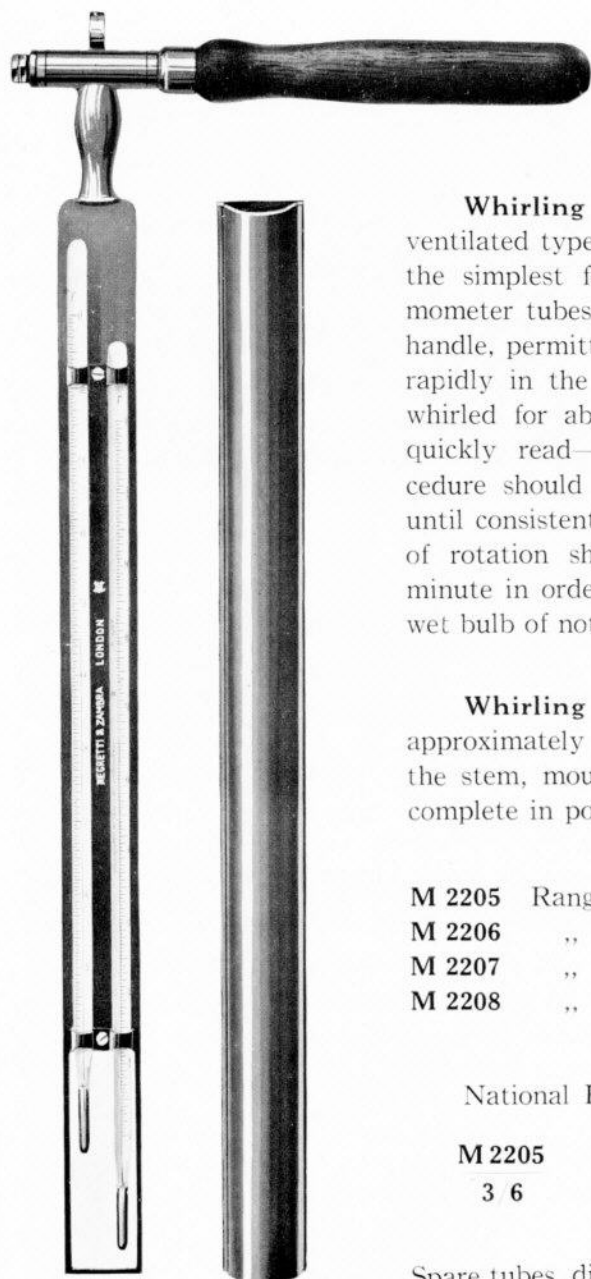
without extra charge

National Physical Laboratory certificate

£0 6 0

Standard Hygrometers, used by the Meteorological Services of the Dominions and Crown Colonies consist of two ordinary thermometers, as described on page 70 or the M 2199A, page 82.

WHIRLING HYGROMETERS



Whirling or Sling Hygrometer. Of the ventilated type of wet and dry bulb hygrometer, the simplest form is that in which two thermometer tubes are mounted side by side with a handle, permitting the hygrometer to be whirled rapidly in the air. The hygrometer should be whirled for about half a minute, stopped, and quickly read—the wet bulb first. This procedure should be repeated three or four times until consistent readings are obtained. The rate of rotation should not be less than 120 per minute in order to obtain an air speed past the wet bulb of not less than 15 feet per second.

Whirling Hygrometer, Precision Type, approximately 11" tubes, divided and figured on the stem, mounted on brass frame with handle complete in polished copper case.

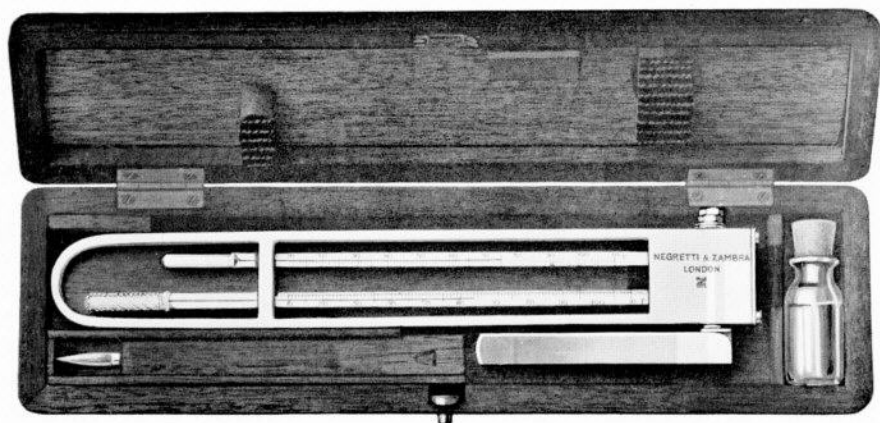
M 2205	Range +10/110° F.	.. ..	£4 10 0
M 2206	.. 20/130° F.	.. ..	£4 5 0
M 2207	.. -10/+45° C.	.. ..	£4 10 0
M 2208	.. -5/+55° C.	.. ..	£4 5 0

National Physical Laboratory certificate.

M 2205	M 2206	M 2207	M 2208
3 6	4/6	4 -	4/-

Spare tubes, divided and figured, each £0 14 0

WHIRLING HYGROMETERS



Pocket Whirling Hygrometer. This pattern was designed for extreme portability, and is particularly adapted for field use in the taking of observations of humidity where the use of the wet and dry bulb instrument of fixed or hanging type is not possible.

In use, this hygrometer should be whirled as rapidly as possible.

Tubes approximately 6" long, length of scale 4", accurately divided and figured on the stem. Mounted on aluminium frame, with folding handle. Complete with spare muslins, brush, etc., and fitted in mahogany box. Size of box, 9 $\frac{3}{4}$ " \times 2 $\frac{1}{2}$ " \times 1".

M 2209	Range +10/ +110° F.	.. .. .	£2 0 0
M 2210	.. -10/ +45° C.	.. .. .	£2 0 0

Pocket Whirling Hygrometer as above, fitted in solid leather pocket case as being more durable and less liable to warping, etc., than wood.

M 2211	Range +10/ +110° F.	.. .. .	£2 9 6
M 2212	.. -10/ +45° C.	.. .. .	£2 9 6



WHIRLING HYGROMETERS



Whirling Hygrometer, Precision Type. Specially adapted for standardizing and calibrating hair hygrometers, and for general reference purposes.

Tubes about 12" long, divided and figured on the stem ; mounted in a nickel-plated cylindrical case, slotted back and front, and provided with wood handle. A screwed-on guard is fitted over the bulbs for protection and removed when the instrument is in use.

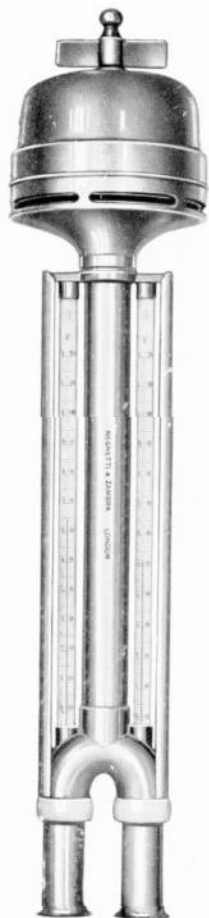
The accessories comprise glass jar and spare muslins, a large glass bottle of distilled water, a small bottle of distilled water for immediate use, and printed tables of relative humidities. Complete in wood case measuring 16" x 7" x 2 3/4".

Type.	Range.	Each.	N.P.L. Certificate.
M 2213	10 to 110° F.	£6 10 0	£0 3 6
M 2214	20 ,, 130° F.	£6 10 0	£0 4 6
M 2215	-10 ,, 45° C.	£6 10 0	£0 4 0
M 2216	-5 ,, 55° C.	£6 10 0	£0 4 0

Spare tubes, divided and figured each £0 14 0



ASSMANN HYGROMETERS



The Assmann Type Hygrometer, or Psychrometer, is for the purpose of obtaining humidity readings with the highest precision.

It consists of two very accurate thermometers divided and figured on the stem, with the bulbs mounted in two air ducts which form an inverted "Y" at the lower end of the instrument. A centrifugal fan, operated either by a clockwork movement *or* by an electric motor, draws the air past the bulbs. The motor can be supplied for 100 to 110 volts or 200 to 250 volts, D.C. or A.C. The bulbs are protected from the effect of radiation by two nickel-plated sleeves, which are insulated from the main frame. The instrument is supplied complete with muslins, water filler, wind-shield and supporting bracket, and is fitted in a polished wood box, size 20" × 4½" × 4¾" deep.

Type.	Range.	Each.	N.P.L. Certificate.
M 2217	10 to 110° F.	£17 10 0	£0 3 6
M 2218	20 ,, 130° F.	£17 10 0	£0 4 6
M 2219	-10 ,, 45° C.	£17 10 0	£0 4 0
M 2220	-5 ,, 55° C.	£17 10 0	£0 4 0

(Price includes clockwork or electric motor.)

Thermometers for Assmann Psychrometer, British Meteorological Office specification. Tubes, overall length, 11". Bulb of normal glass, stem of British lead glass. Range -15/+90° F. (or -25/+30° C.) ; number of degrees Fahr. to the inch not to exceed 17. Divided every degree and figured every 10°. The thermometer is fixed firmly in a cylindrical nickel-plated metal cap ⅜" diameter, ⅞" long ; flange at top. Cylindrical nickel-plated metal collar ⅜" diameter, cemented over the stem of the thermometer 8¼" from the top of the metal cap.

M 2220 Thermometer as above £0 15 0

DEW POINT HYGROMETERS

Dew Point Hygrometer of the Régnault Type of specially robust design.

The thermometers are 15" long, mounted in nickel-plated sheaths, one bulb being immersed in a polished solid silver thimble. This thimble is connected to a filler containing ether, to which is attached a rubber pipe and bulb. Air being drawn through the ether by means of this rubber bulb, the thimble is slowly cooled, and eventually dew is formed on it, when the reading of the thermometer is taken. The dew point, or the temperature at which the existing air would become saturated, is the mean of the temperatures of the formation and disappearance of the dew.

The thermometers are graduated -10° to $+40^{\circ}$ C., and 3 to 55 mm. vapour pressure. The panel measures 10" \times 24".

M 2223 Dew Point Hygrometer,
£13 0 0

Relative Percentage Humidity =

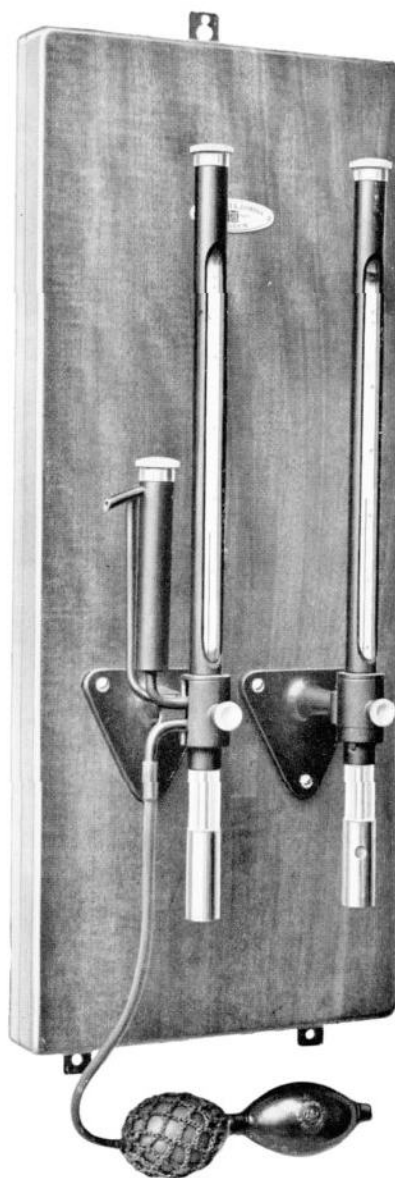
Satd. Vapour Pressure at dew point \times 100

Satd. Vapour Pressure at dry bulb tempt.

or

Weight of moisture at dew point to saturate \times 100

Weight of moisture at dry bulb tempt. to saturate.



HAIR HYGROMETERS



The **Hair Hygrometer** or **Hygroscope** consists of a bundle of hairs or other organic tissue which changes its length when it absorbs moisture.

The instrument takes the form of a 4" diameter case, beneath which is a slotted tube in which the hairs are mounted. At the lower end of the tube an adjustment screw is provided to which the hairs are anchored. At the top end of the hairs a link piece is connected direct to a crank on the pointer spindle.

The primary scale indicates relative percentage humidity, the subsidiary scale—the dewpoint.

There are no springs, gears, or cords in the mechanism, and errors due to backlash, friction, etc., are thus reduced to a minimum.

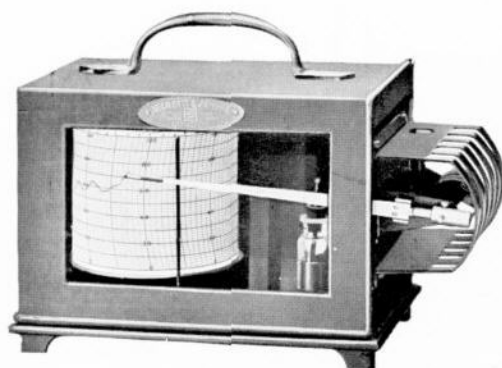
The hygroscope can be readily checked from time to time, either by wetting the hairs, in which case it should read approximately 95%, or better still, by means of the wet and dry bulb whirling hygrometer described on pages 85 to 87.



M 2224 4" Dial Hair Hygrometer, ranged 10/100% relative humidity, £3 10 0

M 2225A 4" Dial Pocket Hair Hygrometer (Hygroscope), range 0/100% relative humidity; metal case, 4½" diameter overall, finished eggshell black; dial enamelled white with black divisions and figures £1 5 0

BIMETALLIC RECORDING THERMOMETERS



The Bimetallic Temperature Recorder is one of the simplest instruments for recording temperature. The mechanism consists of a helix of bimetallic metal, which coils and uncoils with changes of temperature, thereby operating a pen recording on the typical clock-driven chart. This bimetallic type is of greater reliability than the Bourdon tube type filled with alcohol ; it has a much smaller thermal lag and the helix operates direct on the pen-arm spindle without any levers or links. The control is amply sufficient to overcome the friction of the pen ; further, the scale value is constant for even increments of temperature.

Recording Thermometer with bimetallic element mounted on an iron frame and base, and protected by a slotted brass guard.

Daily (8-day clock) or weekly drum, any of the standard ranges below.

Hinged glass-panelled cover of japanned metal, with padlock and key.

Clock drum	.. .. .	3.6" dia. × 3.6" high
Pen travel	.. .. .	3"
Chart	.. .. .	3.6" × 11.8"
Time scale	.. .. .	0.45" per hour
" "	.. .. .	1.54" per day
Temperature scale	.. .. .	33.3° F. (18.3° C.) per inch

Standard Ranges

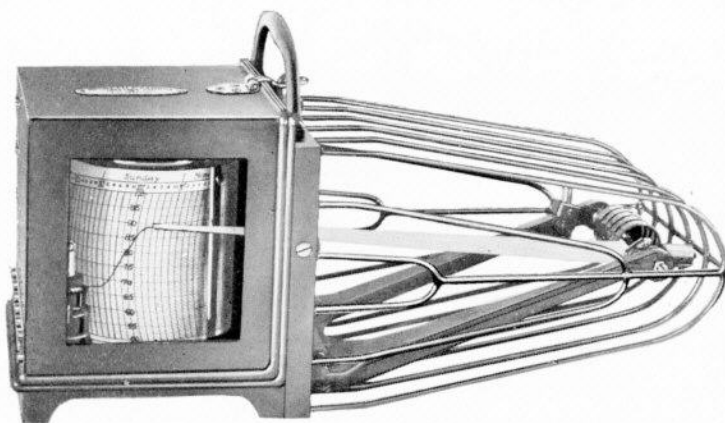
0/ +100° F.	+50/ +150° F.	0/ +55° C.
+30/ +130° F.	-10/ +45° C.	+10/ +65° C.

M 2226 Recording Thermometer as above, complete with
 100 charts, ink and pen, etc. **£7 0 0**
 Charts per 100 **£0 12 0**

Note.—The method adopted by N. & Z. for testing recording thermometers is shown on page 124.

10" × 7½" × 5" 9½-lbs.

BIMETALLIC RECORDING THERMOMETERS



Sensitive Type Recording Thermometer. Constructed to the details given on page 91, but with the element placed well away from the case for greater accuracy and sensitivity.

Daily (8-day clock) or weekly drum, the standard ranges as below. Hinged glass-pannelled metal cover, strong wire protection to element.

Clock drum	3.6" dia. × 3.6" high
Pen travel	3"
Chart	3.6" × 11.8"
Time scale (daily)	0.45" per hour
.. .. (weekly)	1.54" per day
Temperature scale	20° F. or 13.3° C. per inch
	33.3° F. or 18.3° C.

Standard Ranges

+30 / +90° F.	-5 / +35° C.
0 / 100° F.	-10 / +45° C.

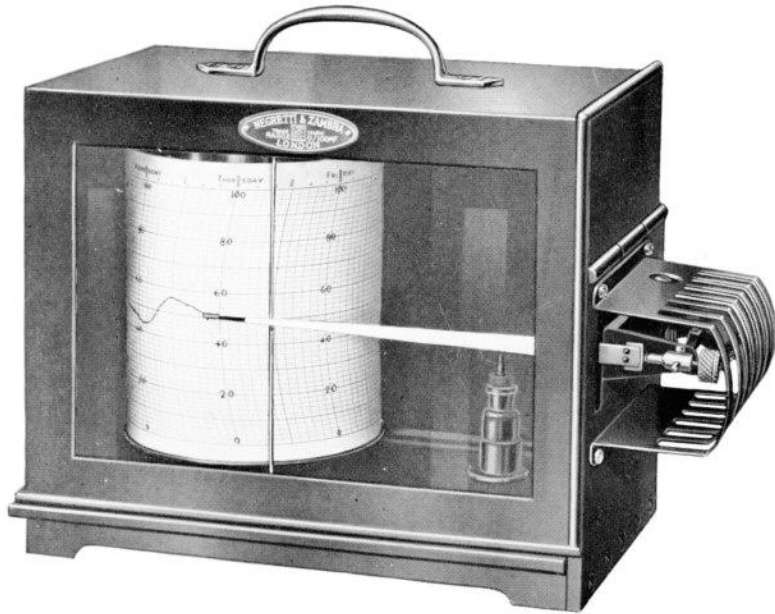
M 2227 Sensitive Type Recording Thermometer as above ..	£10 0 0
Charts per 100	£0 12 0
1' 3" × 7 ³ / ₄ " × 5"	

Standard Thermograph, British Meteorological Office Specification. With copper case on base of gun-metal. Principle and construction similar to above.

Pen arm	185 mm. long, moving over 10 mm. for every 10° F.
Clock drum	92 mm. high × 93 mm. diameter.
Daily clock	Rotating once in 24 hours.
Weekly clock .. .. .	.. .. . 7 ¹ / ₂ days.

M 2228 Standard Thermograph as above	£10 0 0
Charts per 100	£0 12 0
10 ³ / ₄ " × 6" × 5 ¹ / ₂ " 10-lbs.	

BIMETALLIC RECORDING THERMOMETERS



Recording Thermometer, Large Size, bimetallic movement similar to specification on page 91, but with more open time and temperature scales.

Daily (8-day clock) or weekly drum, with any standard range given below.

Hinged glass-panelled cover of japanned metal, with lock and key.

Clock drum	.. .. .	5" dia. × 6" high
Pen travel	.. .. .	5"
Chart	.. .. .	5.8" × 16.2"
Time scale (daily)	.. .. .	0.6" per hour
" " (weekly)	.. .. .	2.06" per day
Temperature scale	.. .. .	20° F. (11° C.) per inch

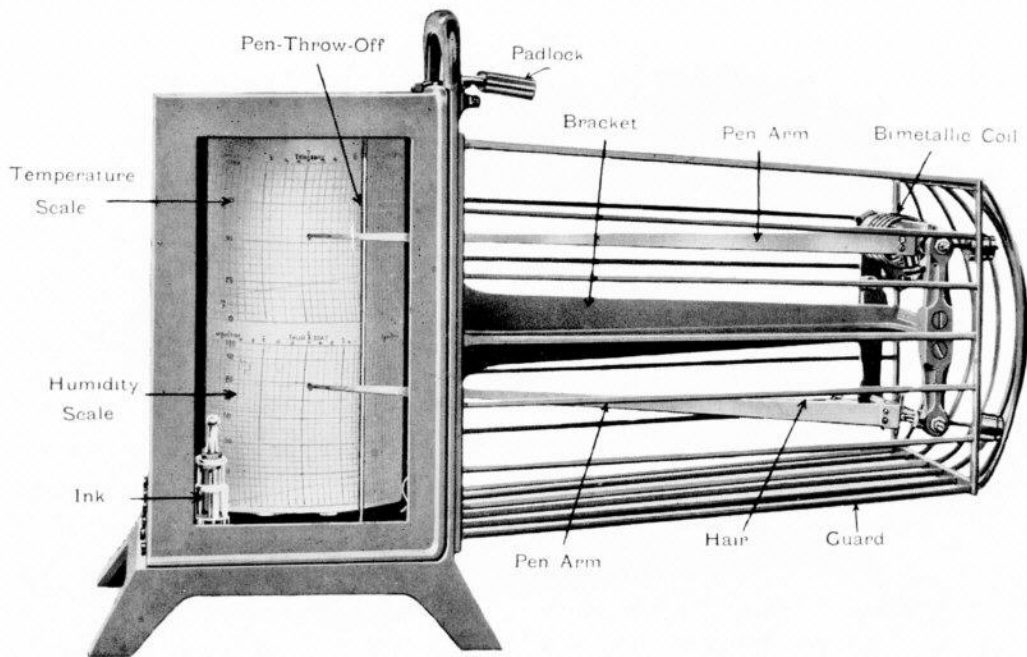
Standard Ranges

0/ +100° F.	-10/ +45° C.
+30/ +130° F.	0/ +55° C.
+50/ +150° F.	+10/ +65° C.

M 2229 Recording Thermometer as above, complete with 100 charts, pen, ink, etc.	.. .. .	£11 0 0
Charts	.. .. . per 100	£0 15 0

19-lbs.

COMBINED RECORDING HYGROMETERS



The **Combined Temperature and Humidity Recorder** records on one chart the changes in both temperature and humidity.

The thermometric element is of the bimetallic type described on page 91, and the pen records on the upper part of the chart.

The hygrometric record is obtained from the action of a human hair, as described on page 107, and is on the lower part of the chart.

Daily (8-day clock) or weekly drum, the ranges as below.

The pen arms and movements, situated well away from the case, are protected by a stout wire frame.

Hinged glass-pannelled cover to case, with padlock and key.

Clock drum	.. .. .	3.6" dia. × 7" high
Pen travel	.. .. .	3" each scale
Chart	.. .. .	7" × 16.2"
Time scale (daily)	.. .. .	0.45" per hour
" " (weekly)	.. .. .	1.54" per day
Temperature scale	.. .. .	33.3° F. (18.3° C.) per inch
Humidity scale	.. .. .	10 to 100% in 3 inches

$\left. \begin{matrix} 10/110^{\circ} \text{ F.} \\ 30/130^{\circ} \text{ F.} \end{matrix} \right\} 10/100\% \text{ Humidity} \left\{ \begin{matrix} -15/40^{\circ} \text{ C.} \\ 0/55^{\circ} \text{ C.} \end{matrix} \right.$

M 2245 Combined Temperature and Humidity Recorder,
 complete with 100 charts, pens and ink, etc. **£15 0 0**
 Charts per 100 **£0 15 0**

1' 5" × 11½" × 6" 15-lbs.

MERCURY-IN-STEEL RECORDING THERMOMETERS

N. & Z. Mercury-in-steel Recording Thermometers are used for records of air temperatures at meteorological stations (pages 96/97) or on aircraft (page 113) ; temperatures of the earth at various depths (pages 98/99) ; temperatures of sea surface (pages 100/101), for deep sea temperatures (page 102), and for wet and dry bulb temperatures (pages 108/111).

The movement consists essentially of three parts—bulb, capillary tubing and Bourdon tube—all made of steel. These are welded together to form the complete system, which is filled with mercury under great pressure.

The action is direct, as the spindle of the pen arm is attached direct to the Bourdon tube without any levers, gears or hairsprings. The result is that friction and consequent inaccuracy are practically eliminated.

Only the finest quality materials are used throughout. All parts are tested and inspected before assembly, and each instrument is separately calibrated against standards certified by the National Physical Laboratory.

The capillary tubing is of specially drawn steel of very fine bore, and is enclosed in an outer copper tubing, or is lead coated, for protection.

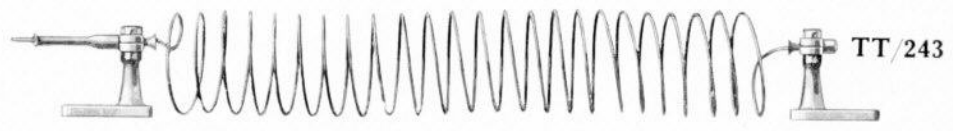
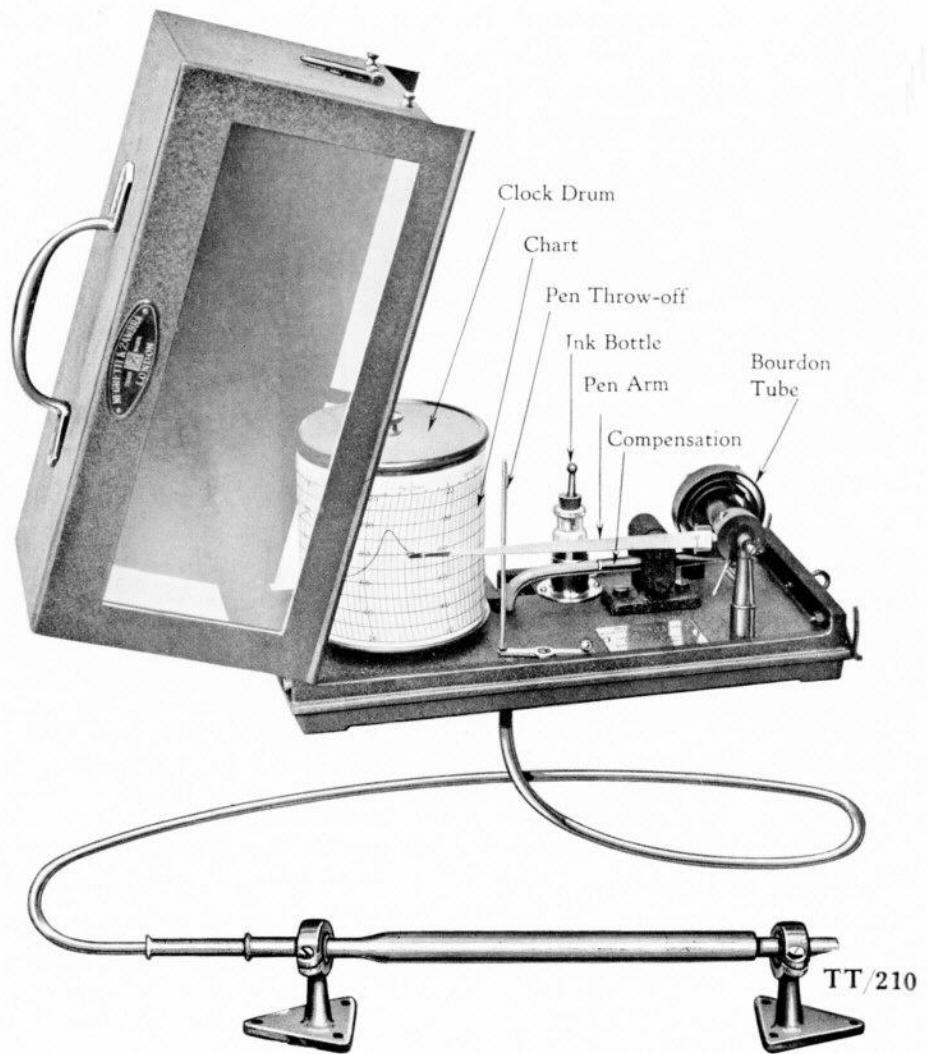
When the length of capillary tubing renders it necessary, one or more "**compensating links**" are inserted in order to eliminate excessive errors due to the variations of temperature of the capillary tubing. Full details regarding these compensating links will be found in our brochure "Mercury-in-steel Thermometers."

No instrument is passed out until it has completed a duration test in the Inspection Department, where a full record of its performance is kept with check readings and calibration corrections, a copy of which is sent with each instrument.

Duplex recording thermometers with two systems and pens can be supplied at an extra cost.



AIR TEMPERATURE RECORDERS



AIR TEMPERATURE RECORDERS

Air Temperature Recorder. Constructed on the Negretti & Zambra patent mercury-in-steel principle described on page 95. The bulb, TT/210, is of small diameter and considerable length in order to obtain sensitivity, and is usually coated with copper. The capillary type bulb, TT/243, is of steel tubing $\frac{5}{32}$ " outside diameter, approximately 35 feet long in 12" diameter coils. It is very much more sensitive than any other type of bulb and will give the average temperature over the area between the fitted brackets. The capillary tubing is protected by well annealed copper tubing, and may be any length up to 150 feet. The standard lengths of capillary are 10 feet, 20 feet, and 30 feet. Very long capillaries are sometimes required, when temperature errors, even with tubing of very fine bore, are not negligible. In such cases, compensation is provided by the introduction of one or more patent compensating links.

With daily (8-day clock) or weekly drum, ranges as stated below.
Hinged glass-panelled metal cover to case.

	Model A	Model B
Clock drum	3.6" dia. × 3.6" high	5" dia. × 6" high
Pen travel	3"	5"
Chart	3.6" × 11.8"	5.8" × 16.2"
Time scale (daily)	0.45" per hour	0.6" per hour
" " (weekly)	1.54" per day	2.06" per day
Temperature scale	33.3° F. or 16.6° C. per inch	20° F. or 10° C. per inch

Standard Ranges

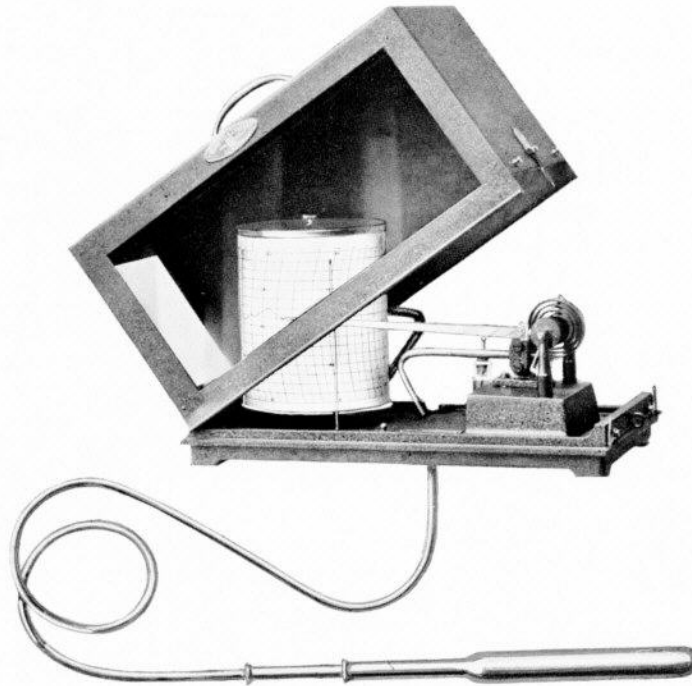
0/+100° F.	+50/+150° F.	0/+50° C.
+30/+130° F.	-10/+40° C.	+10/+60° C.

M 2230 Air Temperature Recorder, Model A, with 10 feet capillary tubing, bulb TT/210, pen, ink, and 100 charts ..	£17	0	0
M 2231 Ditto, 20 feet	£18	10	0
M 2232 Ditto, 30	£20	0	0
M 2233 Ditto, Model B, with 10 feet capillary	£20	10	0
M 2234 Ditto, 20 feet	£22	0	0
M 2235 Ditto, 30	£23	10	0
Extra price for TT/243 Capillary Type Bulb	£3	0	0
Capillary, copper covered, beyond 30 feet per foot	£0	3	0
Charts, Model A per 100	£0	10	0
" " B	£0	12	6

Case : Model A, 11½" × 6" × 5¼"	10-lbs.
Model B, 1' 2½" × 8½" × 7½"	23-lbs.



EARTH TEMPERATURE RECORDERS



Earth Temperature Recorder. Constructed on the Negretti & Zambra patent mercury-in-steel principle as described on previous pages.

These instruments have been supplied to Government Departments and Research Departments in this country and abroad, and have given every satisfaction under varying conditions. Many have been in use for years without requiring any adjustment or attention beyond the winding of clocks and changing of charts.

The bulb is of steel of small diameter and 10" or more in length, coated with lead for protection against corrosion; it is buried horizontally in the ground at the depth of which temperature records are required.

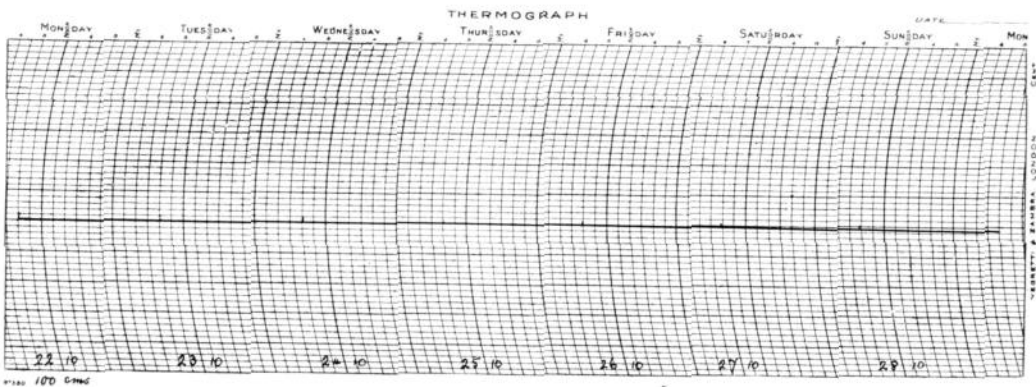
This method of obtaining earth temperatures is one of great precision and much more convenient than taking the readings by means of mercury-in-glass thermometers.

EARTH TEMPERATURE RECORDERS

The capillary is also lead coated to withstand the corrosive effect of chemicals in the ground. It may be any length up to 100 feet, and the standard instrument is supplied with 15 feet of capillary.

- Daily (8-day clock) or weekly drum.
- Range 20/120° F., or -10/+40° C.
- Hinged glass-panelled japanned metal cover to case.
- Clock drum 5" × 6" high
- Pen travel 5"
- Chart 5.8" × 16.2"
- Time scale (daily) 0.6" per hour
- ,, (weekly) 2.06" per day
- Temperature scale 20° F. or 10° C. per inch

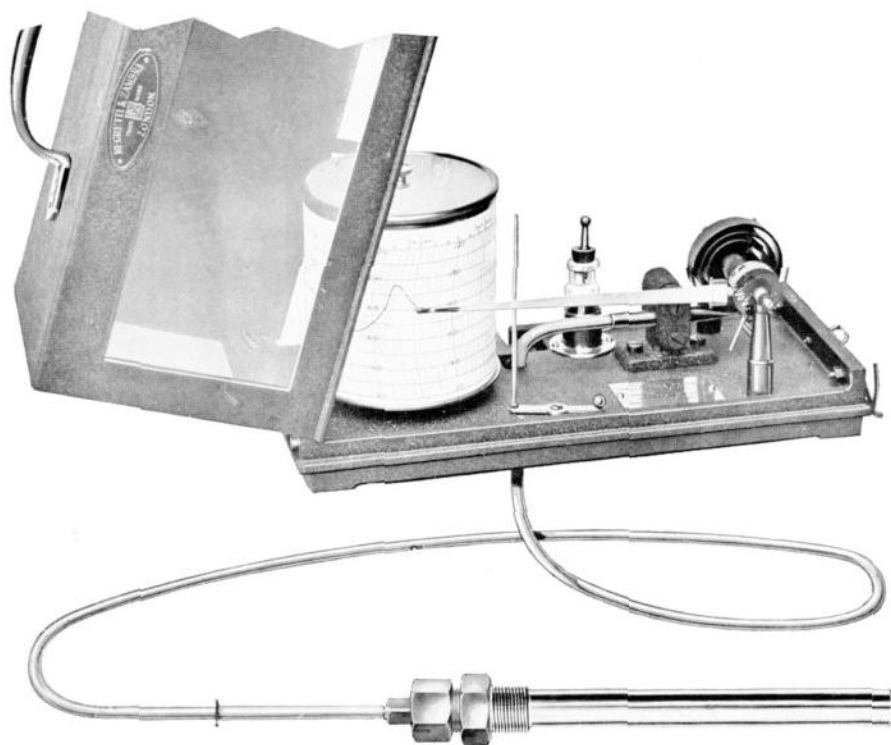
M 2236 Earth Temperature Recorder , with 100 charts, pen and ink	£20 16 3
Capillary, lead coated, over 15 feet per foot	£0 3 9
Charts per 100	£0 12 6
Case, 11½" × 6" × 5¼" 10-lbs.	



The above reproduction (by kind permission of the Cotton Research Board, Egypt) is from one of a set of seven M 2236 recorders, where the bulbs are buried at various depths up to 1 metre. Where the surface graphs show marked daily amplitude, the above shows practically no deviation, and the perfect method of compensation is demonstrated by the fact that the recorder and the capillary tube were subject to a daily variation of temperature of 20° Centigrade or more.



SEA SURFACE TEMPERATURE RECORDERS



Sea Surface Temperature Recorder. Constructed on the N. & Z. patent mercury-in-steel principle previously described.

Bulb and Fitting. Two methods of exposing the bulb in the sea water are in vogue :—

- (a) In a recess in the keel whilst the ship is under construction or repair. In this case the bulb, about 15" long by 1" diameter, is heavily coated with lead to prevent corrosion, and is protected by a stout perforated bronze plate or guard.
- (b) In the main intake pipe for the condensers (see opposite page), which provides a great volume of water immediately from the sea, and has been proved by experience to be the most satisfactory position for the bulb. In this case the bulb, as shown above, is provided with a bronze meta pocket about 7" long by 1" gas thread, which has the double advantage of protecting the bulb against corrosion and of enabling the bulb to be safely removed at any necessary time.

Capillary. This may be any length, depending on the most suitable position for the recorder. It is always lead coated as a protection against corrosion.

SEA SURFACE TEMPERATURE RECORDERS

The Recorder may be model A or model B, with any range required, but the popular ranges are :—

- 5° to +35° C.
- 2½° to +25° C. for Polar work.
- 20° to 100° F., with overload to 110° F.
- 30° to 90° F., with overload to 100° F.

Daily (8-day clock) or weekly drum.



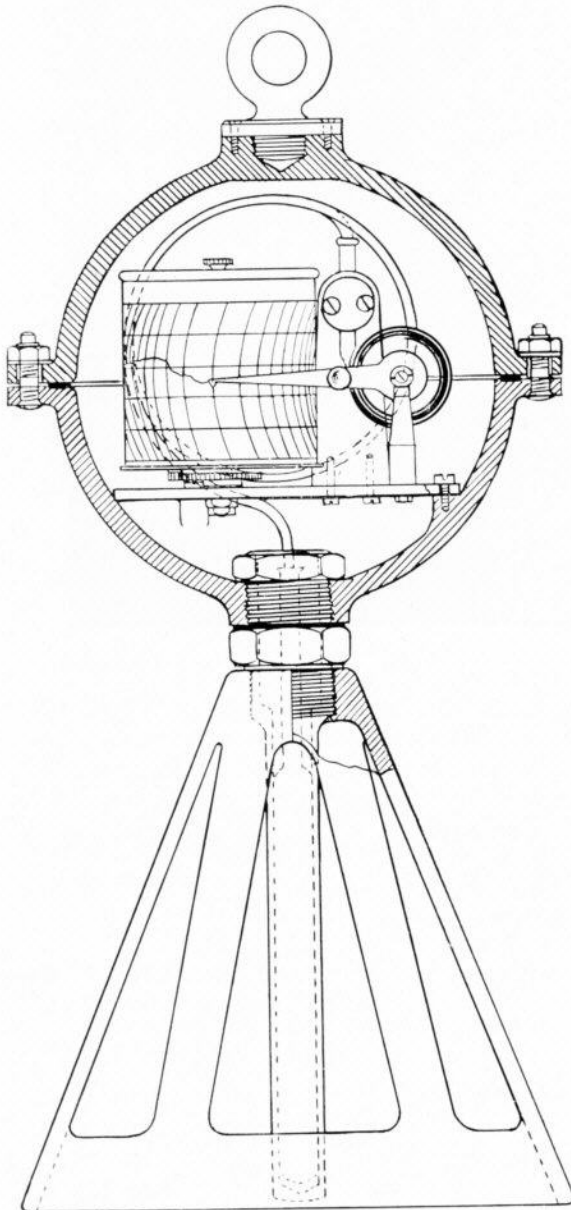
The illustration shows the Chief Engineer on the " HENRY M. FLAGLER " replacing the bulb in the pocket, and is reproduced by the courtesy of Professor Charles F. Brooks, of the Clark University, Washington, U.S.A.

	Model A	Model B
Clock Drum	3.6" dia. × 3.6" high	5" dia. × 6" high
Pen travel	3"	5"
Chart	3.6" × 11.8"	5.8" × 16.2"
Time scale (daily)	0.45" per hour	0.6" per hour
" " (weekly)	1.54" per day	2.06" per day

- M 2237A Model A Sea Surface Temperature Recorder**, with bulb as paragraph (a), page 100, and 10 feet lead-coated capillary tubing. Complete with pen, ink, and 100 charts **£17 17 6**
Guard extra **£0 10 0**
- M 2237B Model B**, ditto ditto **£21 7 6**
- M 2238A Model A Sea Surface Temperature Recorder**, with bulb and pocket as paragraph (b), page 100, and with 10 feet capillary tubing. Complete as above **£17 2 6**
- M 2238B Model B**, ditto ditto **£20 12 6**
Capillary tubing, lead coated extra per foot **£0 3 9**
Charts, Model A extra per 100 **£0 10 0**
" " B " " " **£0 12 6**

Case : Model A, 11½" × 6" × 5¼" 10-lbs.
Model B, 1' 2½" × 8½" × 7½" 23-lbs.

DEEP SEA TEMPERATURE RECORDER



Deep Sea Temperature Recorder constructed on the Negretti & Zambra mercury-in-steel principle, the mechanism being contained in a watertight sphere so that the apparatus may be totally submerged to a depth of approximately 300 metres (700 feet).

The movement is as described on page 95, with drum making one revolution in one week, two weeks, or 28 days, as desired, and is enclosed in a gun-metal sphere held down with 12 bolts, making a seating with a rubber or composition joint.

Range $-2\frac{1}{2}$ to $+22\frac{1}{2}$ ° C.

The bulb of the thermometer is inserted in a gun-metal pocket to protect it from corrosion and from pressure effects, and is so arranged that it can be removed (with the mechanism) if required.

The apparatus will stand a pressure of 400-lbs. per sq. in. (28 kilograms per sq. cm.).

- Clock drum .. 3.6" dia. × 3.6" high
- Pen travel .. 3"
- Chart .. 3.6" × 11.8"
- Time scale
(weekly) .. 1.54" per day

M 2239 Deep Sea Temperature Recorder, with pen, ink, and
 100 charts **£48 0 0**
 2' × 10½" 65-lbs.

MERCURY-IN-STEEL RECORDING THERMOMETERS

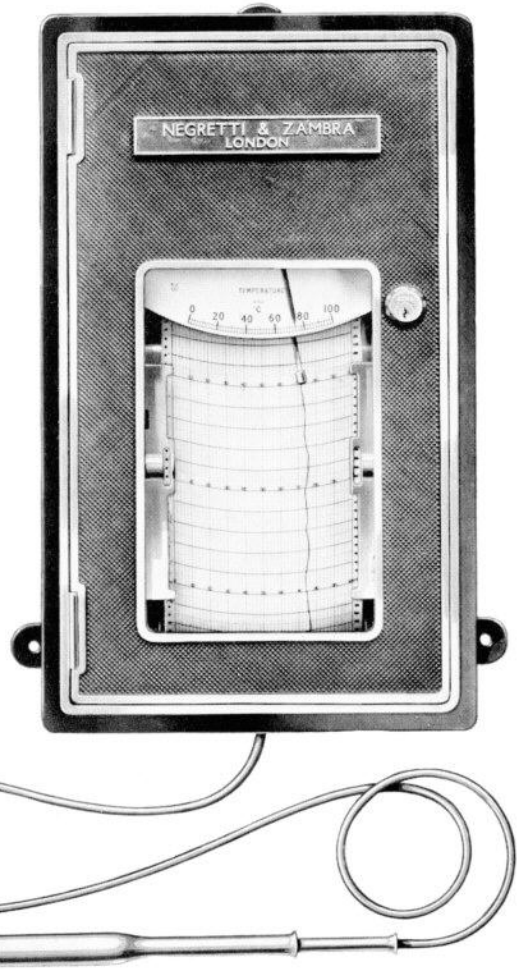
The **Mercury-in-steel Roll Chart Recording Thermometer** is an instrument requiring the minimum of attention, and can be adapted for air, earth or sea temperatures.

Beyond winding the clock once a week, the instrument requires no attention for 50 days.

The movement comprises a mercury-in-steel thermometer system, as described on page 95.

The chart is of the continuous type, 50 feet long, lasting 50 days (with a chart speed of $\frac{1}{2}$ " per hour), and the visible portion is 15 hours.

An upper spool carries the unused chart reel, and the chart is fed over clock-driven wheels with pegs which engage in perforations.



Range 20 120° F., or
-10 / +40° C.
Pen travel5"
Charts . . . 5½" × 50'
Time scale
½" (or 2") per hour

M 2240A	Roll Chart Recording Thermometer , with movement mounted in cast-iron moisture-proof case, heavily enamelled and stoved black; spring-wound clock running 8 days with one winding; with 10 feet of capillary tubing, copper covered; plain bulb as shown. Complete with pen, ink, and one chart roll	£28	0	0
M 2240B	Ditto, Duplex pattern	£36	0	0
	Universal electrically-wound movement	£2	5	0
	Capillary tubing, over 10 feet	£0	3	0
	Lead covering to bulb	£0	10	0
	Lead covering to capillary tubing	£0	0	9
	Charts	£0	10	0

Other types of bulb fittings will be seen on pages 96 and 100.

Case : 1' 7½" × 10¼" × 5¼" 50-lbs.

ELECTRICAL RESISTANCE RECORDING THERMOMETERS

The **Electrical Resistance Recording Thermometer** is also employed for air and earth temperatures. The advantage of this instrument is that the recorder can be placed at practically any distance from the bulbs, whereas in the case of the Mercury-in-steel Recording Thermometer (see pages 95 to 103) this distance is limited to 150 feet. On the other hand, the electrical movement is not so robust as the mercury-in-steel, and the instrument requires careful attention in order to obtain satisfactory results.

The principle employed is that where the change of electrical resistance of a wire-wound element due to variations of temperature is measured by the deflection of a galvanometer in a suitable Wheatstone Bridge circuit, the galvanometer scale being directly calibrated in degrees according to the corresponding temperatures.

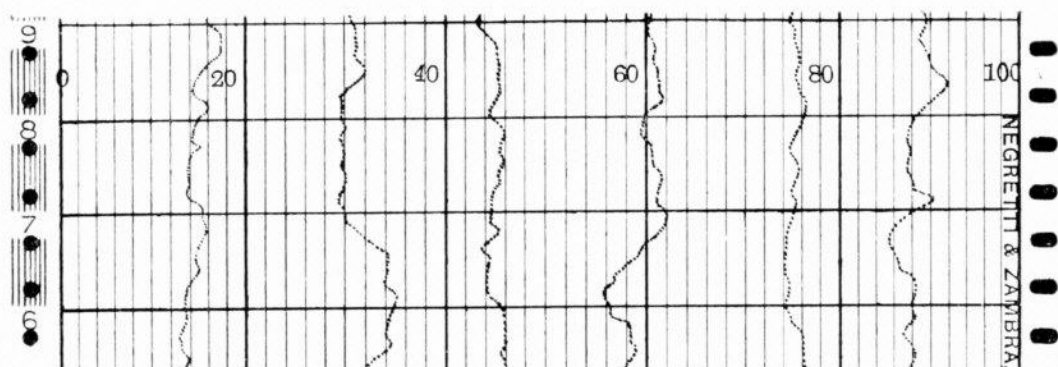
A small accumulator is required to operate the galvanometer.

This **Continuous Chart Recording Thermometer** gives a bold and clear record of the temperature from a number of points, in distinctive coloured traces.

The chart lasts 50 days, the inking ribbon lasts for a year or more, and with the synchronous motor model, all winding of the clock is dispensed with.

The galvanometer is of the moving coil type, spring controlled and double pivoted, with sprung jewelled bearings. It is provided with zero adjustment. The movement is totally enclosed in a separate box inside the main case, the scale and indicating pointer being viewed through a glass window. The galvanometer case is mounted on shock absorbers, ensuring clear records under vibration.

The switching mechanism is fitted with mercury tubeswitches.



Specimen of 6-point record—full size

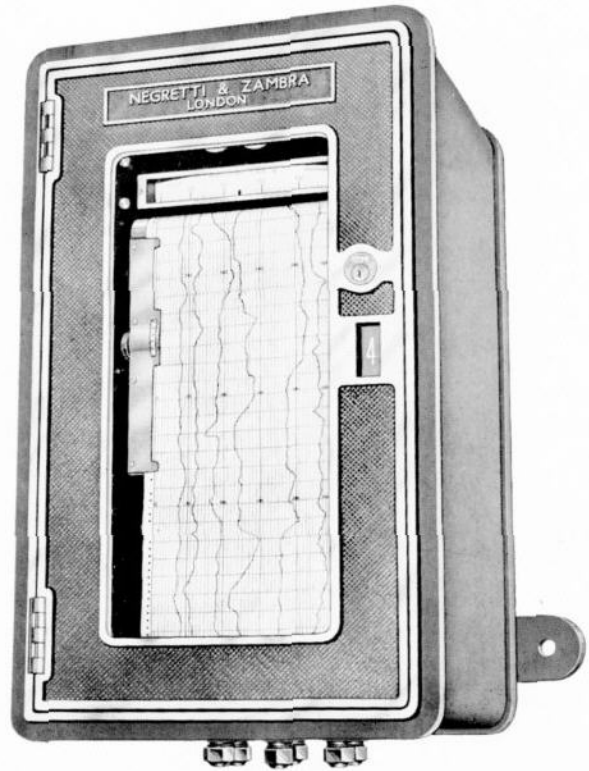
ELECTRICAL RESISTANCE RECORDING THERMOMETERS

A numbered indicator shows through a window which temperature point is in circuit.

The chart is driven by twin driving wheels acting through the perforated edges of the chart. At any time, all the used chart can be unwound for inspection. The marking on the chart is by means of a multi-coloured ribbon which is automatically wound and re-wound from end to end.

Where A.C. supply with controlled frequency is available, an electric clock of the self-starting synchronous motor type can be fitted, allowing the recorder to be left without attention. The current consumed is negligible.

The spring clock consists of a best quality 72-hour clockwork movement with jewelled escapement.



The case is dust-tight and moisture-proof, with cast aluminium back and front, with Yale lock. Finished in dull black with chromium-plated fittings.

Pen travel	5"
Charts	5½" × 50'
Time scale	½" (or 2") per hour.

Thermometer bulbs can be supplied suitable for air or earth temperatures.

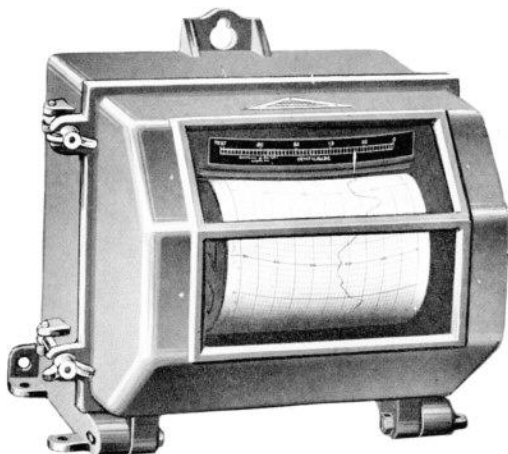
M 2241A. Electrical Resistance Recording Thermometer, Continuous Chart type. Range 0/100° F. or -20/+30° C. for use with nickel or platinum coil bulbs, fitted with battery test switch, variable rheostat, and with two accumulators.

1 point	£72 10 0	Ribbons each	£0 4 0
2 points	£75 0 0	Electrically-wound Clock	
3	£77 10 0	for A.C. or D.C. extra	£3 0 0
4	£82 10 0	Chart rolls each	£0 10 0
6	£92 10 0		

22" × 15½" × 11½"

63-lbs.

ELECTRICAL RESISTANCE RECORDING THERMOMETERS



Electrical Recording Thermometer, Resistance type, the principle of which is described on page 104, with **Drum Chart** for one or two records. Cast-iron moisture-proof case, heavily enamelled and stoved, suitable for panel or bench fixing. Chart mounted on a horizontal clock drum rotating once in 24 hours, giving 5" for the temperature scale and $\frac{1}{2}$ " per hour. Clock drums revolving once in 7 days can also be supplied. The record is obtained by the clockwork depressing the inked pointer on to the chart at one-minute intervals. A scale is fitted above the chart which allows easy reading of the pointer at all times. For two records on one chart an automatic mercury tube switch is fitted, the timing of which is arranged to make two distinguishable records.

Particulars of thermometer bulbs and price of lead-covered connecting cable on request.

M 2242C. Electrical Resistance Recording Thermometer, Drum Chart type, for use with nickel or platinum coil bulbs, range 0/100° F. or -20/+30° C. fitted with battery test switch, variable rheostat, and with two accumulators and 100 charts.

1 point	£48 0 0
2 points	£54 0 0
Charts per 100	£0 15 0
1' 1½" × 1' × 1' 56-lbs.	



RECORDING HAIR HYGROMETERS

Recording Hair Hygrometer. This is practically the only instrument which gives a direct record of humidity without reference to Tables, and although its accuracy is not so great as that of a recording wet and dry bulb hygrometer its direct record is of the greatest value for innumerable purposes.

The instrument is based on the well-known form of De Saussure's hair hygrometer. The hairs, numbering about 15, are specially selected and treated to remove fatty substances. Each hair is loaded with a known weight before the bundle is clamped together: this ensures uniform loading when in operation. The hairs are contained in a well-ventilated cylindrical brass tube, the top end being anchored to an adjustable screw in the cap. The other end of the hairs operates through a connecting link to a crank on the pen-arm spindle, which is mounted in jewelled bearings.

The design necessitates unequal dividing of the chart, but offers the great advantage that all levers, gears, cams, etc., to obtain even divisions, are eliminated, and the hairs are coupled up directly with the pen arm.

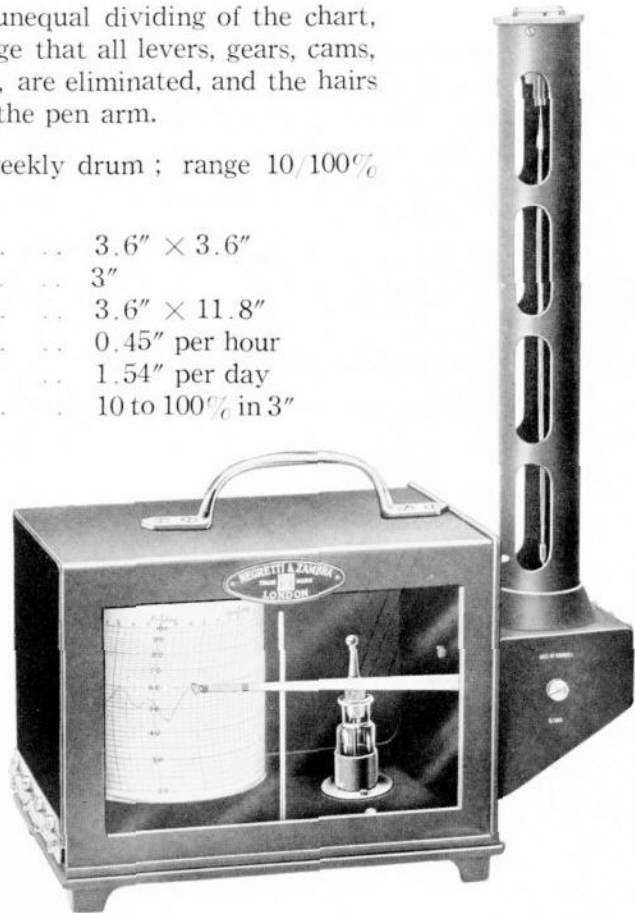
Daily (8-day clock) or weekly drum; range 10/100% relative humidity.

Clock drum	.. .. .	3.6" × 3.6"
Pen travel	.. .. .	3"
Chart	.. .. .	3.6" × 11.8"
Time scale (daily)	.. .. .	0.45" per hour
" " (weekly)	.. .. .	1.54" per day
Humidity scale	.. .. .	10 to 100% in 3"

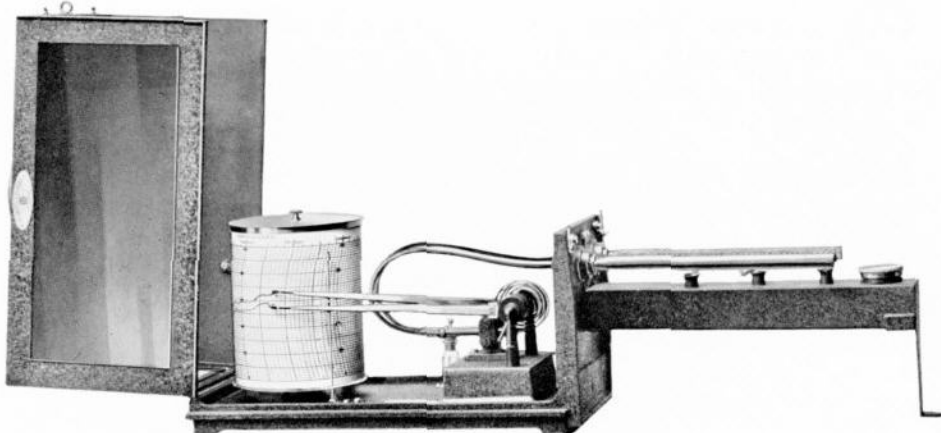
M 2249 Recording Hygrometer, complete with 100 charts and ink **£9 0 0**

Charts, per 100 **£0 12 0**

1' 2" × 10½" × 5" .. 9½-lbs.



MERCURY-IN-STEEL RECORDING HYGROMETERS



The **Mercury-in-Steel Recording Hygrometer** is an instrument of great precision due mainly to the fact that the wet bulb is of cylindrical form, so that a close-fitting wick sleeve can be used and an ample surface of evaporation provided. The wick sleeve is attached to several wicks, which dip into the tank and ensure a film of moisture surrounding the bulb ; these wicks are readily renewable.

The bulbs are protected against corrosion by close-fitting Staybrite sheaths. The mechanism is that of the N. & Z. patent mercury-in-steel type, fully described on page 95.

Daily (8-day clock) or weekly drum, any of the standard ranges below.

Hinged glass-panelled cover to case, with padlock and key.

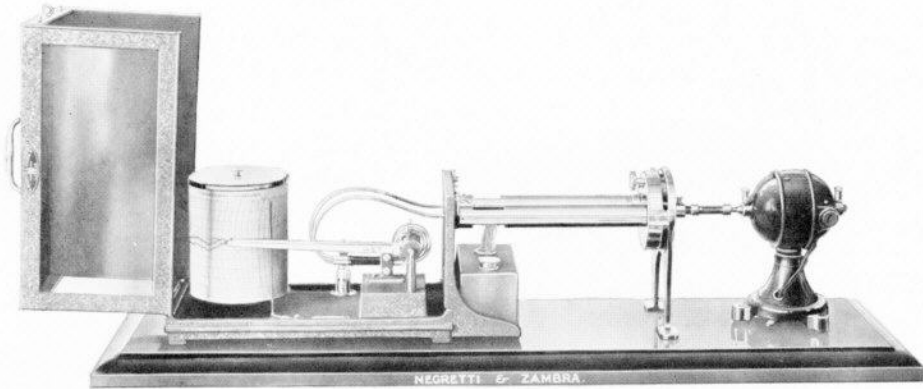
Clock drum	5" dia. × 6" high
Pen travel.. .. .	5"
Chart	5.8" × 16.2"
Time scale (daily)	0.6" per hour
.. .. (weekly)	2.06" per day
Temperature scale	20° F. or 10° C. per inch

Standard Ranges

0/100° F.	50/150° F.	0/50° C.
30/130° F.	-10/+40° C.	10/60° C.

M 2244 Recording Hygrometer , with 100 charts, pens, ink, and six spare wick sleeves	£32 0 0
Charts	per 100 £0 12 6
10" × 2½" × 7½" 30-lbs.	

MERCURY-IN-STEEL RECORDING HYGROMETERS



This **Mercury-in-Steel Recording Hygrometer** is similar to the instrument described on page 108, where the advantages of the cylindrical form of bulb are mentioned.

In addition, it is arranged on the Assmann principle, with a ventilating fan by means of which a constant flow of air is drawn over the bulbs, for the purpose of obtaining humidity readings of the greatest precision.

The mechanism is constructed on the Negretti & Zambra patent mercury-in-steel principle described on page 95, and the bulbs are protected by close-fitting Staybrite sheaths.

Daily (8-day clock) or weekly drum ; with any of the standard ranges below. Hinged glass-panelled cover to case, with padlock and key and polished wood base.

Clock drum	.. .. .	5" dia. × 6" high
Pen travel	.. .. .	5"
Chart	.. .. .	5.8" × 16.2"
Time scale (daily)	.. .. .	0.6" per hour
" " (weekly)	.. .. .	2.06" per day
Temperature scale	.. .. .	20° F. or 10° C. per inch

Standard Ranges

0 / 100° F.	50 / 150° F.	0 / 50° C.
30 / 130° F.	-10 / +40° C.	10 / 60° C.

M 2244A Recording Hygrometer, with 100 charts, pens, ink and six spare wick sleeves ; without motor **£52 0 0**

M 2244B Ditto, complete with one-eighth h.p. motor, for D.C. or A.C. as required **£57 0 0**

Charts per 100 **£0 12 6**

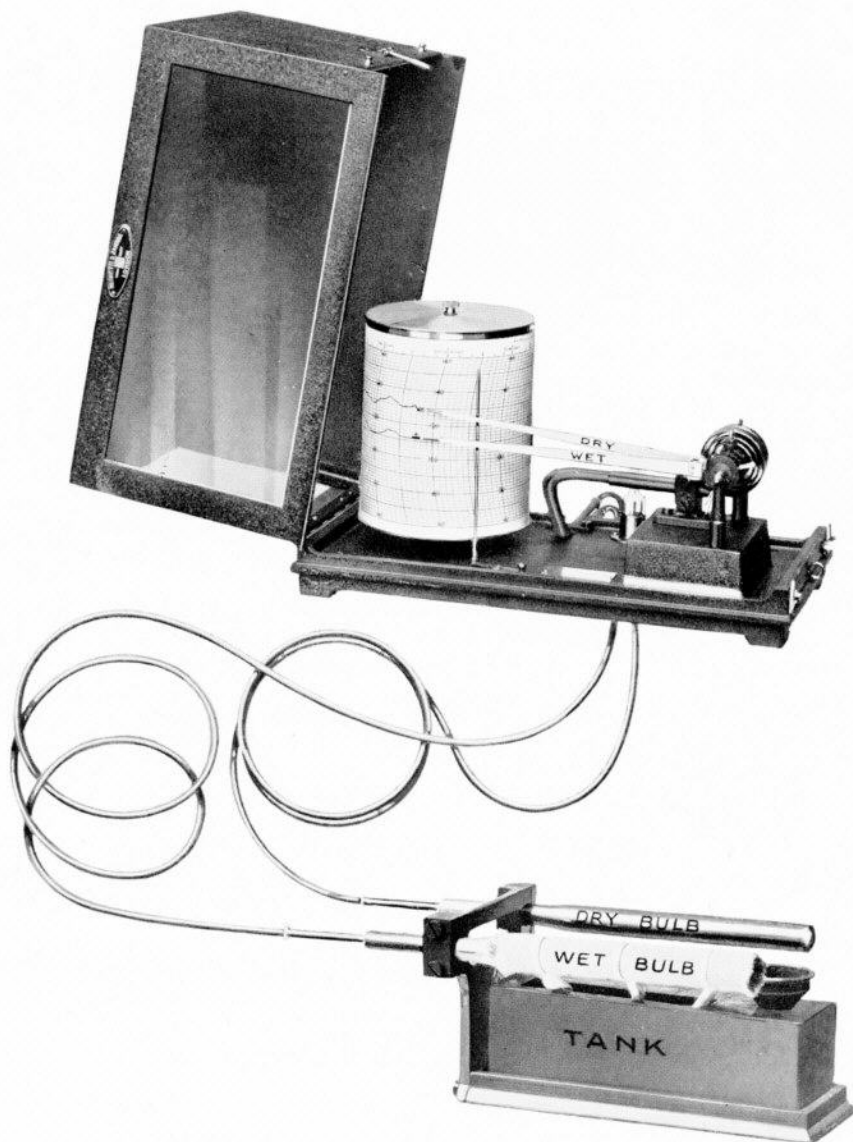
11½" × 3' 5" × 12" 60-lbs.

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NEGRETTI & ZAMBRA

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MERCURY-IN-STEEL RECORDING HYGROMETERS



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MERCURY-IN-STEEL RECORDING HYGROMETERS

Distance Recording Hygrometer. The patent mercury-in-steel principle described on page 95 is utilised in the design of this instrument so that the bulbs, tank, etc., may be located out in the open, and the recorder placed in the observation room. It is admitted that the inside of a Stevenson screen should be as free as possible from superfluous metal, etc., which may tend to vitiate the readings of the thermometers, and the particular advantage of this instrument is that only the bulbs of the apparatus are actually inside the screen. Both bulbs have a Staybrite sheath to prevent corrosion, and one is provided with a close-fitting muslin sleeve and wicks.

The two bulbs are clamped to a casting which carries the water tank situated directly under the bulbs.

The water tank usually supplied holds $1\frac{1}{4}$ pints, but when desired a specially large tank holding $2\frac{1}{2}$ pints can be substituted.

Daily (8-day clock) or weekly drum, standard ranges as below.

Capillary, any length required (standard length 10 feet).

	Model C	Model D
Clock drum	3.6" dia. × 3.6" high	5" dia. × 6" high
Pen travel	3"	5"
Chart	3.6" × 11.8"	5.8" × 16.2"
Time scale (daily)	0.45" per hour	0.6" per hour
„ „ (weekly)	1.54" per day	2.06" per day
Temperature scale	33.3° F. or 16.6° C. per inch	20° F. or 10° C. per inch

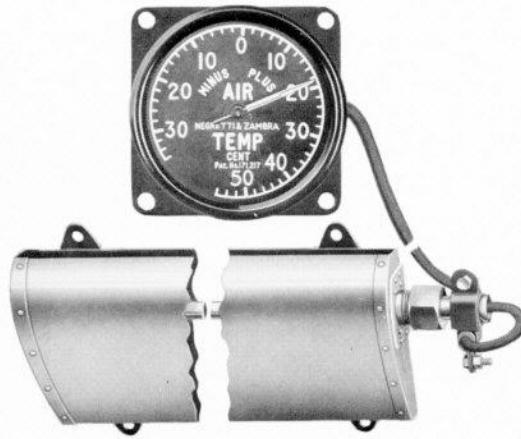
Standard Ranges

0/100° F. 30/130° F. -10/+40° C. 0/50° C.

	Model C	Model D
M 2246 Recording Hygrometer, Distance Type, with 10 feet capillary to each bulb, six spare sleeves, 100 charts, pens and ink	£29 10 0	£32 5 0
Extra Capillary per foot	£0 3 0	£0 3 0
Charts per 100	£0 10 0	£0 12 6

Case : Model C, $11\frac{1}{2}" \times 6" \times 5\frac{1}{4}"$ 15-lbs.
 „ D, $1' 2\frac{1}{2}" \times 8\frac{1}{2}" \times 7\frac{1}{2}"$ 26-lbs.

AIRCRAFT AIR THERMOMETER



Air Temperature Indicator. As the measurement of ordinary temperatures is extremely important in the accumulation of meteorological data, both for the accurate determination of heights and in connection with aircraft performance, a thermometer is frequently mounted on the aeroplane. This indicator incorporates the Negretti & Zambra patent mercury-in-steel system described on page 95.

The bulb is of steel $\frac{1}{4}$ " in diameter and approximately 12" long. It is mounted in a polished sun-shield of streamline section, with flat back for fuselage fitting, of the latest Air Ministry pattern.

The indicating movement is mounted in a $2\frac{1}{2}$ " square flanged case of black moulded material, and the steel capillary is protected by a braided and water-proofed covering of cotton. The instrument is exceptionally sensitive, accurate and robust.

M 2250A Transmitting Air Temperature Thermometer, mercury-in-steel type, range -36 to $+56^{\circ}$ C., to latest British Air Ministry specification.

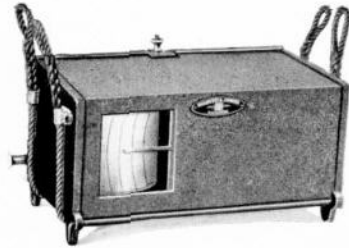
With 10 feet of capillary	.. .. .	£14 2 6
.. 15 .. ..	.. .. .	£14 15 0
.. 20 .. ..	.. .. .	£15 7 6
.. 25 .. ..	.. .. .	£16 0 0
.. 30 .. ..	.. .. .	£16 12 0
.. 35 .. ..	.. .. .	£17 4 6
.. 40 .. ..	.. .. .	£17 17 0

Case : 2.5" x 2.5" x 1.48"

1½-lbs.

AIRCRAFT AIR TEMPERATURE RECORDER

Air Temperature Recorder. This instrument is constructed on the Negretti & Zambra patent mercury-in-steel principle described on page 95, and is similar to the foregoing instrument on page 112, except that the indicator is replaced by a recorder.



The usual range is $-30^{\circ} / +50^{\circ}$ Centigrade.

The mechanism is mounted on a light base, the case is of aluminium, and the lid of reinforced aluminium sheet ; all stoved black.

The instrument is complete with bulb mounted in a polished sun-shield of streamline section, with flat back for fuselage fitting, of the latest Air Ministry pattern, and the steel capillary is braided and waterproofed, as illustrated on the opposite page.

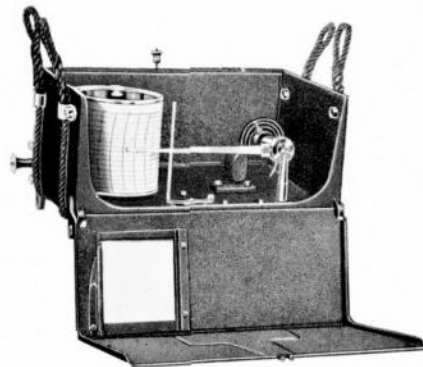
2-hour clock drum	.. .. .	3" dia. \times 3 $\frac{1}{2}$ " high
Pen travel	.. .. .	3"
Chart	.. .. .	3.6" \times 11.8"
Time scale	.. .. .	5.9" per hour
Temperature scale	.. .. .	26.6° C. per inch

M 2251A Air Temperature Recorder,
with 10 feet of capillary tubing,
pen, ink, and 100 charts,

£28 0 0

Capillary, beyond 10 feet, extra
per foot £0 3 0

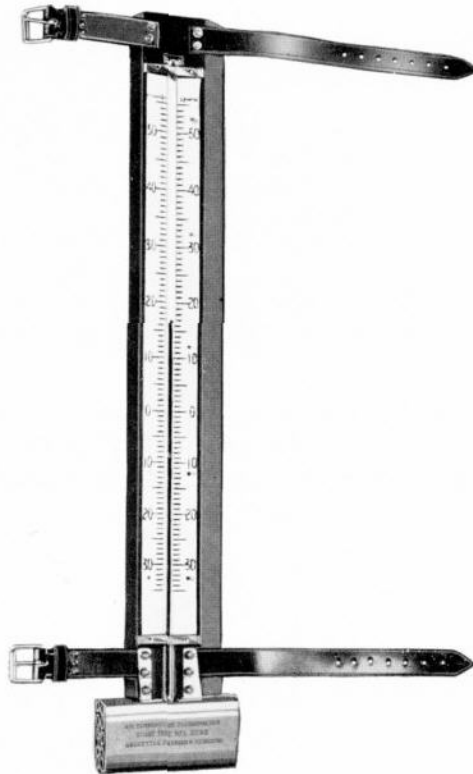
Charts, extra per 100 £0 10 0



With front open, showing
accessibility.

Case : 11" \times 5 $\frac{1}{4}$ " \times 5 $\frac{1}{4}$ " 6-lbs.

AIRCRAFT STRUT THERMOMETER

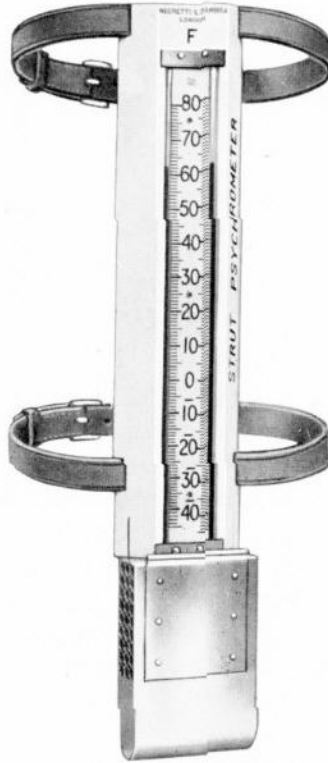


M 2252 Strut Air Thermometer. The Thermometer serves the same purpose as the indicator on page 112, but is of the alcohol-in-glass type. The tube is of lens front, wide-bore type, filled with spirit coloured red for easy reading at a distance ; the bulb of "link" form to increase sensitivity. Range $-35/+55^{\circ}$ C. The scale, of duralumin about $18\frac{3}{4}$ " long, is graduated in degrees and figured boldly at every 10° C. The mount is of seasoned hardwood, shaped to fit the strut of the aeroplane, and covered with felt cloth. Two straps $24" \times 1"$ are fixed to the mount. The sunshield is of polished nickel silver

£5 5 0

1 $\frac{3}{4}$ -lbs.

AIRCRAFT STRUT PSYCHROMETER



Strut Psychrometer. This instrument serves for the determination of temperature and humidity on aircraft. The tubes are of lens front, wide bore type, filled with spirit coloured red for easy reading at a distance, graduated on the stem -45° to $+80^{\circ}$ F. in single degrees ; the bulbs are of British normal glass ; scale plates of white painted metal about 18" long, graduated in degrees and figured boldly every 10° . The mount is of seasoned hardwood, shaped to fit the strut of an aeroplane, covered with felt cloth, and provided with two straps 21" long. The metal guard and tank, nickel finished, has a sliding shutter, giving access to the bulbs.

M 2253	Strut Psychrometer	.. .. .	£14 10 0
	National Physical Laboratory certificate	.. .. .	£1 0 0

2-lbs.

UPPER AIR APPARATUS

M 2254 Pilot Balloons of good quality rubber, with necks ; capable of inflation without bursting to the following sizes, which are circumferences :—

48"	£0 0 6
70"	£0 0 9
90"	£0 1 6
150"	£0 4 6

M2255A Balloon Filler, Mark IV, for adjusting the volume of hydrogen to give the required free lift. In use, the hydrogen, under pressure, is admitted to the balloon through the filler, the pressure of the gas forcing open the valve which drops back when the supply is cut off. By lifting the ball valve, hydrogen can be liberated at will and the free lift adjusted until the balloon just lifts the filler. The filler alone is used for the 48" balloons, and different weights are to be attached for use with larger sizes. Filler and three weights, in wooden case

£2 17 6

M2256A Balloon Filler, Mark V, for 150" size, and with detachable weight for 90" size, in wooden case

£2 10 0

M 2257 Balloon Release comprises a rotor of stout cardboard, with wooden ends, mounted on a steel spindle about which it can rotate freely. Rotor and handle stained with creosote and two coats of shellac finish

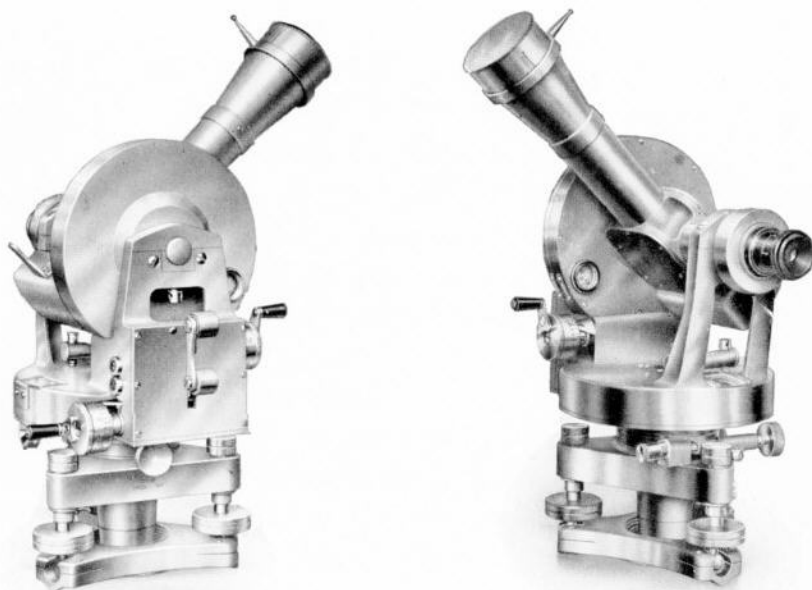
£0 11 6

M 2258 Slide Rule, Mark II., for computation of the wind component velocities from the altitude and azimuth of the balloon, with or without tail and pendant. Scales engraved on white xylonite fixed to a mahogany stick. $2.0\frac{3}{4}'' \times 2\frac{3}{16}''$. Four special cursors are supplied. In leather case

£5 10 0



BALLOON THEODOLITE



M 2259 Balloon Theodolite. Designed specially for observing pilot balloons (or *ballons-sondes*). The telescope is of the prismatic type : object glass 1.3" clear aperture, 10" focus with eyepiece $\times 20$; it is set for infinity ; focussing by eyepiece on a specially-engraved glass diaphragm. The circles, horizontal and vertical, graduated to 1° , are operated by micrometer screws of one revolution = 1° . The drums are graduated into 10 parts to read 1/10th of a degree, or, if required, 60 parts to read one minute. Both circles are completely protected from dust, etc. The tripod is of extra length for convenience in observing. The case is of polished mahogany, and contains the instrument and all accessories. **£49 0 0**

Light Filters to fit over object glass instead of eyepiece . . . **£1 10 0**

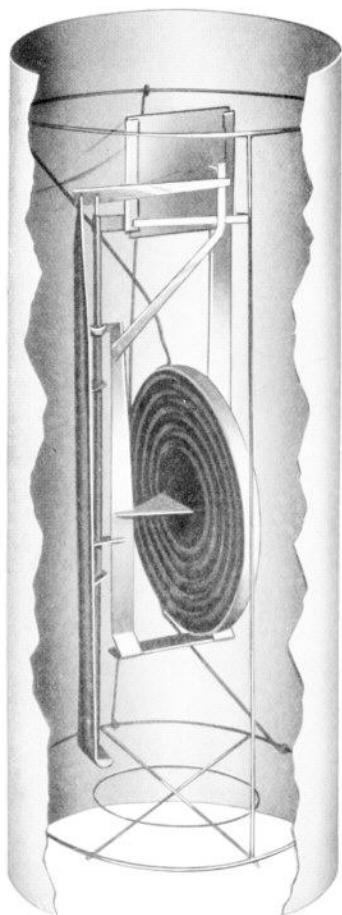
Case, $14\frac{1}{2}'' \times 7\frac{3}{4}'' \times 9''$

Theodolite, 12-lbs. Case, 8-lbs. Tripod, 15-lbs.

M 2260 Fittings for Night Illumination. One lamp beneath telescope eyepiece illuminating horizontal and vertical circles and micrometer drums, the second mounted on a telescope illuminates graticule internally. Complete with battery box, switch and fittings **£8 0 0**

METEOROGRAPH

Meteorograph. The Balloon Meteorograph designed by Mr. W. H. Dines, F.R.S., is an extremely light apparatus for attachment to *ballons-sondes*.



The mechanism incorporates an aneroid capsule and a bimetallic element.

Changes of pressure cause the former to move a small silver-plated square of thin metal on which a trace is drawn by a stylus, which is also deflected approximately at right angles to this movement, by the effect of alterations of temperature on the bimetallic element.

The trace is examined under a low power microscope, having a micrometer eyepiece and a movable stage operated by a micrometer screw.

The whole mechanism is mounted on a very light wire frame in an aluminium sheath, and weighs, complete, 71 grammes.

Each instrument must be calibrated before use, a process which needs special plant and which is not included in the price.

M 2261 Dines Meteorograph £13 10 0

Calibration by the Meteorological Office £0 12 6



TEST THERMOMETERS

Test Thermometers are very suitable for standardising electrical resistance or distance thermometers, and where great accuracy is required without total immersion. The bulb is of a comparatively large volume and the bore of the indicating column of mercury is of large area. The capillary tube leading from the bulb to the indicating tube is of very small diameter. This construction makes for greater accuracy in partially-immersed thermometers and reduces their emergent stem corrections.

These thermometers are calibrated for 4" immersion, and the lower ranges are graduated in both Centigrade and Fahrenheit degrees.

DOUBLE SCALE

Type.	Range.	Sub-divided.	Each.	N.P.L. Certificate.
M 2271	-40° to +140° F. and -40° to 60° C.	0.5° F. 0.2° C.	£1 18 6	£1 5 6
M 2272	0° to 250° F. and -18° to 120° C.	0.5° F. 0.2° C.	£1 15 6	£1 5 6
M 2273	200° to 500° F. and 93° to 260° C.	0.5° F. 0.2° C.	£2 2 0	£1 5 6

SINGLE SCALE

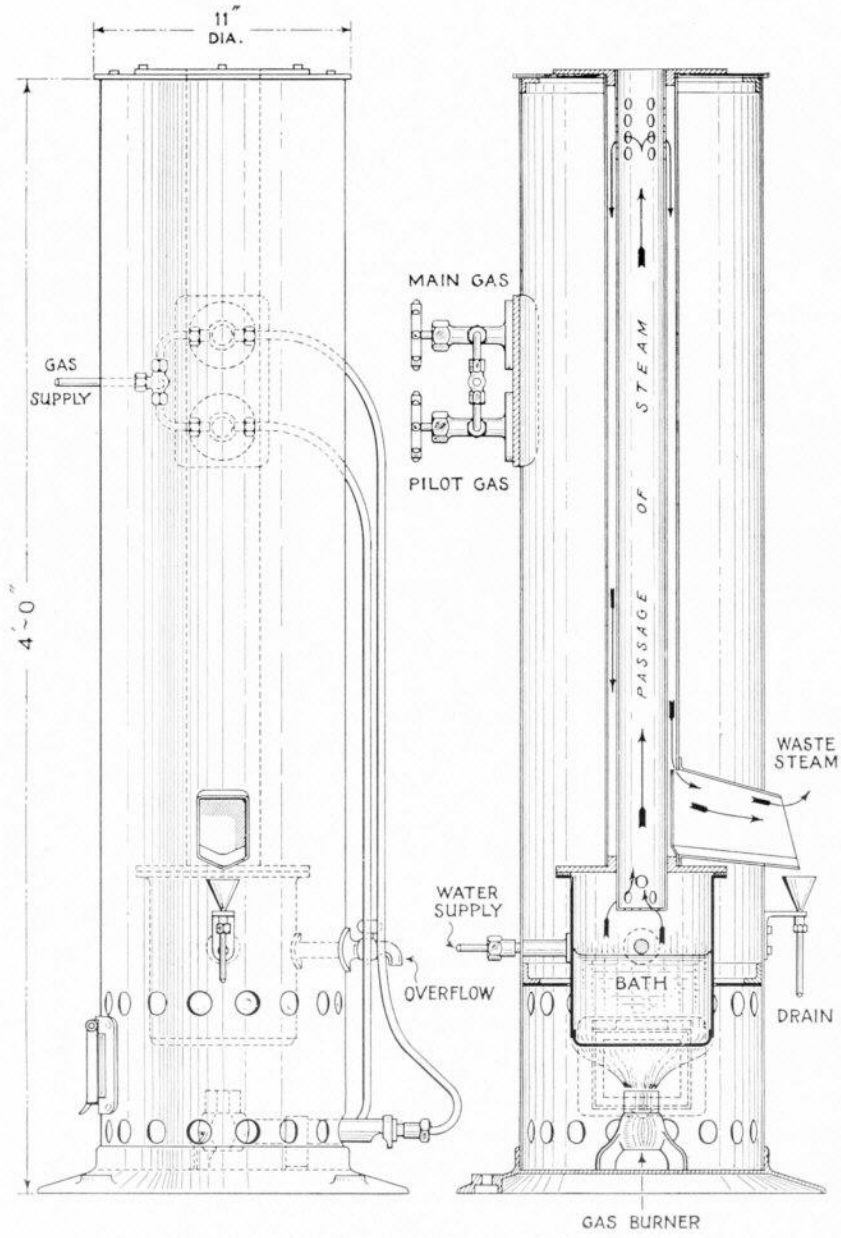
M 2274	200° to 950° F.	2.0° F.	£2 10 0	£1 1 6
M 2275	90° to 510° C.	1.0° C.	£2 10 0	£1 3 0



Each thermometer is supplied in a cardboard case.



THERMOMETER TEST APPARATUS



M 2262

THERMOMETER TEST APPARATUS

The temperature of free steam provides a definite reference point for the checking of a thermometer at or near 212° F. (100° C.), this being correct when the barometer reads 29.92 inches. A correction for the variations of the barometer reading is usually required.

The Hypsometer consists of a gas-heated bath, in which water is caused to boil. The steam from the bath passes up a long central tube and down an outer jacket to atmosphere, the important factor being that the steam escapes freely without back pressure. The bulb and stem of the thermometer under test are inserted in the inner tube to the required depth of immersion.

M 2262 Hypsometer, consisting of a brazed copper bath, 6" diameter, connected to an inner brass tube, 2" bore × 3' 0" long, the whole mounted on a cast-iron base with cylindrical sheet-metal casing 10" in diameter. Complete with special burner and needle valve, also water supply to bath, and connections as illustrated Price on application.

M 2263 Hypsometer of simple form, suitable for testing chemical thermometers, etc., 18" long, consisting of two concentric brass tubes mounted on a copper water container and ring type gas burner, without gas cocks Price on application.

Table of Heights for Hypsometers. (Air Temperature 32° F.)

Boiling Point. ° F.	Altitude. Feet.	Boiling Point. ° F.	Altitude. Feet.	Boiling Point. ° F.	Altitude. Feet.	Boiling Point. ° F.	Altitude. Feet.
213	-518	207	2622	202	5286	197	7997
212	0	206	3151	201	5825	196	8545
211	521	205	3682	200	6366	195	9095
210	1044	204	4215	199	6908	194	9646
209	1568	203	4749	198	7451	193	10199
208	2094						

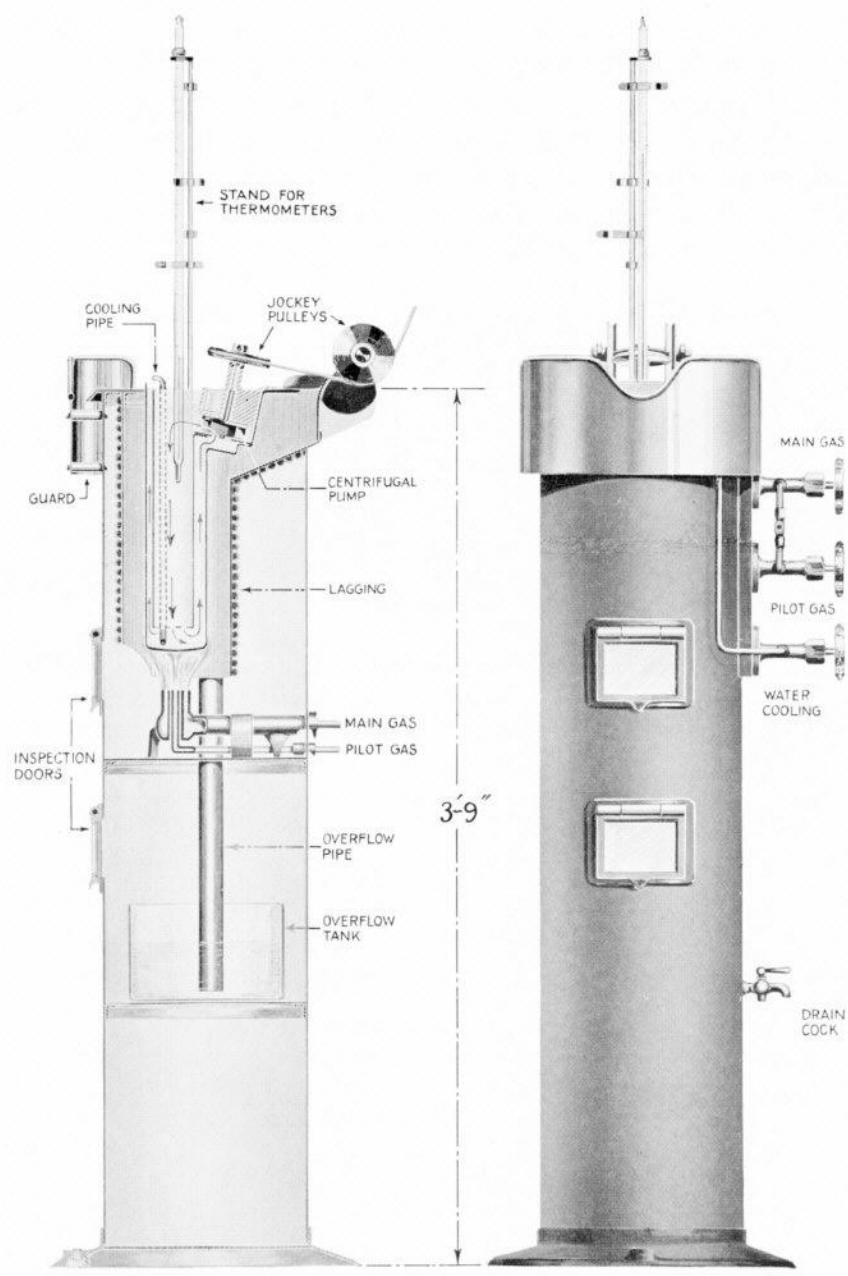
Air Temperature Correction Table.

° F.	Multiplier.	° F.	Multiplier.	° F.	Multiplier.	° F.	Multiplier.
20	0.9734	32	1.0000	46	1.0311	60	1.0622
22	0.9778	34	1.0044	48	1.0355	62	1.0666
24	0.9823	36	1.0088	50	1.0399	64	1.0711
26	0.9867	38	1.0133	52	1.0444	66	1.0755
28	0.9912	40	1.0177	54	1.0488	68	1.0799
30	0.9956	42	1.0222	56	1.0533	70	1.0844
		44	1.0266	58	1.0577		





THERMOMETER TEST APPARATUS



THERMOMETER TEST APPARATUS

For the purpose of testing thermometers up to 1000° F. (550° C.), various testing baths are required, but essentially the construction of the baths is similar : that is, where a two-flame bunsen burner (controlled by needle valves) heats a bath of liquid. The liquid in the bath is rapidly circulated by a centrifugal pump driven from shafting. A standard glass mercury thermometer is inserted in the liquid, and the thermometer under test is compared with the standard.

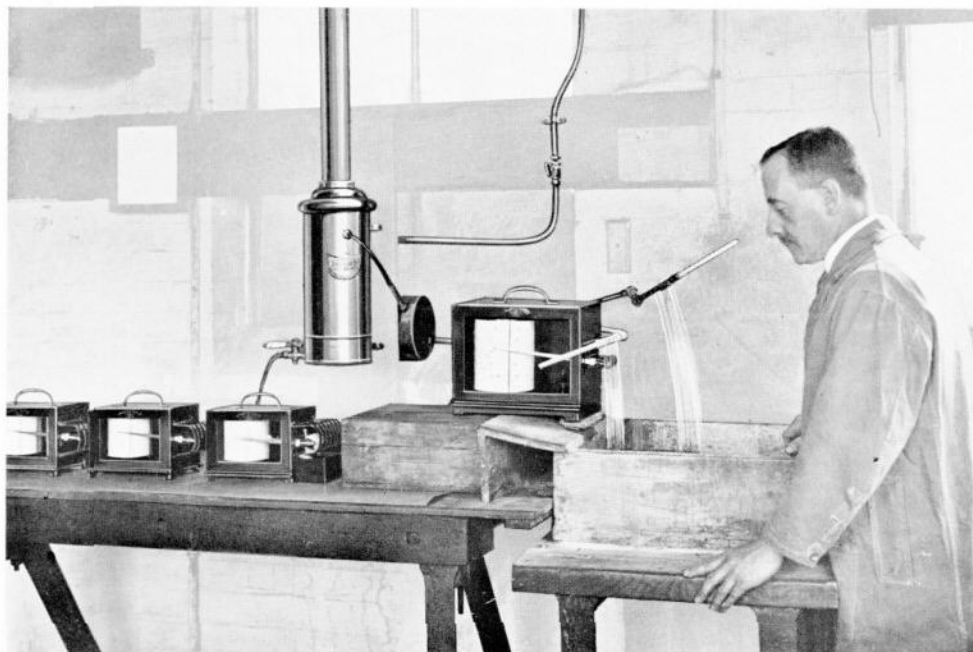
Twelve of these testing sets are installed in our own works, together with various other types of electrically and gas-heated thermometer testing apparatus.

- M 2266 Gas-heated Thermometer Testing Apparatus (Standard Type)**, for use with **water** (or alcohol and CO² snow, for temperatures below normal). Range 60° F. to 210° F. (15° C. to 99° C.). Bath to take a series of glass thermometers or one 1" diameter bulb × 12" long. Diameter of bath 3". Double-flame burner, one a small flame or pilot, the other main flame controlled through a needle valve. Water cooling pipe with needle valve overflow connections, centrifugal pump, jockey pulleys. Bracket to support standard thermometer and glass thermometer under test. As illustration, but without thermometer Price on application.
- M 2267** Range 60° F. to 300° F. (15° C. to 150° C.), as above, but for use with **thin oil**, and with hand pump for transferring the oil from the overflow tank back to the bath. . . Price on application.
- M 2268** Range 100° F. to 600° F. (40° C. to 316° C.), as above, but for use with **thick oil**, and hand pump, as above. Price on application.
- M 2269** Range 400° F. to 1000° F. (200° C. to 540° C.), as above, but for use with **molten metal**, and complete with alloy but without overflow pipe and tank Price on application.

(For Test Thermometers, see page 119).



THERMOMETER TEST APPARATUS

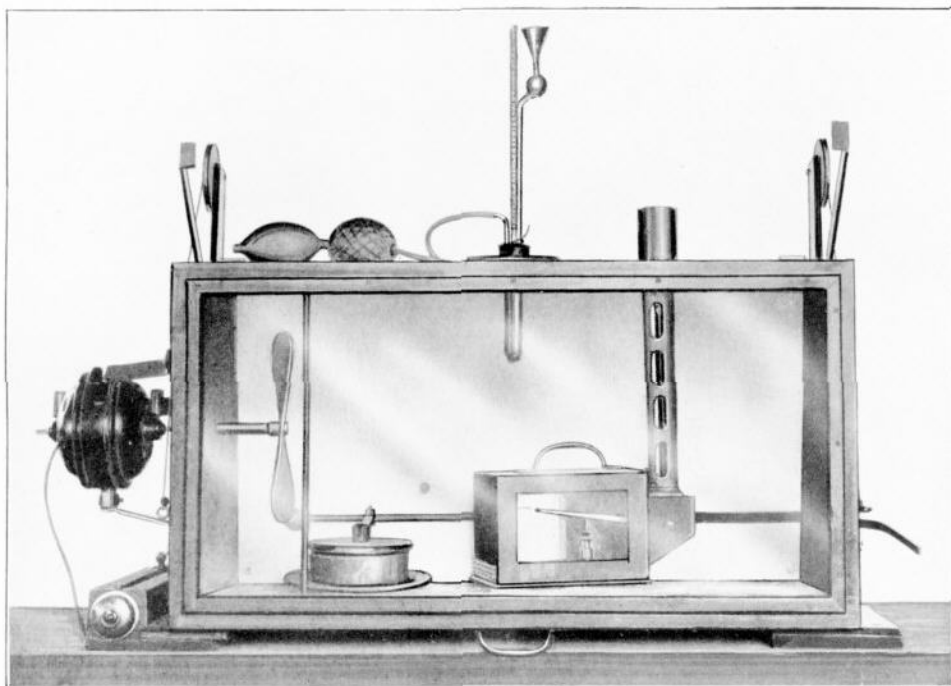


The checking of a Bimetallic Recording Thermometer is not a very simple affair, but it can be carried out roughly by placing a Standard Thermometer close to the coil and comparing the readings.

We employ at our works the method shown above, where a current of water at the desired temperature flows over both the bimetallic coil and the standard thermometer, the errors of which are known. The result is that the bimetallic coil is subjected to identically the same temperature as that of the standard thermometer, and, consequently, the instrument is calibrated to within fine limits.

The above applies to temperatures above 60° F., and below this point we have a special refrigerating chamber arranged with a series of pipes and ventilating fan. Alcohol is forced through the pipe system and flows over the bimetallic coil, the temperature of which is measured by a standard thermometer. At the same time the air is thoroughly circulated by means of the fan, and by these means we are able to ensure that the scale at low temperatures is absolutely correct.

HYGROMETER TEST APPARATUS



The apparatus for testing Hygrometers consists of a chamber constructed of wood and varnished inside with a non-hygroscopic varnish. The chamber is fitted with a balanced hinged door, with a double glass window with intervening air space. Inside the chamber an electrically-operated fan is provided for rapid circulation of the air, and for drying the air with sulphuric acid a lead jar is provided having a glass lid operated from outside the chamber.

A dew point apparatus, for ascertaining the humidity of the chamber, consists of a silver thimble into which a standard thermometer is inserted, and cooling is obtained by means of ether poured in through the funnel shown in the illustration. The ether is evaporated by means of the rubber bellows, and deposition of moisture on the silver thimble is observed through the glass windows.

The method of obtaining relative humidity by means of the dew point apparatus is considered more accurate than the wet and dry bulb hygrometer, and all hygrometers are tested by this means.

The instrument shown in the chamber is a N. & Z. recording hygrometer.

M 2276 Hygrometer Testing Apparatus Price on application

TEST APPARATUS

Precision Manometer. For the precise measurement of pressures up to 50 or 100 cms. head of water, this instrument enables consistent and accurate readings to be taken to .05 mm. or .002-inch.

The apparatus consists of a cathetometer frame with a graduated scale and movable vernier carriage on which is mounted a cistern having an eyepiece set below the water level and at such an angle that a magnified view is obtained of a submerged index point. The surface of the water in the cistern acts as a mirror and a reflected image of the index is also seen, the exact datum level of the water being obtained when the tip of the index and its image just appear to touch.



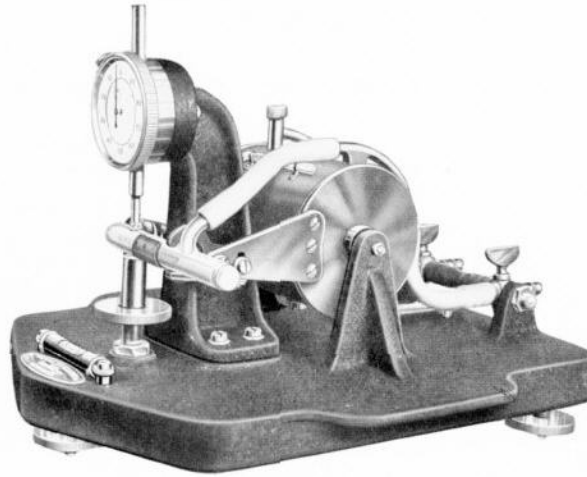
A U-tube is formed by the connection of a thick walled rubber tube from an outlet on the bottom of the cistern to a second chamber or cistern, which can be clamped at any desired position on another vertical rod. Having filled the system so that the datum level is correct with the vernier set at zero or at a selected point on the scale, the pressure or suction to be measured is indicated by the movement of the cistern necessary to produce a balancing head of water, to restore the datum level.

Suctions, pressures, or differential pressures can be measured by making suitable connections to either or both chambers.

The gauge can be used with pitot or venturi tubes for determining air flows or for measuring with precision the depths of water in tanks, for calibrating other gauges and indeed for any purpose involving the exact determination of pressures.

M 2277A	Precision Manometer,	range 0-50 cm.	£34 0 0
M 2277B	„ „	range 0-100 cm.	£35 0 0
M 2277A,	2' 10" × 1' 5" × 1' 4"	66-lbs.	
M 2277B,	4' 5" × 1' 5" × 1' 4"	104-lbs.	

TEST APPARATUS



A **sensitive Manometer**, suitable for measuring positive, negative or differential pressures up to about 8 mm. water gauge. Indications are obtained from a dial gauge of standard type reading to 8 mm. in .01 mm. or .4" in .001".

The manometer is a U-tube of special form, arranged in such a manner that any applied gas or air pressure can be balanced by the movement of one arm of the tube so as to restore the level of the liquid in it to its original position, the latter being indicated in an easily visible and very sensitive manner by the liquid itself.

An important feature is that the manometer can be quickly set up for use, and it responds to changes in pressure with very little lag. The adjustment to obtain a balance of the pressure is quickly made by means of a micrometer screw. An important point is that the sensitivity of its zero indication is normally equal to that of the high-grade dial gauge used, but can, however, be varied if desired.

With a pitot tube, the manometer can be used for measuring the velocity of air flow from about 10 feet per second up to about 35 feet per second, or 3 metres per second up to 10 metres per second.

M 2279A Stalhane Micromanometer, in wood case **£37 10 0**

Case : 11" × 1' 1" × 12" 19½-lbs.



TEST BAROMETERS

This Standard Test Barometer is used for the purpose of measuring pressure below normal atmospheric pressure with precision, such as for instance in the calibration of aneroids, etc.

The bore of the glass tube is 0.5", and the Range is 31" to 5" barometric pressure, reading to .002". The cistern is of cast iron, with a connecting pipe for coupling to a pump or receiver.

In order to make the barometer reasonably safe in transport, the cistern is fitted with a needle valve, which shuts off the connecting pipe, so that when the barometer is inverted there is no loss of mercury. The barometer is transported in an inverted position in a special crate with carrying handle.

The instrument is fitted with a thermometer for temperature corrections.

As supplied to the British Air Ministry.

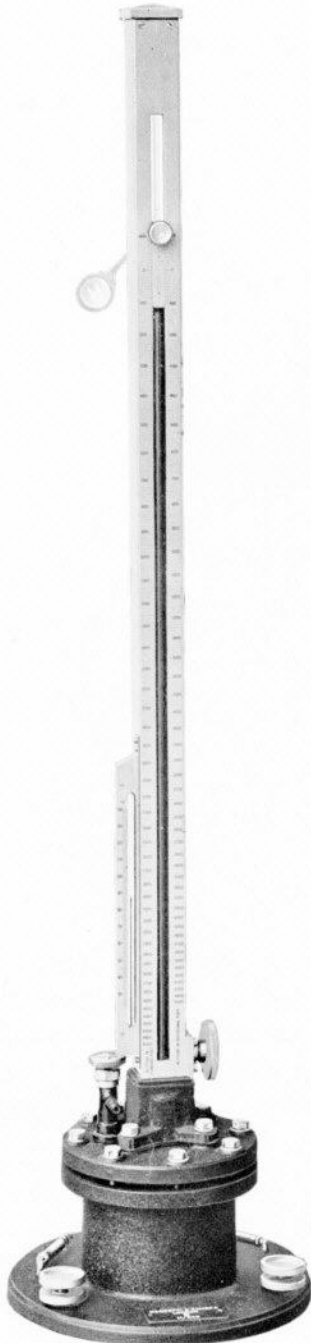
M 2280 Test Barometer, Range 31" to 5", and in altitude to 40,000 feet, as described above and illustrated. Complete in crate **£66 0 0**

M 2281 Test Barometer, Range 790 mms. to 130 mms., and in altitude to 12,000 metres, Ditto **£66 0 0**
National Physical Laboratory certificate for pressure scale **£2 15 0**

In the calibration of this barometer, it should be stated whether the altitude is to be graduated from Airy's Table, Isothermal, or I.C.A.N. Tables.

The range can be extended down to 2" or 50 mm. if specially required, at an extra charge.

3' 7" x 10" 32-lbs.



TEST BAROMETERS

Test Barometer designed primarily for the testing of aneroids and barographs to 8" mercury and approximately 30,000 feet altitude.

The bore of the glass tube is 0.25" internal diameter.

Portability is arranged as follows :—

A spring plunger, which closes the end of the glass tube, is screwed into the base of the iron cistern. When the barometer is received and put into action, this plug is removed (the instrument being held with the cistern uppermost), and another plug without spring is inserted.

The brass tube is fitted with one vernier which will slide over the whole range of the scale by hand, and fine adjustment is provided by means of a milled-head screw concentric with the tube.

The cistern is of special close-grained cast iron, with a cast-iron flange screwed on the base, and drilled with holes suitable for bolting the instrument to a bench.

The thermometer has a range of 0/120° F. or C.

The barometer is supplied in a special box, with rubber packings to prevent undue shocks in transit.

M 2282 Test Barometer as illustrated **£28 10 0**
 3' 4" × 4¼" 32-lbs.

ANEROID TESTING SET

Standard Barometer No. 2280 or No. 2282.

Vacuum Chamber No. 2284 or No. 2289.

Thermal Chamber, viz, a wooden box with a metal box inside to contain the instrument under test ; round the metal box is an air duct in which heating unit and cooling coils are provided, an electric fan circulating the air.

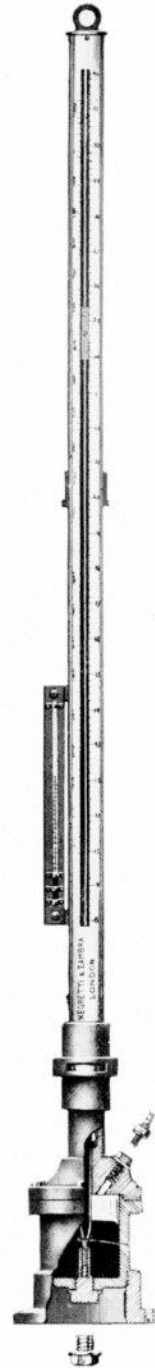
Regulation resistance for heating unit.

Vacuum tank of welded steel 6" diameter × 10" deep.

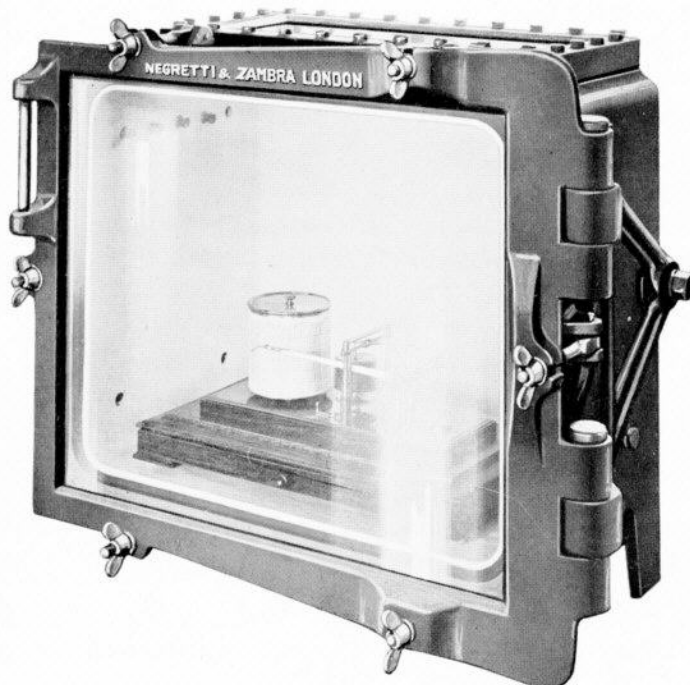
Hand or power-driven exhaust pump of the oil seal type, fitted with a flywheel.

Full set of fine adjustment valves, copper connecting pipe, etc.

M 2283 Complete Testing Set . . . Price on application



BAROMETER TEST APPARATUS



Vacuum Chamber for testing aneroids, barographs, etc., within the range of 34" to 9" of barometric pressure. The chamber is of cast iron, with a 1" plate-glass window at the top, and a 1½" plate-glass panelled door in front. The door is on special hinges, and a joint is made between the plate glass and the chamber with a rubber ring. Six wing nuts are provided for holding the door closed. Wire guard, if required, at additional cost.

A connection is made for exhaust, also terminals for any electric connections that may be required for heaters, etc., when carrying out temperature tests under a vacuum. Inside dimensions 20½" wide × 17" high × 13" deep.

As supplied to the British Air Ministry.

M 2284	Vacuum Chamber	.. . . . .	£72 10 0
M 2285	Needle Valve with union (two required)	.. . . . . each	£0 11 6
M 2286	Copper Tubing, ¼" o/d. × 22 S.W.G.	.. . . . . per foot	£0 0 6
M 2287	Couplings, Brass	.. . . . . each	£0 0 8
M 2288	Tee-piece with unions	.. . . . . „	£0 2 0

2' 2" × 2' 4" × 1' 6" 500-lbs.



BAROMETER TEST APPARATUS



Vacuum Chamber for testing aneroids, etc. The chamber is of welded steel sheet, with a heavy cast-iron flange to which a plate-glass door is hinged.

The hinged frame which carries the plate-glass front is of cast iron, with a brass bezel supporting the plate glass; the whole is held down with four wing nuts.

The plate-glass window is $\frac{1}{2}$ " thick, sufficient to withstand an internal vacuum down to 8" of mercury. A special wire guard can be provided at additional cost, where tests are required to be taken at a lower vacuum.

Two connections are provided—one to connect to the barometer and the other to the control cocks. Three control cocks are provided, but in the event of the vacuum tank being dispensed with, two cocks only are necessary.

M 2289 Vacuum Chamber, with glass window 9 $\frac{1}{8}$ " diameter . . £24 0 0

Note.—It is important in the use of this Chamber to prevent any scratchings on the glass face which might cause fracture when the instrument is used under a high vacuum.

9 $\frac{1}{8}$ " dia. × 11" 60-lbs.

FAHRENHEIT AND CENTIGRADE CONVERSION TABLE

°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.
-40	-40	10	-12.2	60	15.6	110	43.3	160	71.1
-39	-39.4	10.4	-12	60.8	16	111	43.9	161	71.7
-38.2	-39	11	-11.7	61	16.1	111.2	44	161.6	72
-38	-38.9	12	-11.1	62	16.7	112	44.4	162	72.2
-37	-38.3	12.2	-11	62.6	17	113	45	163	72.8
-36.4	-38	13	-10.6	63	17.2	114	45.6	163.4	73
-36	-37.8	14	-10	64	17.8	114.8	46	164	73.3
				64.4	18			165	73.9
-35	-37.2	15	-9.4			115	46.1	165.2	74
-34.6	-37	15.8	-9	65	18.3	116	46.7	166	74.4
-34	-36.7	16	-8.9	66	18.9	116.6	47	167	75
-33	-36.1	17	-8.3	66.2	19	117	47.2	168	75.6
-32.8	-36	17.6	-8	67	19.4	118	47.8	168.8	76
-32	-35.6	18	-7.8	68	20	118.4	48	169	76.1
-31	-35	19	-7.2	69	20.6	119	48.3		
		19.4	-7	69.8	21			170	76.7
-30	-34.4					120	48.9	170.6	77
-29.2	-34	20	-6.7	70	21.1	120.2	49	171	77.2
-29	-33.9	21	-6.1	71	21.7	121	49.4	172	77.8
-28	-33.3	21.2	-6	71.6	22	122	50	172.4	78
-27.4	-33	22	-5.6	72	22.2	123	50.6	173	78.3
-27	-32.8	23	-5	73	22.8	123.8	51	174	78.9
-26	-32.2	24	-4.4	73.4	23	124	51.1	174.2	79
-25.6	-32	24.8	-4	74	23.3				
						125	51.7	175	79.4
-25	-31.7	25	-3.9	75	23.9	125.6	52	176	80
-24	-31.1	26	-3.3	75.2	24	126	52.2	177	80.6
-23.8	-31	26.6	-3	76	24.4	127	52.8	177.8	81
-23	-30.6	27	-2.8	77	25	127.4	53	178	81.1
-22	-30	28	-2.2	78	25.6	128	53.3	179	81.7
-21	-29.4	28.4	-2	78.8	26	129	53.9	179.6	82
-20.2	-29	29	-1.7	79	26.1	129.2	54		
								180	82.2
-20	-28.9	30	-1.1	80	26.7	130	54.4	181	82.8
-19	-28.3	30.2	-1	80.6	27	131	55	181.4	83
-18.4	-28	31	-0.6	81	27.2	132	55.6	182	83.3
-18	-27.8	32	0	82	27.8	132.8	56	183	83.9
-17	-27.2	33	0.6	82.4	28	133	56.1	183.2	84
-16.6	-27	33.8	1	83	28.3	134	56.7	184	84.4
-16	-26.7	34	1.1	84	28.9	134.6	57	185	85
						29		186	85.6
-15	-26.1	35	1.7			135	57.2	186.8	86
-14.8	-26	35.6	2	85	29.4	136	57.8	187	86.1
-14	-25.6	36	2.2	86	30	136.4	58	188	86.7
-13	-25	37	2.8	87	30.6	137	58.3	188.6	87
-12	-24.4	37.4	3	87.8	31	138	58.9	189	87.2
-11.2	-24	38	3.3	88	31.1	138.2	59		
-11	-23.9	39	3.9	89	31.7	139	59.4	190	87.8
		39.2	4	89.6	32			190.4	88
-10	-23.3					140	60	191	88.3
-9.4	-23	40	4.4	90	32.2	141	60.6	192	88.9
-9	-22.8	41	5	91	32.8	141.8	61	192.2	89
-8	-22.2	42	5.6	91.4	33	142	61.1	193	89.4
-7.6	-22	42.8	6	92	33.3	143	61.7	194	90
-7	-21.7	43	6.1	93	33.9	143.6	62		
-6	-21.1	44	6.7	93.2	34	144	62.2	195	90.6
-5.8	-21	44.6	7	94	34.4			195.8	91
						145	62.8	196	91.1
-5	-20.6	45	7.2	95	35	145.4	63	197	91.7
-4	-20	46	7.8	96	35.6	146	63.3	197.6	92
-3	-19.4	46.4	8	96.8	36	147	63.9	198	92.2
-2.2	-19	47	8.3	97	36.1	147.2	64	199	92.8
-2	-18.9	48	8.9	98	36.7	148	64.4	199.4	93
-1	-18.3	48.2	9	98.6	37	149	65	200	93.3
-0.4	-18	49	9.4	99	37.2			201	93.9
						150	65.6	201.2	94
0	-17.8	50	10	100	37.8	150.8	66	202	94.4
1	-17.2	51	10.6	100.4	38	151	66.1	203	95
1.4	-17	51.8	11	101	38.3	152	66.7	204	95.6
2	-16.7	52	11.1	102	38.9	152.6	67	204.8	96
3	-16.1	53	11.7	102.2	39	153	67.2		
3.2	-16	53.6	12	103	39.4	154	67.8	205	96.1
4	-15.6	54	12.2	104	40	154.4	68	206	96.7
								206.6	97
5	-15	55	12.8	105	40.6	155	68.3	207	97.2
6	-14.4	55.4	13	105.8	41	156	68.9	208	97.8
6.8	-14	56	13.3	106	41.1	156.2	69	208.4	98
7	-13.9	57	13.9	107	41.7	157	69.4	209	98.3
8	-13.3	57.2	14	107.6	42	158	70		
8.6	-13	58	14.4	108	42.2	159	70.6	210	98.9
9	-12.8	59	15	109	42.8	159.8	71	210.2	99
				109.4	43			211	99.4
								212	100

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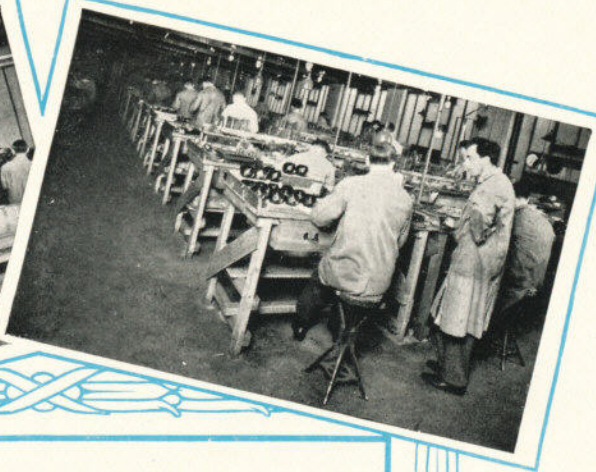
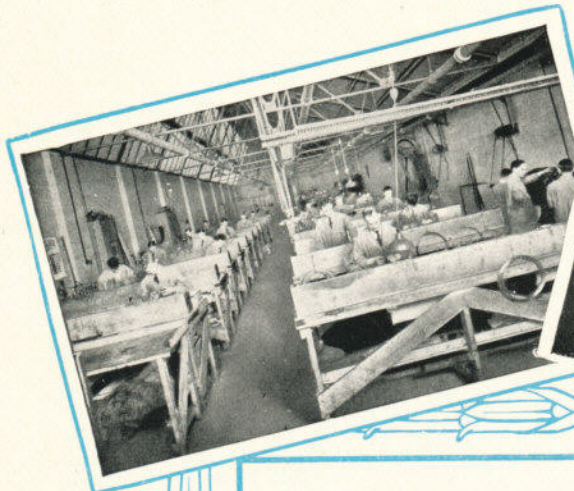
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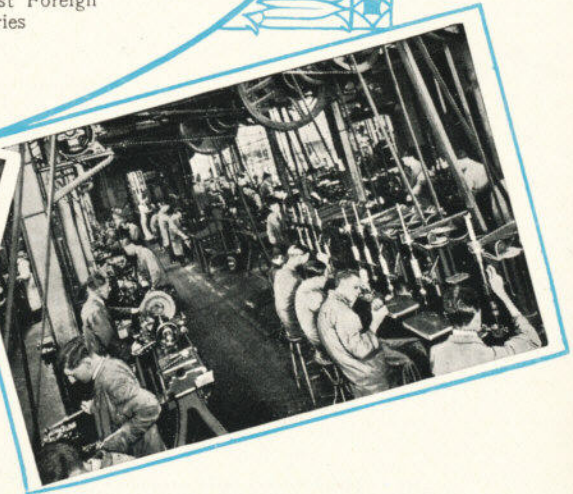
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