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The Scientific Shop

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Scientific Instruments **324 Dearborn St., CHICAGO**

CIRCULAR 331
Second Edition

MAY 1907

The "Scientia" Calorimetric Outfit

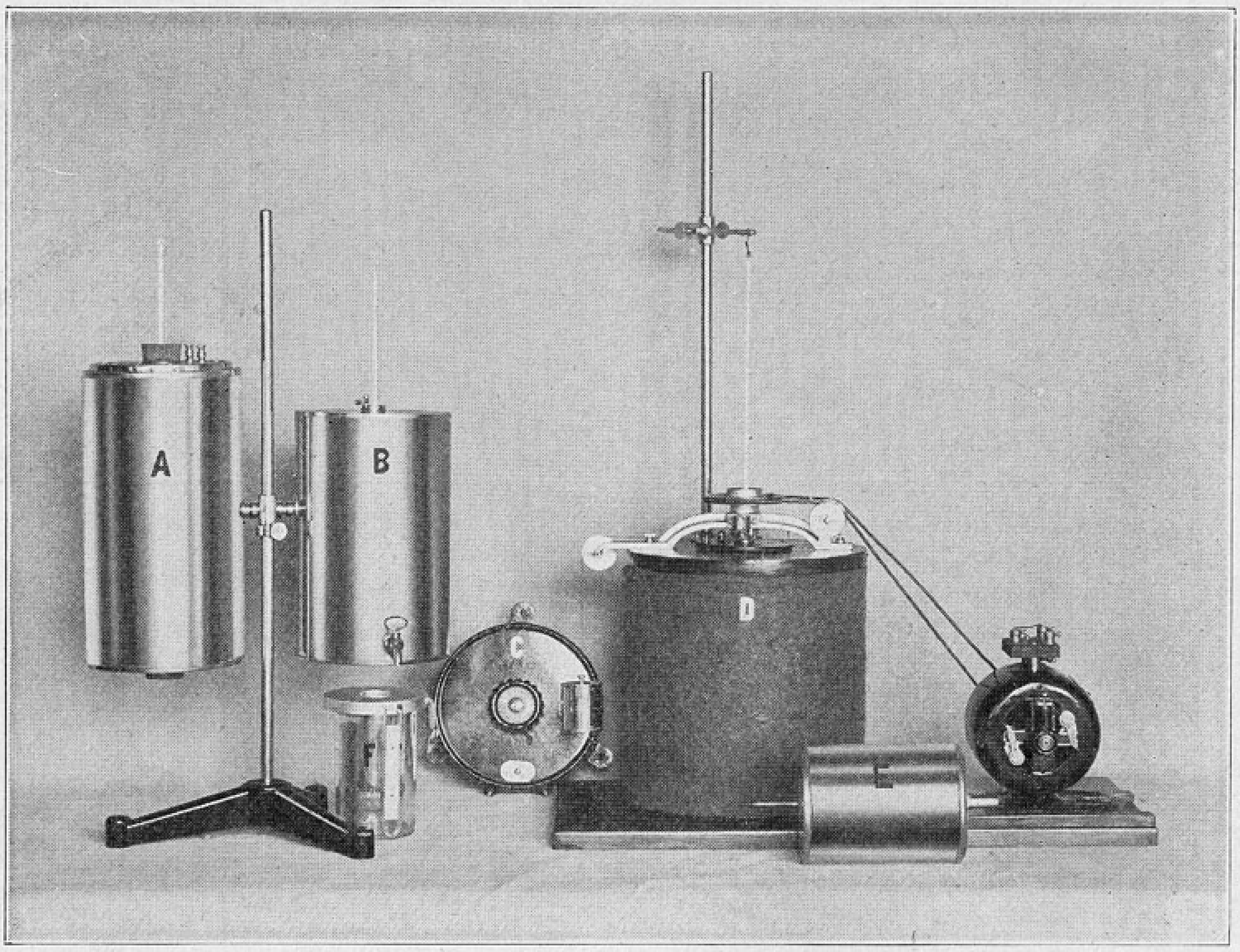


Fig. 1

The "Scientia" Calorimetric Outfit was designed for "The Scientific Shop" by Mr. J. O. Mulvey, mechanician of the Armour Institute of Technology. Many suggestions have been received from members of the Institute faculty, and the apparatus has been thoroughly tested in the Institute laboratories.

The "Scientia" Calorimetric Outfit includes the appliances needed for calorimetric work of all kinds, the separate parts being so arranged that they can be combined in various ways and for various purposes, thus avoiding unnecessary duplication of calorimeters, water-jackets and the like. The component parts are sold separately, and the physicist or engineer may add to his equipment as need arises, or may purchase duplicate sets for the laboratory, with full assurance that all of the elements will be interchangeable.

The apparatus reached its present form as the result of a deal of experimental work, and is now confidently recommended as embodying by far the best calorimetric appliances which have been placed on the market.

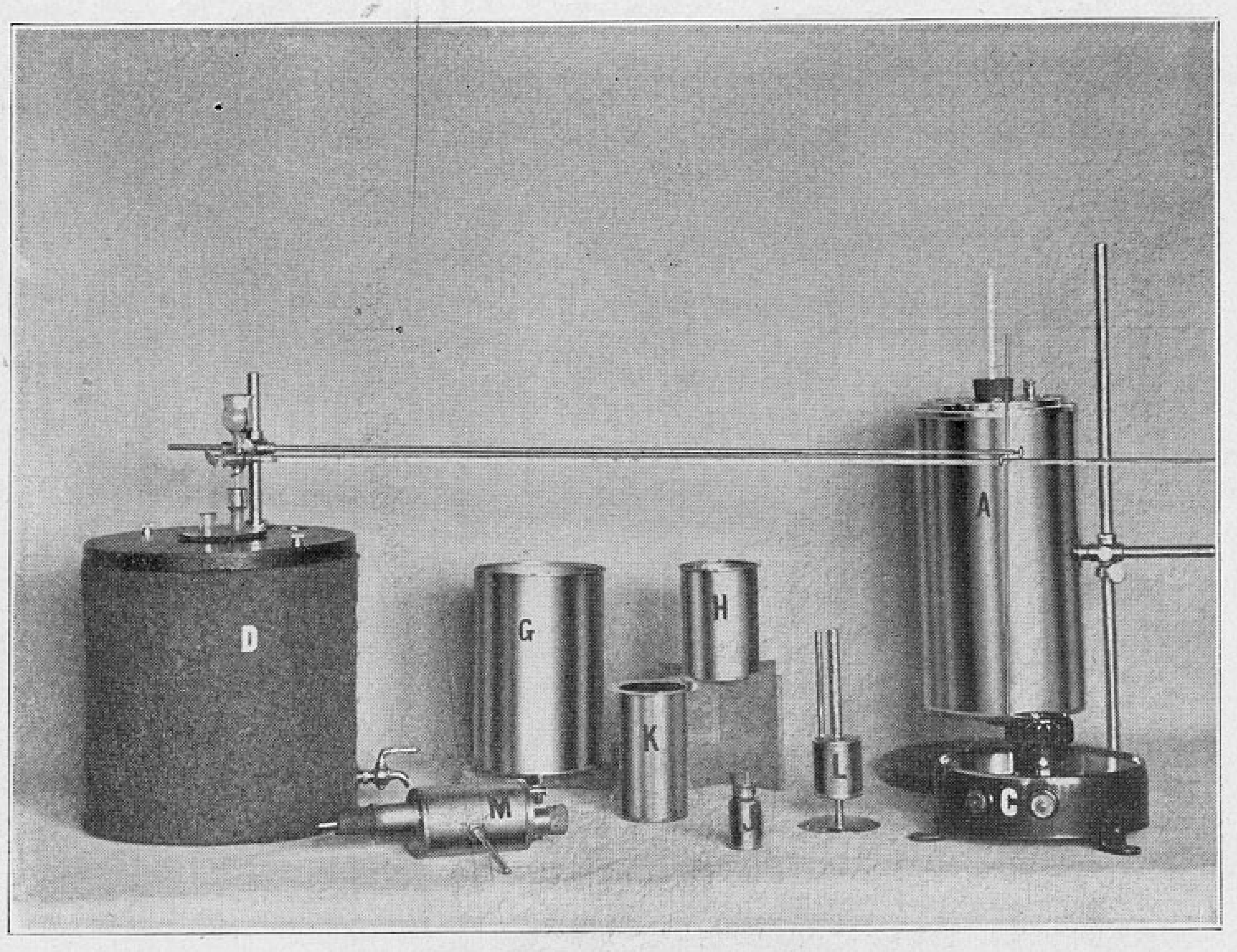


Fig. 2

The half-tone cuts, Figs. 1, 2 and 3, show the component parts of the "Scientia" Calorimetric Outfit, while the diagrams, Figs. 4 to 9, give sectional views of the apparatus in some of its combinations. The sectional diagrams are 1-10 the actual size of the apparatus; the half-tones are to a somewhat smaller scale.

All parts of the calorimetric outfit whose water-equivalents must be taken into account are made of brass or hard rolled copper, and the exposed metallic surfaces of the calorimetric vessels are nickel plated and polished in order to diminish the radiation corrections. The materials used are the best which can be obtained and the workmanship is of the highest order.

The Water-Jacket (C 1121), marked D in the half-tones and shown in section in Figs. 5 to 9, is a double walled vessel of hard rolled copper, nickel plated and polished both inside and outside and covered by a removable felt jacket half an inch (1.3 cm.) thick. The felt covering serves to protect the vessel from outside temperature changes, while the plated and polished inner surface helps to diminish the radiation correction of a calorimeter when surrounded by the jacket. The water-jacket is 10 inches (25.4 cm.) high and 10 inches in diameter over all; the inside dimensions are 9 inches (23 cm.) deep and 6¼ inches (16 cm.) in diameter, while the space between the inner and outer walls is 1⅜ inches (3.5 cm.). Screw sockets are provided on top to attach the yoke of the apparatus for mechanical equivalent of heat, and a tubulure is provided for inserting a thermometer and also for filling the water space. A stopcock at the bottom serves to drain the inner vessel when used as an air-jacketed ice bath in connection with the Bunsen calorimeter.

The Large Inner Vessel or **Calorimeter** (C 1122), marked G in Figs. 2 and 3 and shown in section in Figs. 5, 7 and 9, is made of hard rolled copper and is nickel plated and polished on the outside. It is 8 inches (20 cm.) high and 5 inches (12.5 cm.) in diameter and has a capacity of 2½ litres. With it is supplied a wooden support for holding it clear from the bottom and walls of the water-jacket.

The Large Stirrer (C 1123) is made of a flat ring of sheet copper, turned down at the outer edge for stiffness, and has a copper wire handle long enough to pass through a hole in the cover of the water-jacket as shown in Figs. 5, 7 and 9. The inner diameter of the ring is 3½ inches (6 cm.) enabling objects as large as the Calorimetric Bomb (P) to be placed in the calorimeter without interfering with the stirrer. **The Small Inner Vessel** or **Calorimeter** (C 1124), marked H in the cuts, is 4½ inches (11.5 cm.) high, 3 inches (7.5 cm.) in diameter, and has a capacity of 500 cc. Like the large inner vessel, it is made of hard copper, nickelled and polished on the outside. The wooden support supplied with it, as shown in Fig. 2, is made sufficiently high so that the upper rim of the vessel comes close to the cover of the water-jacket when it is placed inside.

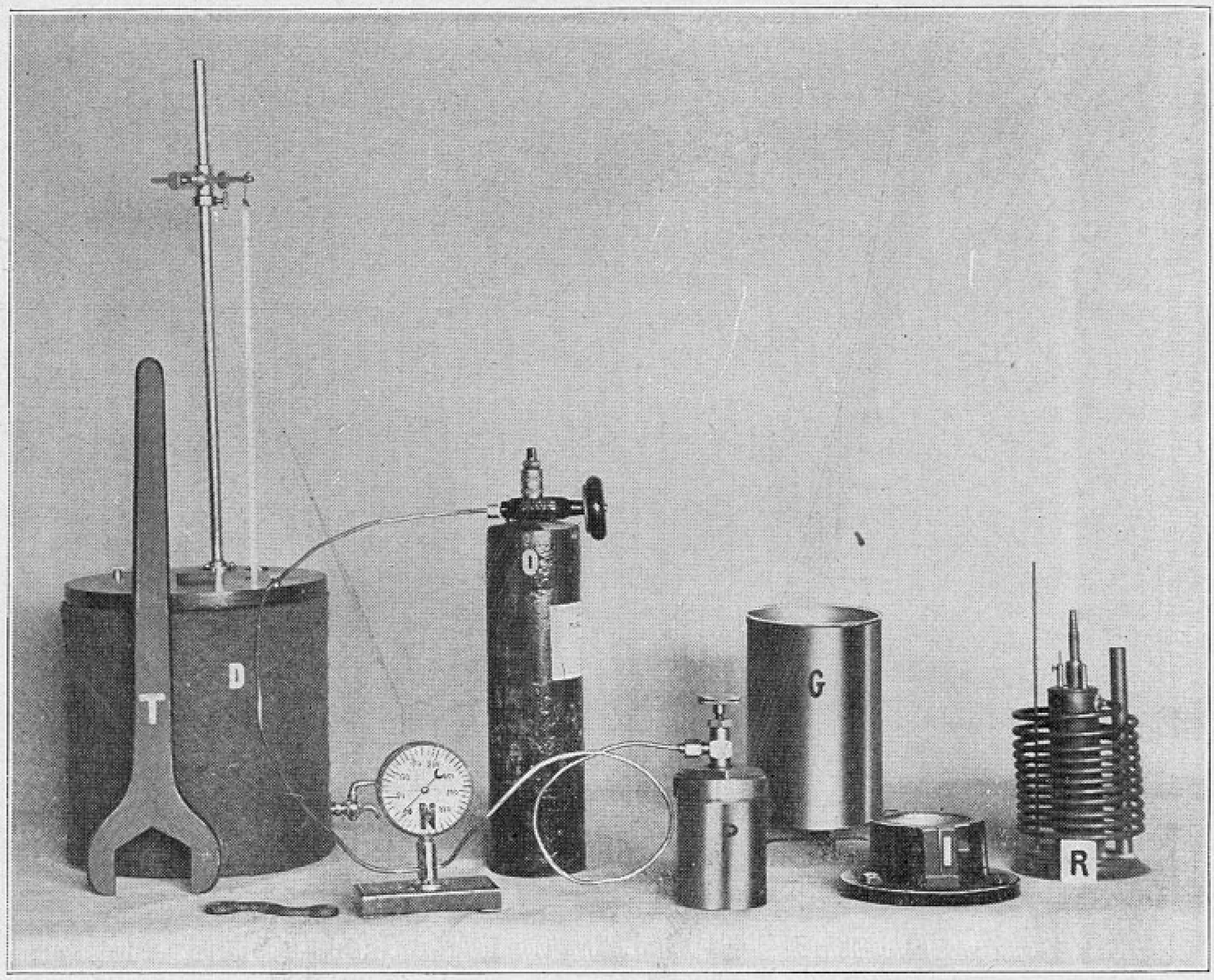


Fig. 3

The Cover (C1126) for the water-jacket, shown in section in Figs. 5, 6, 7 and 9, is made of three thicknesses of white pine, glued up so as to prevent warping, and is heavily shellaced. It is pierced by a central hole 1½ inches (3.7 cm.) in diameter, and by smaller holes for the passage of thermometers, clamping screws, stirrer handle, etc. A nickel plated screw socket attached to the upper surface serves to hold a rod. etc., for supporting a thermometer, the Bunsen calorimeter, the Electric Boiler (M), etc.

The Standard, Clamp and **Cross Rod,** (C 1127) when attached to the **Cover** as shown in Figs. 1, 2 and 3, serve to hold the various accessories mentioned above.

The Electric Heater (C 1130), marked A in Figs. 1 and 2 and shown in section at the left of Fig. 4, is 12½ inches (32 cm.) high and 6¼ inches (16 cm.) in diameter over all. It consists of a steel tube 1½ inches (3.8 cm.) in diameter and 12½ inches (32 cm.) long, open at both ends, surrounded by a wire heating coil imbedded in insulating material, the whole being enclosed inside a triple walled metallic jacket, which is thoroughly ventilated at top and bottom. The outer surface of the metallic jacket is nickel plated and polished so as to lessen radiation. On top of the jacket are two binding screws to which the lead wires are attached. The current passing through the heater is controlled by the **Rheostat** (C 1135), marked C in the cuts, and the temperature is readily kept constant by occasional manipulation of the switch. The heater and rheostat are designed to be connected in series across 110 volt mains. The consumption of power in the heater is from

80 to 175 watts. Temperature of 350°C (660° F.) can be maintained inside the heater without making the outer jacket uncomfortably warm to the touch. In using the heater, the upper and lower ends of the inner tube are closed with corks, and the object to be heated is suspended inside the tube by means of a thread passing through the upper cork. A thermometer is also passed through this cork. When the desired temperature is reached, the bottom cork is removed, and the object lowered into the calorimeter.

The parts which have been described above constitute a very complete set of apparatus for the determination of **Specific Heats by the** ordinary **Method of Mixtures.**

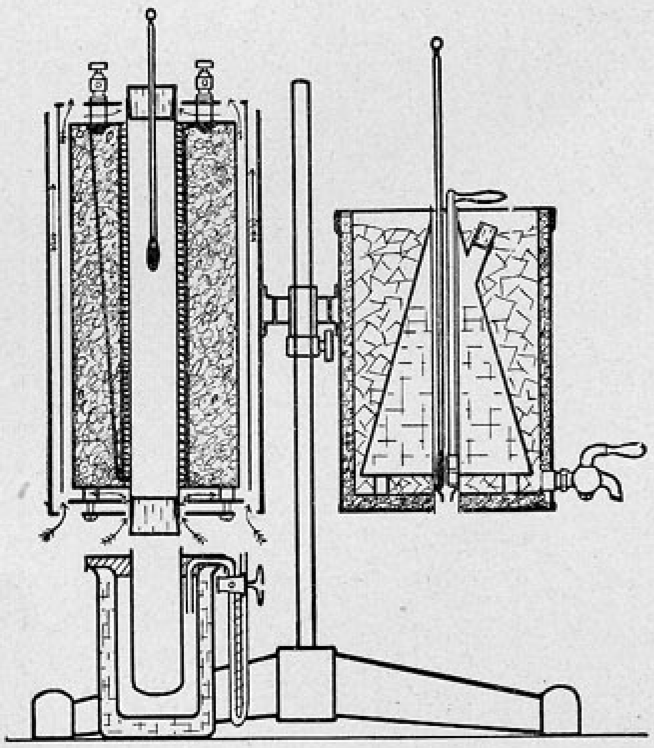


Fig. 4

The Waterman Calorimeter (C 1140), which is shown at the left of Fig. 1 and in section in Fig. 4, makes use of the **Electric Heater** (A) and **Rheostat** (C) which have already been described, and comprises in addition a supporting **Tripod, Rod and Collar** (C 1141), a **Water Cooler** (B), and an **Air Thermometer** (F). This apparatus was devised by Professor F. A. Waterman of Smith College and described in the Philosophical Magazine for November 1895 and in the Physical Review for November 1896. While intended primarily as an instrument of research for determining the specific heats of solids to the highest degree of precision, the method of use is so simple as to succeed in the hands of the unpractised student. The object whose specific heat is to be determined is warmed in the Electric Heater and then lowered into the silver cup of the Air Thermometer. The Water Cooler is then swung round, and ice-cold water is run into the cup so as to hold the temperature of the Air Thermometer at its initial value as shown by the gauge. The weight of the water added is a measure of the heat given up by the hot object. It is not difficult to keep the temperature of the cup practically constant at its initial value throughout an experiment and thus to avoid the necessity of applying radiation corrections or calculating water equivalents.

The Water Cooler (C 1143), marked B in Fig. 1 and shown in section at the right of Fig. 4, is a double-walled brass vessel, nickel plated and polished on the outside, and containing an inner conical water vessel. The outer vessel serves as a jacketed ice bath for cooling the water in the inner vessel, and is provided with a lateral stopcock for drainage. The water compartment is fitted with a specially designed stopcock for letting the water drip into the air thermometer cup, and has a vertical tube passing through it from top to bottom in which a thermometer can be placed to take the temperature of the issuing stream.

The Air Thermometer, marked F in Fig. 1, and shown in section at the lower left hand side of Fig. 4, consists of an inner silver cup, 1½ inches (3.8 cm.) in diameter and 4 inches (10 cm.) deep, fastened to a metallic cover and sealed inside a glass cup 2½ inches (6 cm.) in diameter and 4¾ inches (12 cm.) deep. The air space between the two cups forms the "bulb" of the air thermometer, and changes in temperature are indicated by the motion of the liquid in the arms of an open manometer tube communicating with the bulb. Pressures inside and outside can be equalized at any time by opening a glass stopcock attached to the manometer tube. The glass cup is protected, and the cover is supported, by an outer vessel of heavy glass.

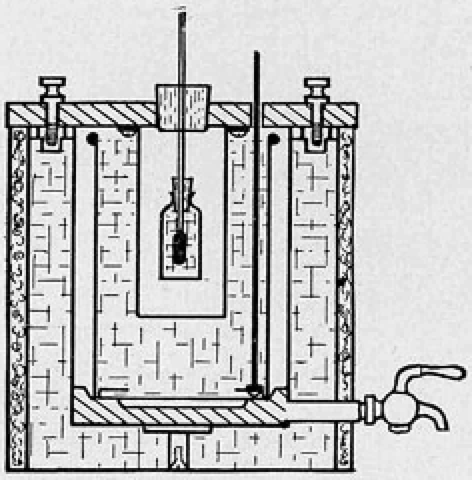


Fig. 5

The Cooling Calorimeter, shown in section in Fig. 5, is used for determining the specific heats of liquids by the method of Dulong and Petit. In addition to the Water Jacket, Cover, Large Inner Vessel, Large Stirrer, etc., this apparatus includes a special **Inner Vessel with Rim** (C 1145) and a **Nickelled Cooling Bottle** (C 1146), shown at K and J respectively in Fig. 2. The special inner vessel is 2½ inches (6.3 cm.) in diameter and 5 inches (12.6 cm.) high; it is nickel plated and polished on the outside and finished dead black inside; a bayonet catch in the rim holds the vessel firmly attached to the cover. The nickelled cooling bottle is 1 inch (2.5 cm.) in diameter, 2¼ inches (5.7 cm.) high, and has a capacity of 25 cc.; the bottle is supported in use by a thermometer passing through the cork and through a second perforated cork fitted to the central hole in the cover.

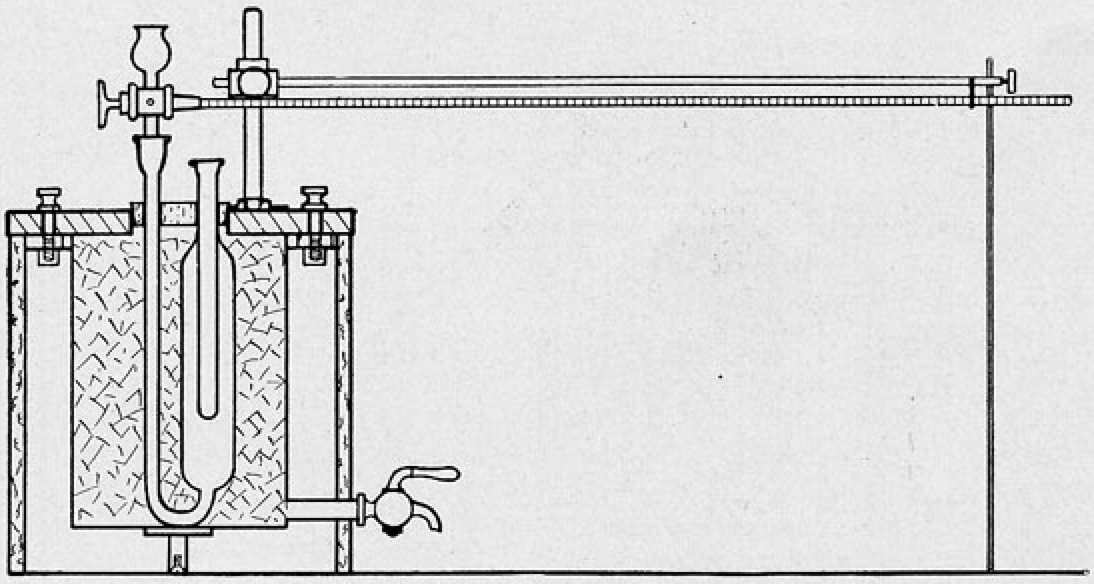


Fig. 6

The Bunsen Calorimeter, which is shown ready for use in Fig. 2 and in section in Fig. 6, utilizes the "water-jacket" as an air jacketed ice bath in connection with a special cover and stand for supporting the glass parts. **The glass parts** consist of a Bunsen Calorimeter of the usual pattern, connected by means of a special two-way stopcock to a mercury reservoir and to a horizontal capillary tube etched with a millimetre scale one metre long. The stopcock is arranged so that the end of the mercury thread is readily adjusted to the desired position in the capillary. **The Special Cover and Stand** are designed for holding the fragile glass parts in such a manner as to avoid danger of breakage when the calorimeter is in use.

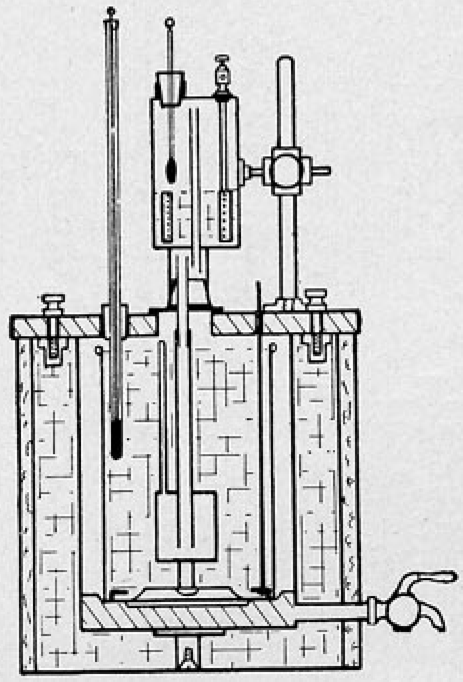


Fig. 7

The apparatus for **Heat of Vaporisation** which is shown in section in Fig. 7, comprises in addition to the Water Jacket, Large Inner Vessel, Cover, etc., an **Electric Boiler** and **Condenser,** shown at M and L respectively in Fig. 2. The **Electric Boiler** consists of a brass vessel 2½ inches (6.3 cm.) in diameter and 4 inches (10 cm.) high, nickel plated and polished on the outside, and provided with binding screws and a tubulure at the top, and a water trap at the bottom for intercepting spray which might otherwise be carried over by the steam. An electric heating coil is permanently fastened inside the boiler; this heating coil is designed to be directly connected across 110 volt mains and evaporates about 4 cc. of water per minute. **The Condenser** is of the simple form described by Schuster and Lees. It consists of a copper vessel 1¾ inches (4.5 cm.) in diameter and 2 inches (5 cm.) high, supported by a flanged base, and carrying two tubes above, one of which fits the outlet of the water trap of the electric boiler.

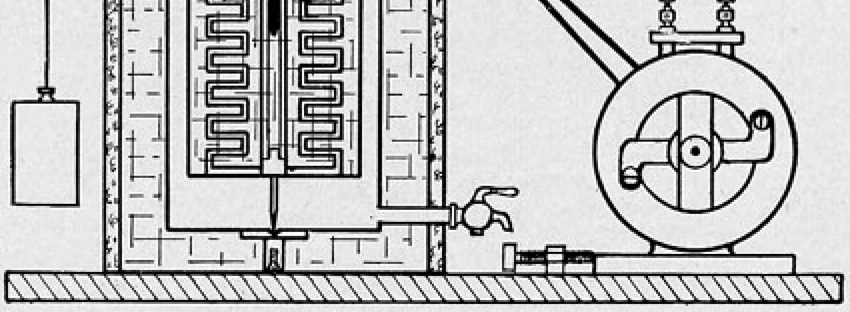


Fig. 8

The Mechanical Equivalent of Heat apparatus, shown at the right in Fig. 2 and in section in Fig. 8, is a clever simplification of the apparatus used by Rowland in his classical experiments. Aside from the Water Jacket with Cover, etc., and a **Motor** for driving the mechanism, this apparatus includes a **"Jouler",** or vessel with paddles in which water is heated by expenditure of mechanical work, a **Yoke** through which the motion is transmitted, a **Counter-Weight** which furnishes the resistance required to hold the shell of the Jouler stationary, and a **Base-Board** for holding the Water Jacket and Motor in their proper relative positions. The **Jouler** is a cylindrical brass vessel 4½ inches (11.5 cm.) in diameter and 6 inches (15.5 cm.) high, nickel plated and polished on the outside, and provided with a screw cover kept tight by means of a rubber gasket. The stirrer consists of a paddle wheel bearing 24 paddles which are inclined slightly so as to cause a flow of water past the bulb of a thermometer thrust through the cover and down into the tubular and perforated axis of the paddle wheel. A series of baffle plates arranged in five vertical rows on the inner walls of the Jouler prevents the water from taking up the rotary motion of the paddles. The paddle wheel is driven by a belt from the Motor, the number of revolutions being given by a Veeder counter on the Yoke, and the shell of the Jouler is held stationary by the resistance offered by the Counter-Weight. The speed of the paddle wheel is controlled by means of a screw which adjusts the tension of the belt, and it is easy to keep the Counter-Weight in equilibrium throughout an experiment. The hollow axis of the paddle is large enough to permit the use of a Beckmann thermometer graduated in hundreths of a degree Centigrade.

The following results, obtained by Professor G. M. Wilcox, indicate the degree of precision which may readily be attained with this apparatus:

Weight of Water Used	2000 g.
Weight of Jouler	1076.5 g.
Specific heat of Jouler	0.093
Water Equivalent of Jouler	100 Cal.
Total Water Equivalent	2100 Cal.
Radius of Pulley	5.00 cm.
Counter-Weight	712.7 g.
Value of Gravity	980.3 cm. / sec2
Time of each experiment	8 min.

Expt.	Temp. Rise	Radn.	Revs.	Work.	Heat.	J
1	1.130°	-0.058°	4297	9.428 X 10^7	2251 cal	4.188 X 10^7
2	1.020°	-0.024°	4000	8.778 X 10^7	2097.6 cal	4.185 X 10^7
3	0.995°	-0.008°	3990	8.757 X 10^7	2073.0 cal	4.224 X 10^7

Mean value of J=4.199 X 10^7

A similar set of three runs made by a student without experience in work of this sort gave the following results:

Expt.	J
1	4.202 X 10^7
2	4.137 X 10^7
3	4.162 X 10^7
Mean	4.167 X 10^7

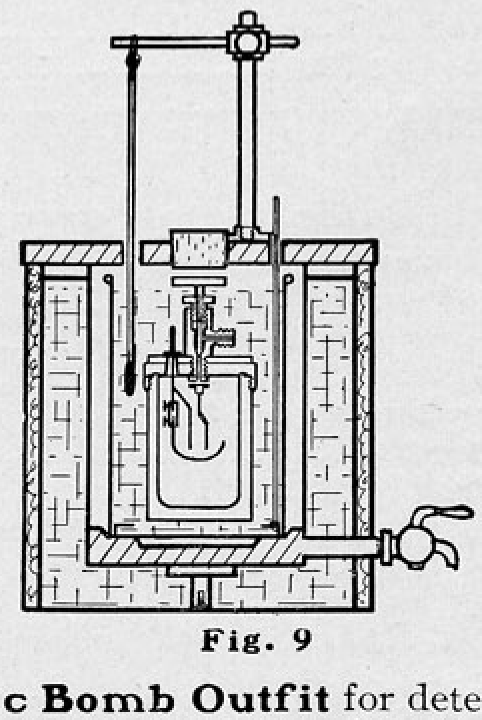


Fig. 9

The Calorimetric Bomb Outfit for determining the heat of combustion of fuels, etc., includes everything shown in Fig. 3 with the exception of the Gas Calorimeter R. The arrangement of apparatus during a combustion is shown in section in Fig. 9. **The Steel Bomb** (P) is 3 inches (7.6 cm.) in diameter and 4 inches (10 cm.) high, with walls ⅜ inch (0.9 cm.) thick. It is heavily coated inside with porcelain enamel, and is furnished with a screw cover kept tight by means of a soft metal gasket. The cover is provided with stopcock and connections for the **Gauge** and **Oxygen Gas Tank**, with platinum electrodes for firing the charge, and with a support for the platinum crucible in which the combustible is burned. The apparatus, which is used according to the method devised by Berthelot and developed by Mahler, is easily handled, quick in action, and gives results both relatively and absolutely more precise than can be obtained with the commercial types of fuel calorimeters.

The Gas Calorimeter is a modification of the Junker type and is adapted to the determination of the heats of combustion of both gaseous and liquid fuels.

Price List

The prices given below are net, f. o. b. cars at Chicago.
No charge is made for boxing or cartage.

C 1120 Scientia Water-Jacketed calorimeter, complete.... **$19.50**

This comprises the following parts:

C 1121	**Water Jacket** with felt cover (D)	$14.00
C 1122	**Large Inner Vessel** and support (G)	1.50
C 1123	**Large Stirrer**	.50
C 1124	**Small Inner Vessel** and support (H)	.75
C 1125	**Small Stirrer**	.25
C 1126	**Cover and Socket**	1.50
C 1127	**Standard, Clamp,** and **Cross Rod**	1.00
		$19.50

C 1130 Scientia Electric Heater (A) **$30.00**

C 1131 Rheostat for Electric Heater (C) **5.00**

C 1135 Scientia Apparatus for Specific Heat by Method of Mixtures, complete **$54.50**

This apparatus comprises:

C 1121	**Water Jacketed Calorimeter,** complete (D)	$19.50
C 1130	**Electric Heater** (A)	30.00
C 1131	**Rheostat** (C)	5.00
		$54.50

C 1140 Scientia Waterman Calorimeter, complete **$75.00**

This apparatus comprises:

C 1141	**Tripod, Rod, Collar,** etc.	$ 2.00
C 1142	**Air Thermometer** (F)	18.00
C 1143	**Water Cooler** (B)	20.00
C 1130	**Electric Heater** (A)	30.00
C 1131	**Rheostat** (C),	5.00
		$75.00

C 1145 Scientia Cooling Calorimeter, complete **$21.00**

This apparatus comprises:

C 1146	**Inner Vessel with Rim** (K)	$ 1.50
C 1147	**Nickelled Cooling Bottle** (J)	1.00
C 1121	**Water Jacket** and felt cover (D)	14.00
C 1122	**Large Inner Vessel** and support (G)	1.50
C 1123	**Large Stirrer**	.50
C 1126	**Cover and Socket**	1.50
C 1127	**Standard, Clamp, and Cross Rod**	1.00
		$21.00

C 1150 Scientia Bunsen Calorimeter, complete **$22.00**

This apparatus comprises:

C 1151	**Glass Parts** (Fig. 2)	$ 5.50
C 1152	**Special Cover and Stand** (Fig. 2)	2.50
C 1121	**Water Jacket** with felt cover (D)	14.00
		$22.00

Note:—In using the Bunsen Calorimeter the "Water Jacket" is emptied and used as an air jacket.

C 1155 Scientia Apparatus for Heat of Vaporisation, complete **$33.50**

This apparatus comprises:

C 1156	**Electric Boiler** (M)	$10.00
C 1157	**Condenser** (L)	5.00
C 1121	**Water Jacket** with felt cover (D)	14.00
C 1122	**Large Inner Vessel** and support (G)	1,50
C 1123	**Large Stirrer**	.50
C 1126	**Cover and Socket**	1.50
C 1127	**Standard, Clamp, and Cross Rod**	1.00
		$33.50

C 1160 Scientia Apparatus for Mechanical Equivalent of Heat, complete with 110 volt direct current motor (Fig. 1) **$80.00**

C 1161 Same, with 110 volt, 60 cycle, single phase motor **89.00**

This apparatus comprises:

C 1162	**Jouler** (E), **Yoke, Counter-weight, Baseboard, and Belt**	$50.00	$50.00
C 1121	**Water Jacket** with felt cover (D)	14.00	14.00
C 1126	**Cover and Socket**	1.50	1.50
C 1127	**Standard, Clamp, and Cross Rod**	1.00	1.00
C 1163	**Direct Current Motor,** 110 volts	13.50	
C 1164	**Single Phase Motor,** 110 volts, 60 cycles		22.50
		$80.00	$89.00

C 1165 Scientia Calorimetric Bomb Outfit, complete **$136.50**

This apparatus comprises:

C 1166	**Steel Bomb** (P), **enameled inside, Holder** (I), **Platinum Crucible, Gauge** (N), **Wrenches** (T), **Connections, etc.**	$110.00
C 1167	**Steel Tank with 40 gallons of Pure Compressed Oxygen** (O)	8.00
	Refilling tank $2.00	
C 1121	**Water Jacket** with felt cover (D)	14.00
C 1122	**Large Inner Vessel** and support (G)	1.50
C 1123	**Large Stirrer**	.50
C 1126	**Cover and Socket**	1.50
C 1127	**Standard, Clamp, and Cross Rod**	1.00
		$136.50

Note:—It is recommended that at least two oxygen tanks be purchased. The filling of the bomb may then be partly effected by means of a nearly exhausted tank, and completed by means of a freshly charged tank

C 1170 Scientia Gas Calorimeter, complete ....

This apparatus comprises:

C 1171	**Combustion Chamber, Worm, Stirrer, etc.,** (R)	$30.00
C 1172	**Gas Meter**	
C 1121	**Water Jacket** with felt cover (D)	14.00
C 1122	**Large Inner Vessel** and support (G)	1.50
C 1126	**Cover and Socket**	1.50
C 1127	**Standard, Clamp, and Cross Rod**	1.00
C 1167	**Steel Tank with 40 gallons of Pure Compressed Oxygen** (O)	8.00

Refilling Tank $2.00

Thermometers for Calorimetric Work

The following thermometers are made of Jena Normal Glass and are of a higher grade than those usually sold for similar purposes.

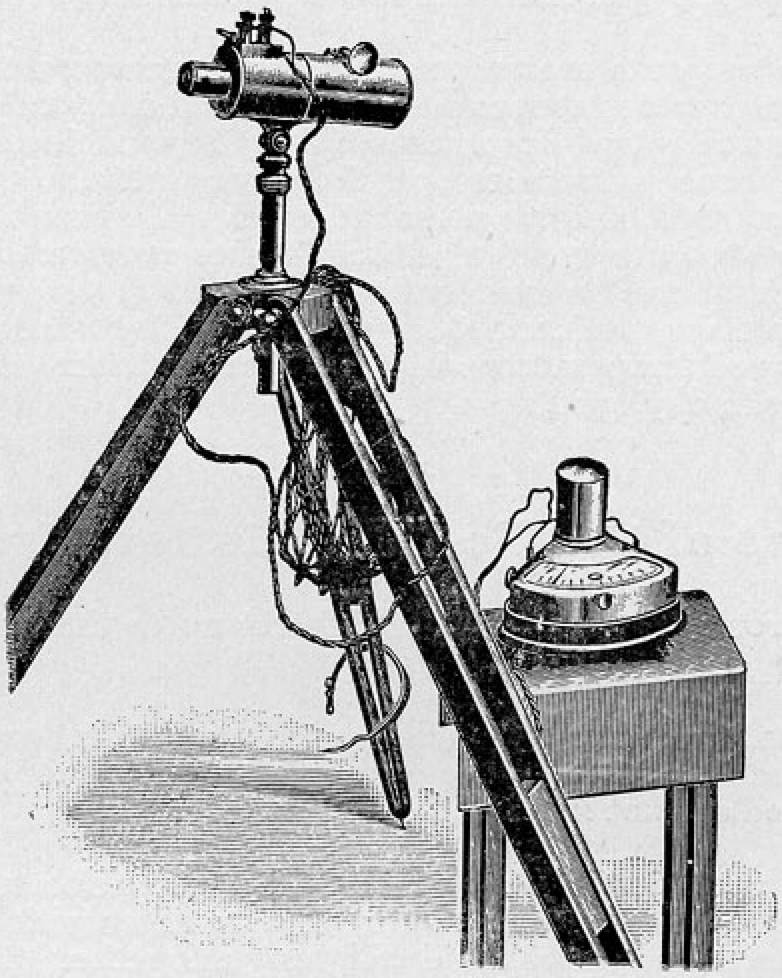
For precise measurement of the small changes of temperature in calorimeters, thermometers of the type devised by Beckmann are recommended. The several thermometers of this type give differential readings over ranges of about 5°, 10° or 25° in any desired part of the scale between the freezing and boiling points, and are graduated in 1-100, 1-50, or 1-20 of a degree. A special thermometer covering a range of but one degree and graduated in 1-500° is also supplied for use at temperatures between the freezing point and ordinary room temperatures. To "set" one of these Beckman thermometers, the bulb is warmed to a point slightly above the upper limit of temperature range through which it is intended to work, thus causing the mercury to expand into the enlargement at the top of the tube; a sharp rap of the bulb on the palm of the hand separates the mercury thread, and the thermometer is then ready for use. In an improved pattern there is an auxiliary scale at the top of the tube which makes it easier to set the thermometer to the range desired, and enables one to adjust it for use near the freezing point without the necessity of cooling the bulb in ice. Although these thermometers may be used at any temperatures between the freezing and boiling points of water, it is well in ordering to state at about what temperatures the thermometers will customarily be used so that they may be tested within that range.

The following Beckmann thermometers are made by Goetze, the original and best maker.

C 1190	**Beckmann Thermometer,** covering a range of 5° or 6° and graduated to 1-100°, with scale fastened by means of glass wool	**$11.00**
C 1191	**Beckmann Thermometer,** covering a range of 5° or 6° and graduated to 1-110°, with scale sealed in by fusion to the glass	**13.75**
C 1192	**Same,** with range of 10° or 12° in 1-50°	**13.75**
C 1193	**Same,** with range of 25° or 30° in 1-20°	**12.50**
C 1194	**Same,** with range of about 1° in 1-500°, suitable only for temperatures lying between room temperature and the freezing point	**21.00**
C 1195	**Beckmann Thermometer,** with scale fastened by fusion to the glass, and **auxiliary scale** to facilitate setting. Range about 5° or 6°, graduated to 1-100°	**15.00**
C 1196	**Same,** with range of 10° or 12° in 1-50°	**15.00**
C 1197	**Same,** with range of 25° or 30° in 1-20°	**13.75**
C 843	**Thermometer,** Jena Glass, scale from —5° to +110°C. in 1° etched on stem	**.60**
C 844	**Same,** —5° +150°C. in 1°	**.65**
C 845	**Same,** —5° +200°C. in 1°	**.70**
C 846	**Same,** —5° +360°C. in 1°	**.75**
C 848	**Same,** —5° +100°C. in 1-10°	**2.00**
C 849	**Same,** —5° +50°C. in 1-10°	**1.50**

The Fery Radiation Pyrometer.

Standardized by the Conservatoire National des Arts et Métiers, Paris



C 1200

In all pyrometers other than radiation pyrometers there is some part which is made to acquire the temperature to be measured. Experience has shown the value of such instruments and the economies effected by their use; at the same time the practical difficulties encountered have shown the need for a convenient and reliable form of radiation pyrometer. It is difficult to construct anything of solid material which can be maintained for long periods at high temperatures without permanent or sub-permanent changes in its properties, and at higher temperatures the difficulties increase in a quite disproportionate degree. A further trouble is found in the chemical activities of furnace products and furnace gases, which attack the resistance wire or thermo-couple.

With the radiation pyrometers invented by M. Féry, Professor of Physics at the École de Physique et de Chimie, Paris, these difficulties are not encountered, the instruments being placed at some distance from the furnace, while no part of them is raised above the air temperature by more than 80 Centigrade degrees. The radiation which emanates from a hot body, or which passes out through an observation hole in the wall of a furnace, falls upon a concave mirror and is thus brought to a focus. In this focus is a thermo-electric couple, whose temperature is raised by the radiation falling upon it; the hotter the furnace, the greater the rise of temperature of the couple. The arrangement of the instruments is such that they are uninfluenced, within wide limits, by the size of the hot body or observation hole on the one hand, or on the other hand by the distance which separates them from the hot body or furnace.

The complete outfit consists of telescope and galvanometer; fixed within the telescope, at a point upon its optic axis, is the junction of a copper-constantan thermo-couple arranged in the form of a cross. The terminals are connected by leads to the galvanometer. To use this apparatus for measuring the temperature of a furnace, an observation hole in the wall of the furnace is sighted through the eyepiece, the image of this hole being brought into coincidence with the thermo-junction. The junction rapidly acquires the temperature of the image, and the electro-motive force which is thus generated is measured by a galvanometer whose scale is divided so as to read temperatures directly.

An adjustable diaphragm is fitted in front of the telescope in order that the amount of radiation falling on the thermo-couple may be varied. When measuring high temperatures the diaphragm is partially closed and the temperatures are read directly on the second scale of the galvanometer. The two temperature scales ordinarily divided on the galvanometer are approximately 700° to 1300° C. and 1000° to 2000° C.

M. Féry's instruments are unique in showing temperatures directly by the indications of a pointer which moves over a graduated dial, following variations of temperature automatically and instantaneously. Beyond levelling the galvanometer, sighting and focusing the telescope, the observer has no adjustment to make, no special skill is required, and no personal errors arise from differences in color vision. Nor is any absolute standard of luminosity required as an auxiliary apparatus. It is also important to notice that the readings given by the Féry pyrometers are not appreciably influenced by extraneous light falling upon the body examined; the observed temperature will be the same whether the body in question is in a dark room or in daylight.

Advantages of the Fery Radiation Pyrometers.

Range. From 500° C (below a red heat) up to the highest temperatures known.

Accuracy and Permanence. The maximum temperature to which the couple is exposed being approximately the boiling point of water, the values of the readings obtained are not liable to change.

Completeness and Portability. No electric battery and no standard of luminosity are required, the simple outfit of pyrometer with direct reading galvanometer being complete in itself, and weighing altogether 13 lbs.

Automatic Indication. Once the apparatus is set up, sighted and focused, no further adjustment is required; the varying temperature of the body observed being automatically shown by the index upon the dial.

Rapidity. The direct reading galvanometer is dead-beat, and the indications of temperatures are practically instantaneous.

Direct Reading. The scale of the dial is divided to give direct readings of temperature on the Centigrade scale.

Simplicity. Any intelligent workman, without previous training can read temperatures from the dial.

Freedom from Personal Error. The readings are in no way dependent upon the color-perception or other individual peculiarity of the observer.

Independence of Lighting. These instruments are not perceptibly affected by extraneous light falling upon the body observed.

Flexibility. A hot or molten mass can readily be followed about as it is moved, and its temperature ascertained from moment to moment.

Complete Outfit.

(Temperature range 700° to 1300°C. and 1000° to 2000°C., unless otherwise ordered.)

		Duty free	Duty paid
C 1200	**Pyrometer and Galvanometer,** with certificate of the Conservatoire National des Arts et Metiers, Paris, leads 33 feet long, in case complete, and tripod stand for pyrometer................	**$161.00**	**$230.00**