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Contributors

Schall, K.

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ELECTRO-MEDICAL INSTRUMENTS

BY

K. SCHALL

55 WIGMORE ST. LONDON, W.

M
21810

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Electro-Medical Instruments And their Management,

AND

ILLUSTRATED PRICE LIST OF ELECTRO-MEDICAL APPARATUS,

BY

K. SCHALL,

55, Wigmore Street, London, W.

Telegraphic Address: "SCHALL, LONDON."

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K. SCHALL,

55, WIGMORE STREET, LONDON, W.

LIST OF

SECOND-HAND BATTERIES FOR SALE.

THE NUMBERS REFER TO OUR CATALOGUE.

	No.		Original Price. £	s.	d.	Sale Price. £	s.	d.
1	86	24-cell acid battery, in very good condition	7	0	0	3	10	0
1	115	40-cell Leclanche battery, case soiled, cells new	5	0	0	3	14	0
1	117	24-cell Leclanche battery, nearly new	5	10	0	4	0	0
1	118	32-cell Leclanche battery, nearly new	6	12	0	5	0	0
1	139	50-cell combined Leclanche battery, as good as new ...	20	0	0	15	0	0
1	1040	in very good condition, case a little soiled	5	10	0	4	0	0
1	1042	in good condition	7	15	0	4	15	0
1	1100	universal Schechs handle, as good as new	1	7	0	1	1	0
1	1330	anterior and 1 posterior cystoscope with telescope and case, with water irrigation for washing out the bladder, as good as new	10	6	0	4	0	0
1	1052	Rheostat, for cautery and light for 100-volt current, as good as new	9	9	0	7	0	0
1	1503	5-inch spark coil for taking Röntgen photographs, perfect working order guaranteed, as good as new	14	0	0	9	0	0

1896

PREFACE.

THE following pages explain as simply as possible the physical laws which are of importance in using Electricity for Medical and Surgical purposes. They describe the necessary apparatus and their construction; they give a few practical hints about the apparatus best suited under special circumstances; they show how faults may be avoided, or, at any rate, how they may be detected and rectified.

Should the reader who lacks time to study larger works on Electricity find the following pages a help in making his electrical instruments familiar to him, thus facilitating their management, this little pamphlet will not have been written in vain.

K. SCHALL.

TERMS.

In ordering, please mention the list number of the apparatus to avoid mistakes. *Detailed printed directions for use are sent with each instrument.* The instruments, which are made of the best materials only, are guaranteed for proper working.

As references, we have given the names of many well-known members of the medical profession and hospitals using the more elaborate of our apparatus.

The prices mentioned in this Catalogue are subject to 5 % discount for cash with order, or on delivery; the prices are net afterwards, and 5 % per annum interest is charged on all accounts not settled within 6 months after delivery.

Packing is most carefully carried out, and charged at cost price, but empty boxes cannot be allowed for; the delivery is at cost and risk of consignee. All the frequently used apparatus are kept in stock, others can be supplied within a reasonable time.

New electric apparatus are made from drawings or descriptions at reasonable prices. The woodcuts are made from photographs taken from the instruments, but as electrical apparatus are subject to frequent alterations, we cannot guarantee every detail to remain as the illustrations show them now. Additional lists of newly constructed apparatus are issued from time to time.

Electro-medical apparatus of every description are promptly repaired. Batteries are kept in order, and looked after at regular intervals by agreement.

Second-hand batteries can occasionally be obtained at considerably reduced prices; special lists about them are published from time to time and can be had on application.

Hospitals and other charitable institutions can obtain special prices on application.

Terms for the hire of batteries will be found on next page.

TERMS FOR LENDING OUT BATTERIES.

Freshly charged batteries for Galvanisation, Electrolysis and Faradisation are lent out to medical men and patients for one month or longer. The terms depend on the value of the battery, number of cells and accessories, and vary between 10/6 and 45/ per month. If there is any freight, the consignee has to pay it both ways.

If a customer decides to keep a battery after having hired it, the money paid for hire will be deducted from the price of the battery.

Patients and Nurses are requested to pay half the value of the battery as a deposit. This money, less the hire, will be repaid when the battery is returned.

Batteries and Instruments for Electric Light and Galvanic Cautery, are lent out to medical men at the rate of 10/6 per week, or less ; £1 5s. for a month. For destroyed lamps and platinum burners there will be an extra charge.

Skilled assistants can be sent to manage batteries during operations. £1 1s. is charged for the first two hours, or less, including the loan of the necessary battery and instruments, and 3/6 for any following hour or part of an hour. If railway has to be used, second class return tickets are charged in addition.

Instruments for taking Roentgen's photographs are lent out with all the required accessories. The prices depend on the size and number of plates required, and the length of time for which they are wanted, and vary from £1 1s. to £5 5s. Damaged tubes and coils will be charged for. Skilled assistants can be sent to take these photographs. Terms on application.

CONTENTS OF "ELECTRO-MEDICAL INSTRUMENTS AND THEIR MANAGEMENT."

CONTENTS OF THE ILLUSTRATED PRICE LIST.

ELECTRO-MEDICAL INSTRUMENTS AND THEIR MANAGEMENT.

WE cannot yet clearly define what electricity really is, but we have good reason to suppose that it is the result of some kind of motion, like heat, light, etc., to which it is closely related, and into which it can be easily converted. We possess, however, many means and ways of producing it, such as friction, chemical action, induction, mechanical power, etc. All these methods are used in applying electricity for medical purposes, but before explaining them one by one, it will be necessary to define a few general expressions.

Positive and Negative.—If we rub a glass bar, or a stick of sealing-wax, with a dry cloth or fur, and apply the knuckle to the rubbed place, a small spark appears. The friction has electrified the sticks, and the consequence thereof is that they attract light things, such as pieces of paper, electrify these as well, and repel them immediately after having touched them. A glass bar repels a piece of paper after having electrified it, but a stick of sealing-wax, after having been rubbed, attracts the same paper very strongly. This shows that the electricity in the glass bar is not the same as the electricity in the stick of wax ; that is to say, there are two kinds of electricity. It is the custom to call the kind of electricity produced through rubbing a glass bar *positive* electricity, and the electricity produced by rubbing a stick of wax or india-rubber, *negative* electricity. The above experiment shows that two bodies charged with the same kind of electricity repel each other, and that bodies charged with different kinds of electricity attract each other.

Normal Condition.—It is a mistake to imagine that the friction has charmed some new strange power into the sticks. It will be more correct to suppose, that in their normal (that is to say unrubbed) condition, the sticks contained negative and positive electricity in equal quantities, and as long as this was the case we could not discern the presence of the power at all. The friction, however, disturbed the normal condition by separating the two kinds of electricity contained in those bodies, and under these conditions only can we detect the presence of electricity.

Conductors and Insulators.—The separated kinds of electricity can be united by means of a conductor. After rubbing a glass bar, or a stick of wax, we find that it has become electrified in the rubbed places only, and remains non-electric where it was not rubbed. Obviously therefore electricity cannot spread equally over glass or wax, but remains localised. Substances which do not conduct electricity, such as glass, silk, ivory, oil, pure water, air, paraffin, etc., are called non-conductors or insulators. Other substances, which allow electricity to pass freely, such as all metals, carbon, some minerals, etc., are called conductors. Between conductors and non-conductors there is, however, a third class of materials, which do not conduct electricity nearly as well, as, for instance, metals do, but which still conduct it decidedly to a certain extent; such as acids, salt and alkali solutions, etc. Such fluids are called half-conductors. Now to this class belongs the human body.

It is of the greatest importance and convenience that there are bodies which conduct, and others which do not conduct electricity, for we are thus enabled to direct the electricity exactly to the spot where we desire its action, and to send it along metal wires which are supported by insulators, over any distance we like.

By rubbing a glass stick, we have separated the positive and the negative electricity contained in the stick: the positive electricity remained in the glass bar; the negative passed through the rubbing cloth and the body of the rubbing person into the earth. In rubbing a metal stick we separate the two kinds of electricity in the same way; but we can prove this only by insulating one end of the metal stick, for instance, by cementing it into a glass tube, and holding the glass tube in our hand while rubbing the metal. If we were to touch the non insulated metal stick, the separated negative and positive electricity would get re-united again immediately through the body of the rubbing person, and would leave no trace at all.

For a long time friction was the only means known to electrify bodies; but just a hundred years ago, Volta and Galvani discovered another and far more convenient method to produce electricity, *i.e.*, the simple contact of two different metals, and chemical action. They thereby gave the first impulse to the wonderful development of electricity which we have witnessed in our day. The electricity produced in this way has been called galvanic electricity, in honour of one of its discoverers.

GALVANIC ELECTRICITY.

Electro-motive Force.—If we immerse a piece of metal in some fluid which has the power of acting chemically on the metal, the two kinds of electricity are separated too. The power which disturbs the normal condition, and separates the positive from the negative electricity, is called *electro-motive force.* The E.M.F. is in some proportion to the intensity of the chemical action, but is *independent of the size or shape of the metal.*

It we immerse zinc in diluted sulphuric acid, the zinc becomes negatively, the sulphuric acid a little positively electric. Copper immersed in sulphuric acid becomes negatively electric, but not so strongly as zinc. Platinum immersed in sulphuric acid gets positively electric, and the acid becomes negative. This shows that different metals react differently with one and the same liquid, and they can be classified in such an order that, in contact with a liquid, always the preceding metal gets negative compared with those that follow. This order changes slightly with various liquids, but not very much. In diluted sulphuric acid, for instance, the most important metals follow one another as follows: Zinc, iron, lead, nickel, bismuth, copper, silver, platinum, carbon.

By immersing at the same time two different metals, the one of which gets negatively, and the other positively electric, in the exciting liquid, we increase the tension, for in this case we have two E.M.F.'s. instead of one. On the exciting liquid much depends too; zinc and carbon, for instance, have twice as high an E.M.F. if dipped in chromic acid than when dipped in sulphuric acid only. Such an arrangement, *i.e.*, two metals, or a carbon and a metal in an exciting fluid, is called a galvanic element or cell. Some special kinds of cells will be mentioned later on. The following list shows the different metals and exciting liquids of which the cells mostly used in medical electricity are composed, as well as their respective E.M.F.'s.

If the E.M.F. of a Daniell cell, *i.e.*, zinc in diluted sulphuric acid, and copper in saturated solution of sulphate of copper, is equal to 1, the following combinations would be equal to:—

Chloride of silver, diluted chloride of ammonium, or chloride of zinc solution, zinc (De la Rue's cell) . . .	1·0
Manganese and carbon, saturated chloride of ammonium solution, zinc (Leclanché cell)	1·48
Carbon, bichromate of potassium, diluted sulphuric acid, zinc (Grenet cell)	2·0
The same element with bisulphate of mercury instead of bichromate	2·0

Arrangement of Cells.—The above list shows that no single cell possesses an E.M.F. higher than two units, if we take that of the Daniell cell as one unit. For reasons, however, which we shall explain later on, a much larger E.M.F. is often needed, and in order to obtain it we have to connect several cells, so that the zinc of the first cell is connected with the carbon of the second, the zinc of the second with the carbon of the third, etc. In this way we add the E.M.F's. of the single cells together, and if, for instance, forty Leclanché cells are connected like this, the E.M.F. at the two end poles (*i.e.*, the first carbon and the fortieth zinc), will be forty times as high as that of a single Leclanché cell. To connect the cells in this manner is called connection "in series;" it is the most frequently used method of connecting cells. There are, however, other ways of connecting elements, but as these are of importance for cautery only, we shall explain them under cautery.

Current.—As soon as the two metals are connected by a conductor or half-conductor, the two separated kinds of electricity are able to reunite again. While discharging, the electricity accumulated at the poles gets less, but it is replaced immediately by the E.M.F., so that the discharge goes on as long as the electrifying cause (in this case the chemical action) exists, or till the circuit gets broken. There exists, then, in the circuit a *continuous current*, which is generally supposed to start from the positive pole, and to pass through the conductor to the negative pole, and inside the cell from the negative metal through the exciting liquid to the positive metal, thereby forming a complete circuit.

The larger a cell and its store of chemicals is, the longer will it be able therefore to maintain a current, and the constancy of an element, *i.e.*, the length of time for which an even strength of current can be got out of it, is in direct proportion to its size.

If we call the metal *positive* from which the current starts into the conductor, the copper, for instance, is *positive* as far as it projects above the liquid, but is *negative* as far as it is covered by the liquid, and *vice versa* with the zinc.

Resistance.—The free passage of the current depends on the nature of the conductor through which the current has to pass. We have already mentioned that the conducting capacity of various bodies varies widely. Metals are the best conductors, but even they differ much. For instance, one yard of copper wire allows ten times as much electricity to pass as one yard of German silver wire under otherwise equal conditions. It would be more correct to say that German silver has ten times the resistance of copper. The following table shows the resistance of some materials; wires of one metre length and one millimetre sectional area have the following resistances:—

Copper	0·056	Units
Iron	0·24	„
Platinum	0·35	„
German silver	0·47	„
Carbon, as used for incandescent lamps	76·0	„
Salt water	950000·0	„
Diluted sulphuric acid, 1 to 11	2800000·0	„
Distilled water	4200000000·0	„

The resistance of a body depends on its length and diameter. The resistance increases with the length, ten yards of wire having twice as much resistance as five yards of the same wire. If, however, the diameter of the conductor increases, the resistance decreases accordingly. The resistance of the human body, for instance, is ten times less if we apply electrodes ten inches square than if we apply electrodes one inch square only.

Up to now we have only mentioned the external resistance, that is, the resistance which the current has to overcome outside the element. The current meets, however, some resistance inside the cell, and this is called internal resistance. The internal resistance depends on the conducting capacity of the exciting liquid, and, moreover, if the size of the metal plates gets increased, the resistance gets diminished accordingly, and *vice versa.* If the external resistance is great, 500 or more ohms, the internal resistance of the battery can be practically neglected ; if the external resistance is, however, as small as, for instance, in a cautery burner, the internal resistance is of great importance. Some examples will follow later on.

Polarisation.—There is another obstacle to the rapid discharge of electricity. The electric current decomposes the fluids through which it is passing ; for instance, it decomposes water into hydrogen and oxygen. As soon as the metals of a cell are connected by a conductor, or to express it shorter, as soon as the current is closed, bubbles of oxygen gas appear on the negative, and bubbles of hydrogen gas on the positive metal.

The quantity of the produced gas is exactly in proportion to the strength of current. In a cell consisting, for instance, of zinc, salammoniac and silver, the silver gets covered with gas bubbles very shortly after the circuit is closed, and then the cell consists only of zinc and hydrogen, which has a very much lower E.M.F. than zinc and silver. The strength of current decreases very considerably in consequence of this formation of gas, and therefore the first consideration in constructing a cell is to prevent this action, which is called *polarisation.*

Depolarisation.—It can be achieved in different ways: either by shaking the metals or blowing air into the fluid, in order to get rid of the bubbles mechanically by simply shaking them off, or by chemical action. The positive metal is then surrounded with materials containing plenty of oxygen, which unites eagerly with the hydrogen and becomes water, annihilating thus the gas bubbles. For this reason the Bunsen or Grove cell contains nitric acid, the Grenet cell chromic acid, the Leclanché cell manganese di-oxide, and the chloride of silver cell chlorine.

The *depolarisation*, as we call this process, works perfectly in the chloride of silver or Daniell cell. Such cells are therefore called constant elements, compared with a chromic acid cell, for instance, in which the depolarisation is slower and less perfect, and which is called inconstant, because its strength of current decreases after a short time. A Leclanché cell is constant if it is worked for short intervals only or with weak currents, but it is inconstant if it has to yield a current too strong in proportion to its size, or if it remains closed for many hours without rest. In order to get a current of even strength out of an inconstant element, the size of the cell should be made rather large in proportion to the current it has to supply, in order to have always a spare surface which is not yet covered with gas.

Units—It became necessary soon to introduce units, in order to be able to express in figures the amount of E.M.F., or the strength of current and the amount of resistance, etc. These measures were at first arbitrary and varied in different countries; an International Congress of Electricians, however, decided this matter in Paris in 1881. It was agreed there to derive the electrical units from the generally recognised measures for length, weight and time (centimetre, gramme and second) in order to be able to compare the effects produced by electricity with those produced by other physical forces, such as magnetism, heat, light, etc., and moreover, they agreed to name the different units for E.M.F., strength of current, resistance, capacity, etc., after the physicists, who have, by their great discoveries, materially developed the knowledge and usefulness of electricity, such as Volta, Ampère, Ohm, Faraday, etc.

The E.M.F. of a Daniell cell was accepted as unit for E.M.F., or tension or potential, and called 1 volt.

The unit of resistance is 1 ohm. It equals the resistance of a mercuric column of 1 square millimetre sectional area, and 1·06 metre length at a temperature of 32° F.

The unit of strength of current is called 1 ampère. It is the current which an E.M.F. of 1 volt produces in a circuit, the resistance of which is 1 ohm. A current of 1 ampère deposits 4·08 grammes silver per hour, or develops 171·9 cubic millimetres mixed gas per second, if sent through water. 1 ampère is too much for medical purposes, and therefore its one-thousandth part, or 1 milliampère, has been adopted as unit for measurements of intensity, in accordance with a proposal made by Dr. de Watteville. A source of electricity with an E.M.F. of 1 volt passing through a circuit, the resistance of which amounts to 1000 ohms, produces in it a current of 1 milliampère.

In the following pages the expression ampère hour is sometimes used; this means a current of 1 ampère for one hour, or 2 ampères for thirty minutes, or 1 milliampère for 1000 hours, etc.

There exist other units besides these; for instance 1 coulomb is the work 1 ampère can do in one second; 1 farad is the unit for electrical capacity. For our purposes, however, there are only volts, ampères and ohms of importance.

Ohm's Law.—We have already seen in the previous statements that an E.M.F. of 1 volt produces 1 ampère in a circuit, the resistance of which is 1 ohm. If we increase the E.M.F., say to 5 volts, we shall find that the strength of current in the circuit has increased to 5 ampères. The strength of current increases therefore in the same proportion as the E.M.F. In increasing the resistance, however, the strength of current is diminished; 5 volts can send 1 ampère only through 5 ohms, or only ½ ampère through 10 ohms, etc. The strength of current decreases in proportion with the increase of the resistance. This can be expressed by the formula :—

$$\frac{\text{Electro-motive force}}{\text{Resistance}} = \text{Current}; \text{ or shorter, } \frac{E}{R} = C.$$

The resistance in this case means all the different resistances which are in the circuit, the resistance in the outer circuit as well as the internal resistance of the battery. This law, which is as simple as it is important, was discovered by Ohm, and has been named after him. It is the foundation stone of electrical measurements, and it is practically the only electrical law which has to be considered in using electricity for medical purposes. No knowledge of higher mathematics is needed in order to understand it, and he who takes the trouble to grasp and learn to use it, will be amply rewarded for his small pain by finding hardly any more theoretical difficulties afterwards in using and regulating his batteries. We will therefore devote a few more remarks to this subject, and quote a few examples.

1.—Thirty Leclanché cells, each of which has an E.M.F. of 1·5 volt, and an internal resistance of 0·8 ohm will, with an external resistance of 4800 ohms yield

$$\frac{45 \text{ volts}}{(30 \times 0{\cdot}8) + 4800 \text{ ohms}} = 0{\cdot}0093 \text{ ampères or } = 9{\cdot}3 \text{ milliampères.}$$

2.—Should the same battery be used for electrolysis, a method where the resistance of the body is generally much smaller in consequence of the different size and application of electrodes, say 220 ohms, the current it would yield would be

$$\frac{45 \text{ volts}}{(30 \times 0{\cdot}8) + 220 \text{ ohms}} = 0{\cdot}1844 \text{ ampères or } = 184{\cdot}4 \text{ milliampères.}$$

3.—If the same battery is used for small incandescent lamps, such as are required for illuminating cavities of the body, the resistance of which varies between 8 and 25 ohms, the current with a lamp of 22 ohms resistance would be

$$\frac{45 \text{ volts}}{(30 \times 0{\cdot}8) + 22 \text{ ohms}} = 0{\cdot}978 \text{ ampères or } = 978 \text{ milliampères.}$$

4.—This current is sufficiently strong to render many of these little lamps incandescent, but if in consequence of polarisation, or of small crystals which cover zinc and carbon gradually, the internal resistance has increased up to 1·6 ohm, the battery would be too weak to bring the carbon filament to white heat, for

$$\frac{45 \text{ volts}}{(30 \times 1{\cdot}6) + 22 \text{ ohms}} = 0{\cdot}642 \text{ ampères or } = 642 \text{ milliampères.}$$

5.—If the same battery is connected with a platinum burner, such as are generally used for galvanic cautery, and which have about 0·02 ohm resistance, the 30 cells will yield a current of

$$\frac{45 \text{ volts}}{(30 \times 0{\cdot}8) + 0{\cdot}02 \text{ ohms}} = 1{\cdot}8 \text{ ampères,}$$

a strength of current quite insufficient for making the platinum wire even warm, as the burners generally in use require a current of 10 to 15 ampères in order to get red hot.

6.—A bichromate battery with two *large* cells, however, which have got an E.M.F. of 2 volts each, and only 0·03 ohm internal resistance, will give with the same burner a current of

$$\frac{4 \text{ volts}}{(2 \times 0{\cdot}03) + 0{\cdot}02} = 50 \text{ ampères.}$$

7.—With the resistance quoted in example 1, these two large cells would still give only

$$\frac{4 \text{ volts}}{0{\cdot}06 + 4800 \text{ ohms}} = 0{\cdot}0008 \text{ ampères or } = 0{\cdot}8 \text{ milliampères.}$$

This example shows why the current of a battery with 2 or 4 large cells is sufficient to heat or even to fuse platinum wires, which offer a small resistance; whereas it is too weak to be felt at all if it passes through the high resistance of the human body.

8.—Two very small bichromate cells, which have the same E.M.F., but ten times more internal resistance, would give exactly the same amount of current as the two large cells with a *high* external resistance, for:

$$\frac{4 \text{ volts}}{0{\cdot}6 + 4800 \text{ ohms}} = 0{\cdot}0008 \text{ ampères or } = 0{\cdot}8 \text{ milliampères.}$$

We shall refer to some of these examples later on.

Ohm's law does not only help to find out the strength of current if the E.M.F. and resistance are known, it also enables us to find out the resistance, if we know the E.M.F. and strength of current. In this case, Ohm's law reads as follows:

$$\frac{\text{E.M.F.}}{\text{Current}} = \text{Resistance.}$$

9.—For instance, if the strength of current is 9 milliampères, and the E.M.F. of the cells used 41 volts, the resistance will be:

$$\frac{41 \text{ volts}}{0{\cdot}009 \text{ ampères}} = 4555{\cdot}5 \text{ ohms.}$$

Lastly, you can find out the E.M.F. if you know the resistance and strength of current. The formula then reads as follows: Strength of current × resistance = E.M.F. For instance:—

10.—If the strength of current is 184·4 milliampères, and the total resistance 244 ohms, as shown in example 2, you get

$$0{\cdot}1844 \text{ ampères} \times 244 \text{ ohms} = 44{\cdot}999 \text{ volts.}$$

Effects produced by the Electric Current.—Before closing these general remarks, we have to mention the principal effects which the current produces.

A magnetic needle is deflected from its direction towards north if a current circulates in its neighbourhood, a quality which is used to detect the presence of a current, and to measure the strength of it. A piece of steel or iron, round which a current passes, gets magnetic, and has consequently the power to attract other pieces of iron, steel, or nickel. Fluids are decomposed by the current. If we connect two metal or carbon plates with a battery, and immerse them in water, the current will decompose the water ; oxygen gas appears at the plate connected with the positive pole (anode), and hydrogen gas on the plate connected with the negative pole (kathode). If the plates are immersed in a solution of metal oxides—for instance, sulphate of copper—metallic copper will be deposited on the plate connected with the negative pole. If we send the current through the human body, at the negative electrode, potassium, sodium, hydrogen, etc., are liberated ; and at the positive electrode, oxygen, chlorine, acids, etc. Electrolysis has been chiefly investigated by Faraday, but its theory is very complicat d, and not at all sufficiently solved yet. As far as we know, the chemical changes take place *at* the poles only, but *not between them.*

If electrodes are placed on the human body, and the current is suddenly closed, or suddenly broken, the muscles will contract. Flashes appear in the eyes, noises in the ears, and a peculiar taste on the tongue ; the irritability of nerves gets diminished near the anode, and increased near the kathode ; alternating currents of very high frequency produce local anæsthesia ; the circulation of the blood and the nutrition of the tissues get stimulated.

The current heats metallic conductors, carbons, etc., in passing through them. Bad conductors get more heated than good ones. If a current of 12 ampères passes through a platinum wire, of about 0·6 millimetre diameter, the wire gets red hot, so that it can be used for bur ing away tumours, etc. ; and if a current of about 0·75 ampères passes through the thin carbon filament of an incandescent lamp, the lamp gives a brilliant white light, which we use for illuminating our houses, and for examining cavities of the body.

APPARATUS FOR GALVANISATION AND ELECTROLYSIS.

The Resistance of the Human Body varies widely. If two small metal electrodes of one centimetre diameter each are placed on the *dry* skin, the resistance will be near 100,000 ohms. If we use, however, larger electrodes, about 5 centimetres diameter, cover them with leather, and place them on the skin, after having well soaked them in warm salt water, the resistance will not be more than about 3,000 ohms, and get less, within a short time, under the influence of the current itself. If we introduce an electrode into the rectum or vagina, and place a large electrode, 8 inches diameter, on the abdomen, the resistance will be about 150 ohms, or even less. The same result is obtained by pricking the skin with a few needles, for it is principally the skin which offers the great resistance, whereas the blood, etc., conduct comparatively very well. Still, we have at any rate 100, and in most cases 1000 to 5000 ohms resistance to deal with, and therefore a large number of cells is indispensable, in order to obtain with these resistances currents varying between 1 and 100, or even more, milliampères.

Which are the most suitable Cells?—It is not our intention to enumerate all the cells which have been invented since Volta till to-day. On the other hand, it is impossible to give the preference to one certain cell under all circumstances, as the wants and wishes differ very much. *Any* cell can be used which is capable of yielding the desired strength of current, but if we consider convenience, the time necessary to keep a battery in working order, its portability, etc., the number of useful cells will be reduced to very few indeed, and these few only will be mentioned here.

In choosing a battery, it is a consideration whether it can be charged by the proprietor himself, or whether it has to be returned to the maker when exhausted. In the latter case, the battery would be suitable for those medical men only who live in convenient reach of the manu acturer. The capacity of the battery, *i.e.*, the amount of current which it will yield before having to be recharged, the cost of recharging, the price of the battery, and its size and weight, are important.

E.M.F. of the Cells.—It stands to reason, that cells with high E.M.F. and small internal resistance have a considerable advantage over cells with low E.M.F. and high internal resistance; for 50 cells with 1 volt and 8 ohms internal resistance each, will yield with an external resistance of 2500 ohms,

$$\frac{50 \text{ volts}}{(50 \times 8) + 2500 \text{ ohms}} = 0{\cdot}0172 \text{ ampères, or } = 17{\cdot}2 \text{ milliampères.}$$

whereas 22 cells of 2 volts and 0·3 ohm each would yield in the same case

$$\frac{44 \text{ volts}}{(22 \times 0{\cdot}3) + 2500 \text{ ohms}} = 0{\cdot}0175 \text{ ampères, or } = 17{\cdot}5 \text{ milliampères.}$$

In order to obtain 17 milliampères with 2500 ohms external resistance, we should therefore require 50 cells of 1 volt each, whereas the same result could be obtained already with 22 cells of 2 volts each; and, of course, with this latter kind of cells, the batteries are smaller and less expensive in every way, on account of the smaller number of cells.

The cells most frequently used may be classified in two groups: Cells which contain acids, and where the zincs therefore have to be taken out of the fluid after the battery has been used—Plunge Batteries; and cells, the exciting fluid of which does not attack the zinc as long as the circuit remains open, and in which, consequently, the zinc may remain constantly immersed in the exciting fluid.

Leclanché Cells.—Let us first consider the cell which is more used than all the other cells taken together—the Leclanché cell. For galvanisation and electrolysis, there can hardly be found a cell more reliable, and in every way more convenient than the Leclanché cell, provided that its size be not reduced too much for portability's sake. Its E.M.F. is good, 1·5 volt, and the internal resistance is moderate, 0·4 to 1 ohm, according to the size of the cell. As long as the circuit is not closed, there is theoretically none, and, practically, very little local action. It is always ready for use, and a well constructed cell will last for over two years without having to be seen to during this time. Moreover, every part of these cells is so easily accessible that they can be cleaned and refilled without technical aid. In order to clean Leclanché cells, the crystals which stick to the carbons and zincs have to be scraped off with a knife, carbon and glasses should be washed, and after the cells have been put together again, they are refilled with a saturated solution of pure salammoniac.

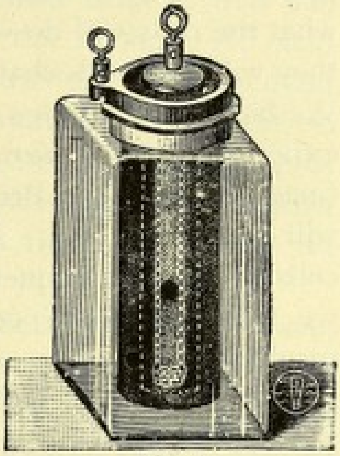


Fig. 1.

With Leclanché cells, as with most other cells, it is of the greatest importance not to select them smaller than absolutely necessary, for the smaller they are made the less satisfactory they get. Many attempts have been made to make them as small as 1 by 1 by 4 inches, but they have invariably failed up to now. The constancy of such small Leclanché cells is insufficient, and for various reasons the local action is greater in the small cells than in the large ones.

Dry Leclanché Cells.—If portability has to be considered, the dry cells, which belong to the Leclanché type too, have great advantages over the liquor cells, for there is no fluid to be spilled or to corrode the brass parts, and there is no glass etc., to get broken. Their internal resistance is a little lower, and their E.M.F. a little higher than that of the liquor Leclanché cells. They can be sent charged all over the world, and are excellently suitable for all batteries which have to be carried about frequently.

Their only drawback is that the cells, after being exhausted cannot be recharged, but have to be replaced by new ones, and this makes the refilling rather expensive. On the other hand, batteries filled with *good* dry cells will certainly last for fully 2 to 4 years without requiring recharging, and they are less likely to require repairs than the liquor cells, because accidents like the smashing of glasses, and spilling of corrosive liquor cannot happen, so that the difference in the cost of maintaining the batteries is not quite as great as it appears at first sight. The new cells can be sent by post, and can easily be put into the place of the old ones, so that the battery itself need not be returned to the maker.

There are many kinds of dry cells in the markets. Which of these is the best? This is an important question. Comparative tests of various types have been published in electrical papers, but though we have no doubt that the experiments were made by competent men in good faith, we nevertheless consider most of these experiments as misleading, for they refer only to *new* cells, while for our purposes it is of little interest what the cells will do while they are *new*, whereas it is all important how they will *keep* and what they will do when one, or two, or more years old. We have had samples of most of the existing dry cells, but as far as our experience as to *durability* is concerned, Hellesen and Obach's cells (made by Siemens Bros.) seem to surpass all the others. An example will show this best. We have taken 6 new Obach cells (S size) and 6 cells of another frequently used type, of the same size and shape, which we will call the C cells. While new, the cells gave the following results :—

	With 10	100	1000 Ohm external resistance.
Obach cells . .	180	21	2 milliampères.
C „ . .	175	21	2

6 months later the current had dropped to :—

Obach cells . .	160	20	1·9 milliamperes.
C „ . .	95	12	1·5 „

12 months later the readings were :—

Obach cells . .	155	19	1·8 milliampères.
C „ . .	20	4	1·2 „

This shows that the Obach cells have lost not more than about 15 per cent. in one year, while the C cells have lost 90 per cent. and are practically useless.

If another proof were wanted it is this: we have sold, during the last 4 years, many thousand Hellesen and Obach cells, and not a single complaint has reached us about batteries charged with these cells. (N.B. we refer here to batteries for galvanisation and electrolysis only.)

Acid Cells.—As far as cleanliness and convenience are concerned the acid cells have decidedly some disadvantages compared with Leclanché cells. As they must be plunge elements, the vessels cannot be so well closed, and evaporation and spilling cannot be prevented altogether, although lately these defects have been considerably improved by means of suitably shaped vessels and india-rubber floats. With daily use an acid battery has to be cleaned and refilled about once in every three months. The refilling, however, may be easily performed even by the most inexperienced. As the acid batteries require less skill to be kept in order than any other battery, they are especially suitable for use in those countries where technical help is difficult to be had, such as the Colonies, and moreover, for those medical men who do not use their batteries regularly. It takes not more than an hour to clean the battery and put it into working order again, even if it has stood unused in a corner for years. They have, moreover, the advantage of being very powerful. They have a very high E.M.F., 2 volts, and less than 0·05 ohm internal resistance, so that 22 acid cells are even stronger than 30 Leclanché cells. They are specially suitable for the strong currents required for electrolysis. The zincs last about five years with normal use, and can also be easily replaced without technical help, so that the owner of such a battery is really independent of the maker. All acid cells consist of carbon and zinc, and various solutions are recommended for them ; we prefer a solution of 1 oz. of bichromate of potassium, 20 ozs. of water. 2 ozs. of strong sulphuric acid, and 1 oz. of bisulphate of mercury. In order to clean the cells, the vessels have to be filled with water, and the elements should be left soaking in them, over night, to dissolve crystals, etc.

Number of Cells.—The number of cells a battery ought to have, depends on the purposes for which it is required. Specialists for eye, ear, and throat diseases will be able to obtain the strongest currents usually applied to the head with 20 to 25 Leclanché cells; that is, with 30 to 35 volts. General practitioners, surgeons and specialists for gynæcology use as a rule batteries of about 40 volts, and 50 to 80 volts are necessary for diagnostic purposes and for the treatment of nervous and paralytic diseases.

A suitable number of cells alone is not yet sufficient for a medical man ; there have to be different appliances for regulating the strength of current, for interrupting, reversing, and measuring the current, and for applying it to the body. The strength of current can be regulated in two ways ; either by varying the E.M.F., or by means of artificial resistances. The first mentioned method is more frequently used, and is managed with the help of the current collectors.

Current Collectors.—The current collectors are destined to increase or diminish the number of cells in the circuit, thus changing the E.M.F., and regulating the strength of current. They ought to be constructed so that the current is never interrupted while the number of cells is being changed, as this would give disagreeable shocks. This demand is often the cause why elements are destroyed, as we shall see later on. Moreover the cells should be put in the circuit one by one, not five by five, etc., as this would also cause shocks.

Crank Collectors are most frequently used. A number of pegs, equal to the number of cells in the battery, are arranged in a circle, so that a crank can be brought in contact with every one of these pegs. The cells are connected with these pegs ; a wire leads from the first zinc to the negative terminal, another wire from the carbon of the first cell to peg 1, another wire from the carbon of the second cell to peg 2, etc., and one wire leads from the crank to the positive terminal. By turning the crank the number of cells connected with the terminals can thus be conveniently increased or diminished. In order to avoid interrupting the current, the pegs are so arranged that the crank touches the next peg before having quite left the former one.

As long, however, as the crank touches two pegs, for instance pegs 5 and 6, *at the same time*, the 6th cell is short circuited, for the current

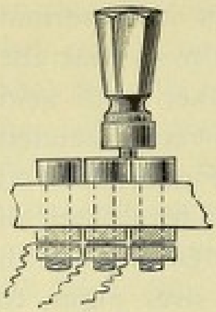


Fig. 2.

can pass from the zinc of cell 6, which is connected with the carbon of cell 5, on to peg 5 through the crank to peg 6, and from there back to the carbon of cell 6 without finding on its way any resistance worth mentioning. If this state lasts but very shortly, it causes no damage, but if it lasted for any length of time, the short circuited cell would be exhausted. It is therefore important with all crank collectors, not to let the crank rest so that it can touch two pegs at the same time, as Fig. 2 shows; the crank should always touch one peg only, as shown in Fig. 3. The number next to the peg on which the crank rests shows the number of cells in action. This kind of collector is convenient, but they have one drawback yet, especially if used with batteries containing a great number of cells, viz., that by being always put in the circuit, the first cells of the batteries get used up much quicker than the last ones.

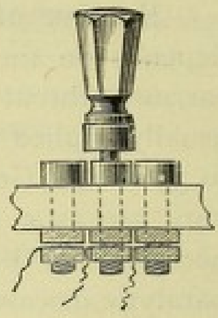


Fig. 3.

Double Collector.—In order to avoid this drawback, we have constructed the double collector. It has two cranks, which are placed on the same axis, but are insulated from one another, and the zinc of the first cell is not connected any more with a terminal, but with an additional peg 0. One crank is connected with the positive, and the other with the negative terminal. By means of these two cranks any batch of cells may be inserted, and thereby the whole battery can be used up evenly. An index fitted to one of the cranks points to a division, thus showing the number of cells in action. Finally, by means of the double collector, each single cell can easily be connected with a galvanometer, and tested, so that damaged or exhausted cells may be found out without trouble. In this way the double collector is a great convenience in testing the battery, and no doubt it is the best current collector known up to now.

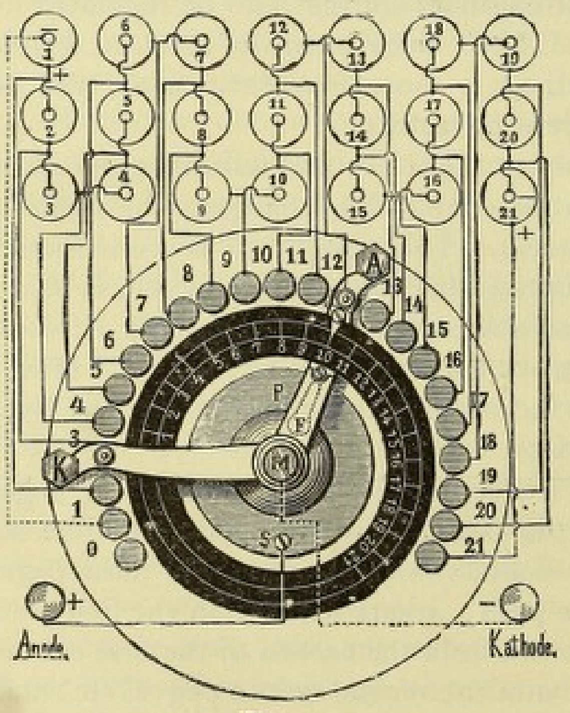


Fig. 4.

Rheostats.—Batteries provided with a good current collector need only on rare special cases have a rheostat, but the rheostat may be used instead of the current collector as a means of regulating the strength of current; and when the current supplied for lighting houses gets more frequently utilised for medical purposes, rheostats will be of greater importance. In order to reduce the current of a battery of 45 volts to about ½ milliampère, the resistance required would be, according to Ohm's law:—

$$\frac{45 \text{ volts}}{0{\cdot}0005 \text{ ampère}} = 90000 \text{ ohms},$$

and it should be possible to diminish this resistance *gradually*, in order to avoid all shocks in increasing the currents.

Liquid Rheostats.—Liquid rheostats have the advantage of cheapness. They consist generally of a glass tube, the lower end of which is closed with a piece of platinum, which acts as one electrode. The second electrode is a piece of zinc, which may be moved up and down in the glass tube. If the tube is filled with some badly conducting liquid, and the piece of zinc is drawn out as far as possible, the resistance is greatest. The number of ohms depends on the length of the tube, the diameter of the electrode, and the conducting capacity of the liquid. The resistance gets diminished by moving the zinc downwards. As decomposition must take place in these rheostats too, small gas bubbles form on the electrodes, changing the surface of the electrodes and the resistance continually. In order to prevent this, a depolarising substance, for instance, chloride of zinc, is mixed with the water. A weak solution of chloride of zinc, however, depolarises only a little, and would therefore prevent the gas bubbles only with very weak currents; but a strong solution of chloride of zinc conducts pretty well, and in order to obtain, nevertheless, a high resistance, the glass tube would have to be very long, a thing which is impossible with portable batteries, and on account of these difficulties, the use of liquid rheostats must always be limited, but in some cases they are convenient.

Metal Rheostats.—Metal rheostats are most frequently used. They are the only suitable ones for measuring purposes, as they are the most accurate and the least subject to changes. The metal rheostats for medical purposes are provided with a crank like the current collectors; each peg is connected with its neighbours with long and fine German silver wire, through which the current has to pass, till it reaches the peg on which the crank rests. In order to obtain high resistances without making the number of ohms between the various pegs too great, a good many pegs are necessary. As a rule several crank rheostats are arranged so that the first increases the number of ohms 10 by 10 up to say 200 ohms, the second 50 by 50 up to 1000, the third 100 by 100 up to 2000, etc. Such rheostats are good and convenient, but they are big and costly. They are, as a rule, used for the more expensive office batteries only.

Graphite Rheostats.—Convenient and inexpensive rheostats of very high resistances may be made of graphite, and they can be so arranged that the current can be varied without giving any shocks. The only disadvantage of graphite rheostats is, that the conducting capacity of the graphite varies ; this makes these rheostats quite unfit for measuring purposes, but it is of no importance for rheostats required only for regulating the strength of currents, and certainly the graphite rheostats are up to now the only suitable resistances for portable batteries. They are best made of lead pencils; the length which the current has to pass through can be varied conveniently by a spring gliding on the pencils.

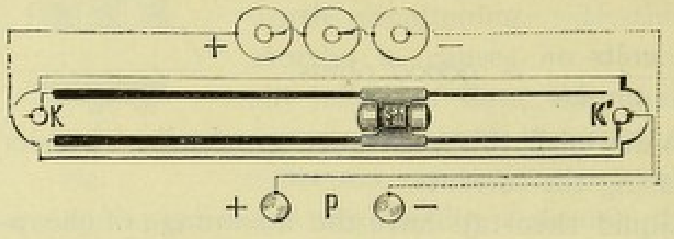


Fig. 5.

Galvanometers.—The great value of galvanometers for medical purposes has been so universally recognised in recent years, that it will hardly be necessary now to say much in their favour. Their purpose is to measure the strength of the current while it passes through the patient, and to enable the physician to dose the current accurately, notwithstanding the great difference in the resistance and the sensation in different patients, and notwithstanding the changes and differences of batteries. For administering electricity properly, they are about as important as a scale is for administering drugs ; and there is good reason to say, that their introduction through Drs. v. Ziemssen, De Watteville, Edelmann and Gaiffe, mark a turning point in electro-therapeutics.

Horizontal or Vertical Galvanometers ?—When galvanometers first came into use, there were different opinions about the shape they ought to have. The vertical form was mostly preferred because it is certainly easier to read from a vertical scale than from a horizontal one. But it was soon discovered that vertical galvanometers with *permanent* magnets are unreliable in consequence of the changes in the magnetism of the needles. The magnetism of the needles changes, but the directing power of the weight (or magnet) which causes the needle always to return to the 0 point, does not change. The changes of magnetism occur certainly in horizontal galvanometers too, but here they have no influence on the accuracy of the division, for, if the amount of magnetism in the needle were to change after the graduation, the directing influence of the earth's magnetism, and the deflecting influence of the current, change in exactly the same proportion, and thus the angle of deflection remains the same. The horizontal galvanometers are now universally recognised as the only reliable instruments.

Suspension of the Magnet.—The inertia is slightest in the case of instruments the magnet of which is suspended on a coccoon fibre, and in this case the friction also remains always the same. Such instruments have therefore the very great advantage, that in the case of their graduation being correct for a certain locality, this graduation will always remain correct and reliable.* These are, no doubt, the most sensitive instruments, as currents up to $\frac{1}{10}$th or even $\frac{1}{100}$th of a milliampère can be measured. In all cases where perfect accuracy is required, only such apparatus should be used. As these instruments are somewhat delicate and expensive, we employ for portable batteries, galvanometers the magnets of which are suspended on a steel point, as in a compass. Ordinary sewing needles are used now for this purpose, which can be easily replaced by new ones from time to time in order to keep them sharp and the instrument sensitive.

Shunt.—According to Dr. de Watteville's suggestion, all medical galvanometers are divided into milliampères. In order to be able to measure weak currents for galvanisation as well as strong currents for electrolysis with the same instrument, most galvanometers are fitted with one (or two) shunt, which can easily be switched on and off. As long as this shunt is not used, the whole current has to pass through a long fine wire, which is arranged so as to make the magnet decline from the magnetic meridian. If, however, the shunt is brought into action, by screwing a screw marked 10 home, the current finds another passage through a short and thicker wire, which is wound so as *not* to influence the magnet, and in this way, two paths being open to the current, it will divide itself among both, so that its strength in each branch is inversely proportional to the resistance of the wire. If, for instance, the resistance of the shunt wire is chosen so that its resistance is $\frac{1}{10}$th of the resistance of that wire which makes the needle decline, only $\frac{1}{10}$th of the current will flow through the latter wire and $\frac{9}{10}$ths through the shunt wire.

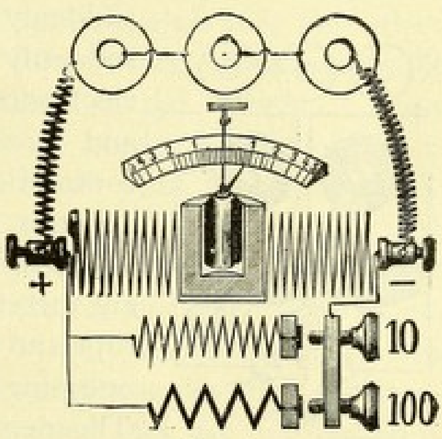


Fig. 6.

The magnet, therefore, will be influenced by only $\frac{1}{10}$th of the current which actually passes through the galvanometer, and consequently the numbers indicated on the dial have to be multiplied by ten in order to find the real strength of the current. A galvanometer, for instance, which, without the shunt indicates up to 25 milliampères one by one, will, if the shunt is used, show up to 250 milliampères 10 by 10. The resistance of the shunt can also be so arranged, that the numbers on the dial have to be multiplied by 100.

Voltmetre.—If the resistance of a milliampère metre has been

* This is not literally correct, as the terrestrial magnetism also varies and gradually increases. For instance, in London the earth-magnetism at the present time is about 1·82, and, if the increase of the latter continues at the same ratio as hitherto, it will be about 1·86 in ten years. A galvanometer, which now shows with perfect accuracy a current of 10 milliampères, would then with the same current, at this increased ratio of intensity of earth-magnetism, not indicate more than 9·97 milliampères, thus being 2 per cent. wrong.

increased up to 1000 ohms, it can be used for measuring E.M.F's., for as a current of 1 volt produces 1 M.A. in 1000 ohms, the milliampères are equal to the volts *as long as the resistance in the circuit is 1000 ohms.* The body of a patient, or any other unknown resistance, must therefore *not* be in the circuit while the E.M.F. of the cells is being measured.

If the strength of current obtained through a patient is known, and the E.M.F. of the cells which had been used to produce the above strength has been measured in volts in the way just mentioned, the resistance of the patient can be found out with the formula :—

$$\frac{\text{E.M.F.}}{\text{Current}} = \text{Resistance.}$$

(See example 9, page 8.)

A galvanometer, the sensitiveness of which has been reduced by screwing home the shunt, is of course insensible to weak currents; on the other hand, however, one single cell is already sufficient to deflect the needle of a galvanometer to a right angle, as long as there is not the resistance of a patient in a circuit.

Current Reversers, Current Combiners.—It is important for most physicians to possess an arrangement which makes it possible suddenly to close or interrupt the current, or else suddenly to connect with the negative pole the electrode hitherto connected with the positive pole, and *vice versa.* These sudden changes produce contractions of the muscles, the intensity of which depends on the strength of the current, and the sensitiveness and healthiness of the muscle. They are therefore very important for diagnosis. To interrupt and to reverse the current can be managed with one single instrument, of which we add a diagram. The negative pole of the battery is connected with W and N, the positive pole with the metal piece between these two. While the crank points towards N (normal), as the drawing shows, the crank on the right hand side is connected with the negative pole, and the crank on the left hand side with the positive pole. By moving the cranks slightly to the left, so that they rest on W and N, both cranks are in contact with the negative pole, consequently there is no current at all; but if we move the cranks further, so that they point towards W, the left hand crank is connected with the negative, and the right hand crank with the positive pole. From each crank a wire is leading to a terminal screw. Current reversers are manufactured in many shapes, but in principle their construction is always the same.

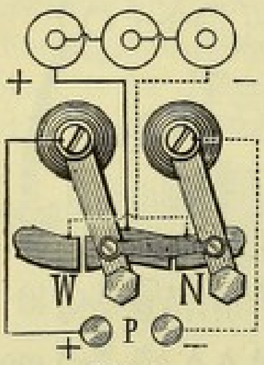


Fig. 7.

Current Alternator and Combiner.—In order to be able to change the continuous or the faradic current suddenly, without having to connect the electrodes with other terminals, and in order to be able to apply at the same time continuous and faradic currents combined, Dr. de Watteville has suggested a convenient apparatus, which outwardly resembles a current reverser, and of which we add a diagram too (Fig. 8). While the cranks point to G, the galvanic current is connected with the terminals; while the cranks point to F, the faradic current is connected with the terminals; and while they stand half way (G F), the galvanic and faradic currents are connected with each other in series, *i.e.*, the continuous current has to pass through the bobbin of the induction coil and the patient, and the faradic current has to pass through the patient and all the cells of the continuous current battery. Thus both currents pass through the patient at the same time.

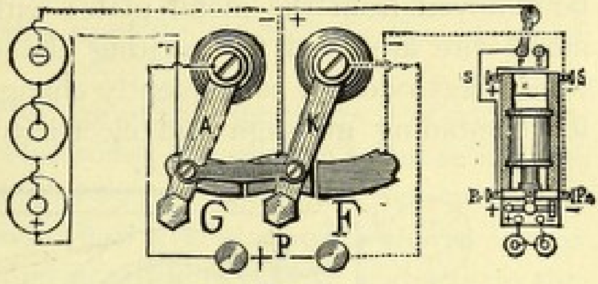


Fig. 8.

Cords.—Two connecting cords of suitable length, covered with some insulating material, are necessary for conducting the current from the battery to the patient. Insulated copper wire, which is bare for half an inch at both ends, is quite sufficient, but on account of the greater flexibility we mostly use a cord made of some twelve very fine wires, terminating on both ends in short and thick wires, which are to be fastened in the handles and in the terminals of the battery. These short wires should not be soldered on to the cords, as soldered parts stand no bending, and would soon break; a ball joint, however, is convenient and durable. Some prefer the cords to be insulated with india-rubber tubes, some others with silk or cotton. In the former case the cords are well protected against moisture, but the india-rubber contains sulphur, which makes the copper brittle. India-rubber covered cords do not last longer than one or two years, whereas silk or cotton-covered cords last for a very long time, provided they are not soaked in water together with the electrodes.

Handles.—The handles are provided with a terminal for the reception of a connecting cord, and with a thread fitting the electrodes. They are always provided with an insulating handle, so that the physician holding them is not exposed to the action of the current. Many handles are provided with a trigger, for making or breaking the current; this can conveniently be managed on the handles with one finger only, whereas a hand is required to work an interrupter on the battery. There are also handles which contain a current reverser or a rheostat, but they are complicated, and are of real advantage in very few cases only.

Electrodes.—There exists a great variety of electrodes: buttons, round and square plates of all dimensions, made of tin, aluminium, or carbon, and covered with flannel or chamois leather, which may be screwed on to the handles, or have a terminal to receive the cords direct. Through frequent use—the moisture and the oxide—the covers get soiled, and should be renewed from time to time, and the oxide has to be removed from the metal plates with emery paper. Brushes of fine metal wire are used for exciting the muscles and nerves of the skin; wheel electrodes for conveniently changing the place of application, and for combining massage and electricity. Small metal knobs on long

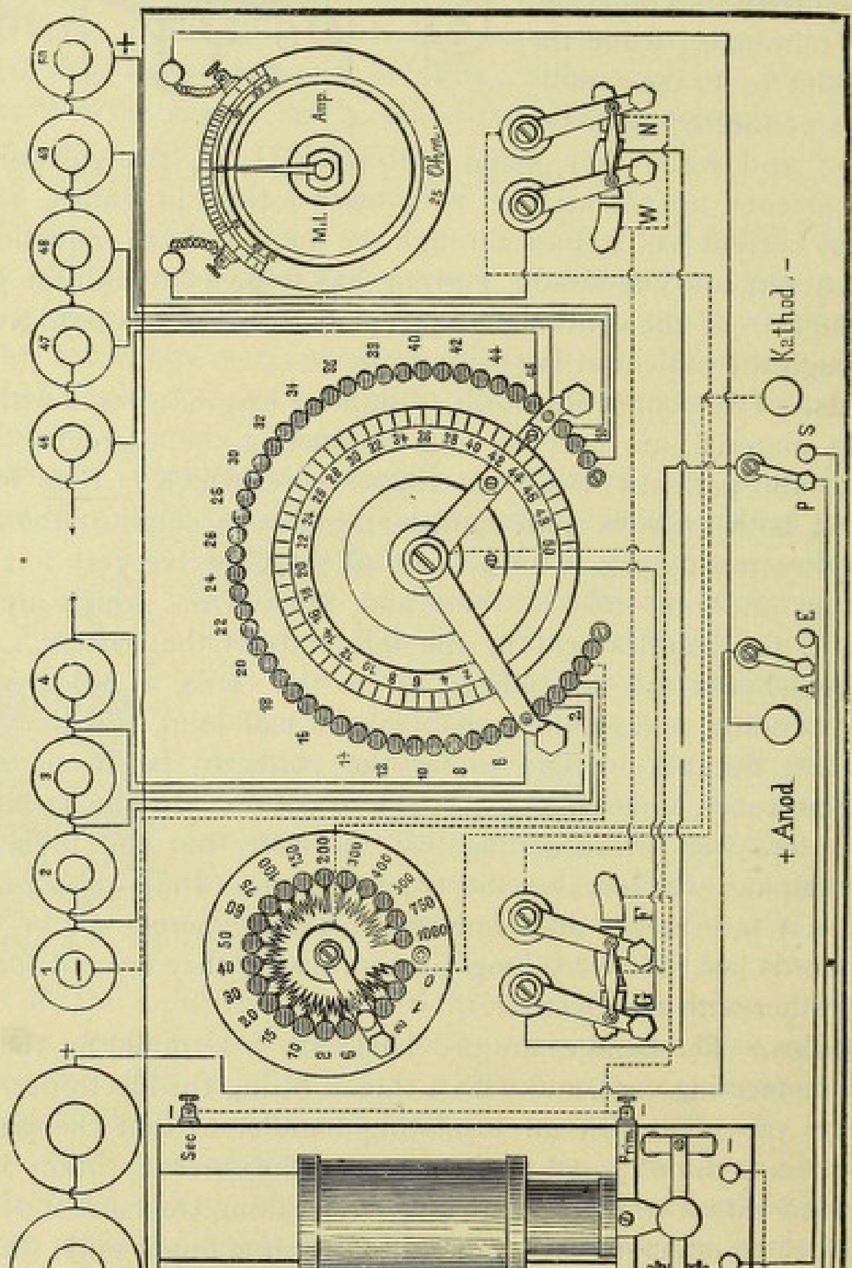


Fig. 9.
DIAGRAM OF THE CONNECTIONS OF BATTERY NO. 139.

insulated wires are in use for conducting the current to the larynx, nose, rectum, vagina, uterus, etc., and for treatment of strictures. Needles are employed for destroying hairs, nævi, tumours, etc. All these electrodes get polarised, and all electrodes made of common metal are subject to oxidation; they ought therefore not to be placed on the mucous membrane unless they are connected with the negative pole. To be used with the positive pole, the electrodes used for electrolysis should be of carbon, gold or platinum.

Density of the Current.—The size of the electrodes is of considerable importance. The larger the electrodes, the smaller is the resistance of the human body. With electrodes of ten square inches twice the current can be sent through the body than with electrodes of five square inches surface under otherwise equal conditions. This leads us to the density of the current, or, in other words, the proportion of the strength of current to the sectional area of the conductor. If, for instance, with electrodes of three square inches surface 20 milliampères are passing through the body, the current is three times as dense as if electrodes of nine square inches and the same strength of current were used; in other words, in the first case each square inch of the places of application receives 6·6 milliampères, whereas in the second case only 2·2 milliampères are received by the same area. The physiological and chemical effects would in the first case be three times as strong on and near the place where we apply the electrodes as in the second case. Statements that such and such results have been obtained with so and so many milliampères are therefore incomplete, unless the diameter of the electrodes used, and the time of application are mentioned as well. On entering the body the current divides itself into numerous loops and branches, and follows the best conducting parts till it reaches the other electrode. The density is greatest where the two electrodes touch the body; it is a little less near the straight line connecting the two electrodes, and smallest in those parts of the body which are most distant from the electrodes; but experiment shows that even those parts are reached by some small part of the current.

The effect of the current is frequently desired in one definite spot only, but as we necessarily require two electrodes to complete the circuit, they are chosen of very different diameter: a small one (active electrode), to concentrate the current on the nerve or muscle, etc., which is to be influenced by the current, and a large one (called the indifferent electrode), which may be applied to the hands or any easily accessible part of the body. If the latter electrode is chosen sufficiently large, undesired effects, such as pain or blisters, etc., will be avoided.

Electrolysis.—This is of special importance if the chemical properties of the current are to be used for destroying any tissues, etc., (electrolysis). If, for instance, a needle connected with the negative pole is inserted close to a follicle, and an electrode of two inches diameter, connected with the positive pole, is held with the patient's hand, the current is of course equally strong in both electrodes, but in the one the whole effect of the current is concentrated on a needle's point, and the chemical action of 1 milliampère suffices already to destroy the follicle, so that the hair can be extracted after a few seconds. The chemical action on the other electrode, however, is divided over so large a surface that the current mentioned will leave no visible effect.

Faults.—It is not an easy undertaking to describe in a few words the faults which may occur in a battery, and how they can be found out and rectified. The preceding sections, explaining the batteries and accessories, will enable anyone who takes an interest in his instruments to find out the reason of any disturbance; whereas for him who does not trouble to learn to understand the anatomy of his battery, any number of pages about this theme will be insufficient, for he will ever remain dependent on the help of an electrician. If a battery does not work, the only reasonable thing to do is to ascertain where the fault is, whether it is in the cells, or in the connection between the cells and the terminals, or in the cords, handles, etc. In all batteries with a great number of elements, a spark appears if the two ends of the connecting cords are brought in contact and separated again. If no spark is seen, fasten one end of a cord to a terminal, and touch with the other end the other terminal. If still no spark is visible, touch peg 1 with one end of a cord, and with the other end touch the last peg of the collector, and if there is still no spark, try with groups of say five elements each, either on the pegs of the current collector or directly on the terminals of the cells. If the elements are not very old, a spark will be obtained from several of these groups, and the faulty cells may be singled out. A whole battery may fail because one of the many screws on the cells may have got loose, on account of differences of temperature or shaking in the transit, for a loose screw no longer makes any contact with the wire which connects the cell with the next one. This can easily be rectified by tightening the screw. Another reason may be, that in consequence of short circuit (caused by a wrong position of the current collector, or by a fault in the cell) a zinc is eaten through, or that the fluid has escaped through a crack in the element vessel. In both cases the connection is interrupted, and the defective cell or cells have to be removed and refilled, or replaced by new ones; if this is impossible at the time, the last cells of the battery may be taken off and put in place of the defective ones, until new ones can be obtained. (Batteries which are so constructed that each single cell can be taken out, are for this reason much better than those in which the cells are soldered together, or otherwise inaccessible, for if one single cell in them goes wrong, the whole battery has to be sent back to the maker.) A galvanometer makes it much easier to find such a fault; the cords are connected with the galvanometer, and the other ends are placed first on pegs 1 and 2, then on pegs 2 and 3, etc.; in this way each cell can be tested, and a fault found out at once. In batteries provided with a double collector it is simpler still. The tongue is a sensitive galvanoscope, too. If we touch with it two wires connected with a cell, we feel a peculiar taste if the cell is working. We strongly recommend, however, to try this experiment with groups of not more than ten cells only, for we heard of a case where a doctor, believing that his patient got no current from a 40-cell battery, put the cords on his tongue, and remained unconscious for three-quarters of an hour in consequence of the shock.

It is rare that a fault occurs in the connections between the cells and the current collector, the wires being mostly well protected and all the invisible connections being soldered. The pegs of the current collector as well as the current reverser, are liable to get oxidised, especially in acid batteries, and have to be cleaned occasionally with fine emery paper; dust between the pegs should be removed with a fine hair brush. The screws which keep the crank of the current collector and reverser on their axes may get loose and have to be tightened. Connecting cords may break, and this shows itself by their too great flexibility; they are cut off then up to the unspoiled part. The handles with an interrupter may fail to make contact through oxidation, or through the spring being loose. Cords, handles or wet electrodes ought never to be placed on the current collector, etc., as they may cause short circuit.

We have yet to mention the faults which are caused by false application. Some people believe in being able to test a battery if they touch with dry fingers the varnished terminals, or else the ends of the connecting cords. Of course, in both cases, the current is exceedingly weak on account of the very high resistance, and can hardly be felt even by experienced persons. Currents of a few milliampères are felt by most patients only if they are suddenly closed or broken, and whenever a battery is tested, the only proper way to do it is to soak the electrodes in warm salt water, and to apply them as in real use.

Current supplied from Dynamos.—We have yet to describe how the current from dynamos can be used for galvanisation and electrolysis. The electric light is available now in every town, and as it is obviously more convenient to get the current supplied to the house ready-made, than to have to generate it oneself by means of batteries, the latter will be replaced frequently by the current supplied by dynamos for lighting houses. Only the continuous, or low tension, or direct current can be used for galvanisation and electrolysis, the alternating or high tension current cannot* be used for these purposes.

Is the Current from a Dynamo quite safe?—We have often been asked: Is it perfectly safe to use the current of a dynamo for galvanisation and electrolysis? It is, however, impossible to settle this question in general, as it depends too much on special circumstances.

* This is not literally correct. The Alternating current can be converted into a Continuous current by means of an Alternating current motor driving a Continuous current dynamo. These two dynamos together cost £16, and in addition a board, No. 184, or something similar, is required for controlling the current from the dynamo. We have made such installations, but in most cases it will be simpler and cheaper to use a battery for galvanisation than such an elaborate machinery.

Some medical men have expressed the fear, that by some accident the E.M.F. might suddenly increase to dangerous proportions. This objection, however, is admissible only in those towns where low tension and high tension wires are used, and where they are drawn *overhead:* a collapse of the supporters, caused by fire or storm, might bring the different wires into contact. To the best of our knowledge all the cables in Great Britain are laid underground, and this makes such accidents impossible. Moreover, a dynamo built for 100-volt supply cannot possibly yield suddenly 200 or more volts. In our opinion, these apprehensions are unfounded.

There is, however, another danger, namely, the current might be suddenly broken, or the dynamo might be switched off and a battery of accumulators switched on instead. Such a change is likely to happen once in the morning and once in the evening in most electric light stations. If the strength of current applied to the patients does not exceed, say, 20 milliampères, such an unforeseen break may be inconvenient or disagreeable, but not dangerous; and if 20 milliampères are not exceeded, we consider the current from a dynamo quite as safe and more convenient than the current from a battery. But it is different when heavier currents are to be employed, for instance, for electrolysis. A sudden break while 50 milliampères are passing through the head, or 200 milliampères through the abdomen, might have serious consequences; and if a doctor intends to employ currents as strong as this, we should urgently advise him first of all to obtain careful information from the engineer in charge of the station whether, and at what times of the day, breaks will happen, and whether it is at all likely or possible that breaks will happen at any other time. We should not advise the use of the current from a dynamo for heavy applications, unless quite reassuring information has been obtained from the responsible engineer.

Safety Resistance.—Every apparatus ought to be provided with a resistance so arranged that it cannot possibly be switched off through any misunderstanding or forgetfulness on the part of the operator. The object of this resistance is to protect the patient from an overdose, in case that by a mistake all other resistances are switched off; and, moreover, it prevents the galvanometer, rheostats, etc., getting destroyed by heat, if by any chance the connecting cords touch and thereby cause a short circuit. For this reason we call this resistance the safety resistance. An incandescent lamp is suitable for it. With a 100-volt 8-candle lamp in the circuit, the maximal current obtainable at the terminals cannot exceed 260 milliampères, as the resistance of the lamp amounts to about 385 ohms. With a 16-candle lamp, the maximal current would be about 550 milliampères. If short circuit is made at the terminals, by connecting them with a wire the lamp will glow, but no damage will be done.

As to the accessories required for regulating and measuring the current, we refer to the previous descriptions of the galvanometers, current reversers, etc.

Construction of the Apparatus.—The apparatus may be constructed in two different ways:—

(1,) The body of the patient may be in the main circuit, as shown in Fig. 10. In this case, the total resistance of the rheostats must be great, for you want about 100,000 ohms to reduce a 100-volt current to 1 milliampère. It is of great importance that the resistances may be varied *gradually and without jumps*. Graphite rheostats seem to us to be the most suitable for this purpose.

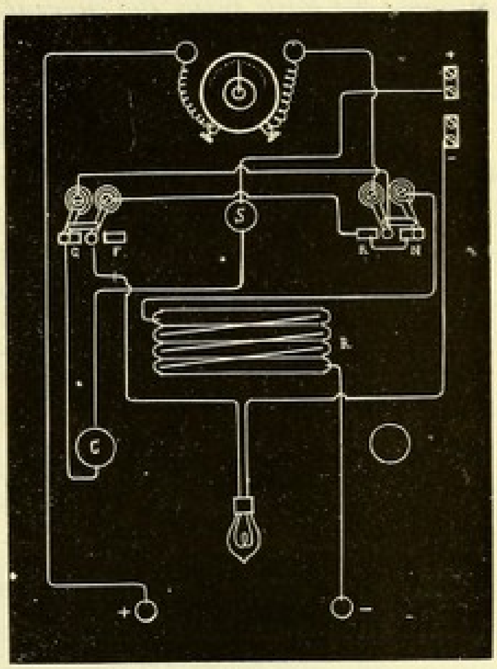


Fig. 10.

(2,) The body of the patient may be in a shunt circuit, as shown in Fig. 11. With this arrangement it is possible to reduce the E.M.F. at the terminals to about 0·1 volt, and to increase it *gradually* without jumps to about 70 volts by moving the sliding spring of the rheostat, which we call, therefore, the Volt-regulator. In this way the current can be regulated more delicately and gradually than it is possible even with the best current collector of a battery.

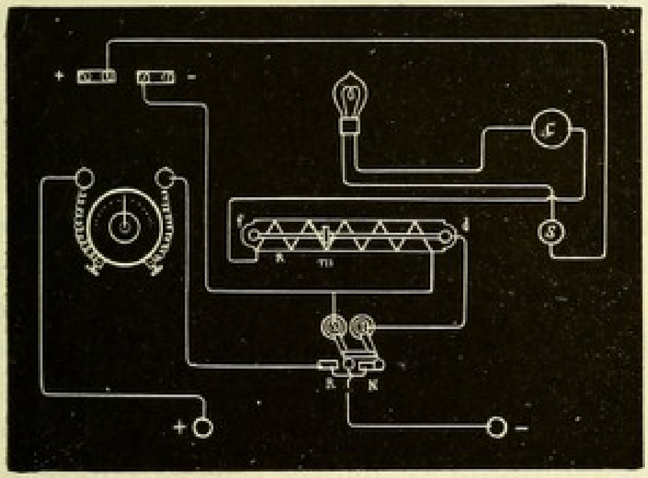


Fig. 11

We have repeatedly tested the effects of both systems, and have found that with an apparatus arranged like Fig. 10, a current of, for instance, 2 milliampères will produce a slight burning sensation, which is not felt if a current of the same strength passes through an apparatus arranged according to Fig. 11. With this latter arrangement it is impossible to discern the current of a dynamo from the current of a battery. On account of this and also because the current can be graduated so very delicately, we are inclined to prefer the latter arrangement to the former. The apparatus with a Volt-regulator are, moreover, cheaper than those with graphite rheostats.

Dr. HEDLEY, of BRIGHTON, writes us about the Volt-regulator as follows: "*I have tried the current controller, and I think the sliding shunt is very smooth and satisfactory. The compactness and the arrangement are wonderful.*"

There ought always to be a galvanometer with these apparatus. If a battery is used without a galvanometer, the number of cells employed is a very unreliable measurement, but still it is some sort of a guide, whereas one is absolutely in the dark with a 100-volt current without a galvanometer.

BATTERIES AND INSTRUMENTS FOR GALVANIC CAUTERY.

A very strong current is required for rendering platinum wires, of the thickness needed for cautery operations, incandescent, for most of the burners require 10 to 15 ampères (10,000 to 15,000 milliampères) and in order to keep a current of this strength constant, even for a few minutes only, *large* cells are absolutely necessary. On the other hand, platinum burners have a very low resistance—burner, handles and cords together about 0·06 ohm. If the cells have a small internal resistance too, for instance, 0·06 ohm per cell, two cells of 1·5 volt each are already sufficient for producing the necessary strength of current with these resistances, for

$$\frac{3 \text{ volts}}{0{\cdot}06 + 0{\cdot}12 \text{ ohm}} = 16{\cdot}6 \text{ ampères.}$$

The requirements for cautery are therefore totally different from those for galvanisation and electrolysis. In the latter case many cells are needed to force even a weak current through the high resistance of the human body. The cells, however, can be small, because even the strongest current used for electrolysis rarely exceeds 200 milliampères. For cautery, however, the E.M.F. of two cells is already sufficient on account of the very small external resistance, but the cells have to be of large size, as the current required must be more than 1000 times as strong as the currents generally used for galvanisation. Even a 100-cell Leclanché battery with cells of 0·6 ohm internal resistance, would give only

$$\frac{150 \text{ volts}}{60 + 0{\cdot}06 \text{ ohm}} = 2{\cdot}49 \text{ ampères.}$$

This explains why a continuous current battery cannot be used for galvanic cautery, and why a cautery battery cannot be used for galvanisation, notwithstanding its big cells—two questions which are very frequently put to us.

Connection of Cells.—Up to now *one* method of arranging the cells has been mentioned only, the connection "*in series*," for high external resistances. The cells can, however, be arranged so that the carbon of the first cell is connected with the carbon of the second, and the zinc of the first with the zinc of the second cell, etc., and this is called connecting the cells "*parallel.*" The E.M.F. *does not* increase thereby, no matter how many cells are connected in this way, but the surface of the metal or carbon plates increases, and consequently the internal resistance diminishes with each additional cell. Two cells connected in this way are equal to one single cell of double size, and this is a great advantage for galvanic cautery, for by lessening the internal resistance we enable it to yield, with small external resistance, a stronger current. Principally, however, we double the constancy, for large plates do not polarise as quickly as small ones do, and the capacity in ampère hours of two cells connected parallel, is twice as large as the capacity of two cells connected in series. There are yet some other combinations possible. We can, for instance, connect 6 cells, of 1·5 volt, 0·15 ohm internal resistance, and 20 ampère hours capacity each, in series, and obtain then 9 volts, 0·9 ohm internal resistance, and 20 ampère hours; or else we can connect every two cells parallel, and the three double cells in series. We then obtain 4·5 volts, 0·225 ohm, and 40 ampère hours; or 3 cells parallel and the two groups in series, which would give 3 volts, 0·10 ohm, and 60 ampère hours; and lastly we can connect them all parallel, and would then obtain 1·5 volt, 0·025 ohm, and 120 ampère hours. The mixed connection is the most convenient one for cautery batteries, and is most frequently used. The two diagrams show the two different ways of connecting the 4 cells of a frequently used cautery battery. As already mentioned, the E.M.F. of two cells is sufficient to produce with so small a resistance the necessary strength of current; for wire loops, however, 3 to 4 cells are necessary, and the batteries most frequently used for cautery have 4 cells. If

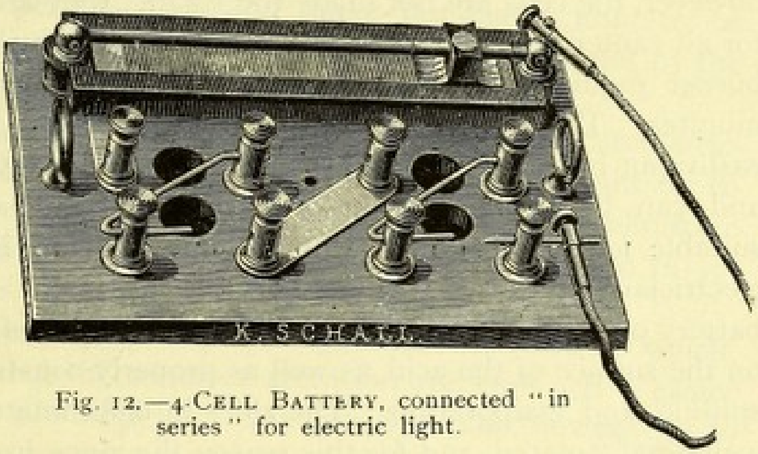


Fig. 12.—4-Cell Battery, connected "in series" for electric light.

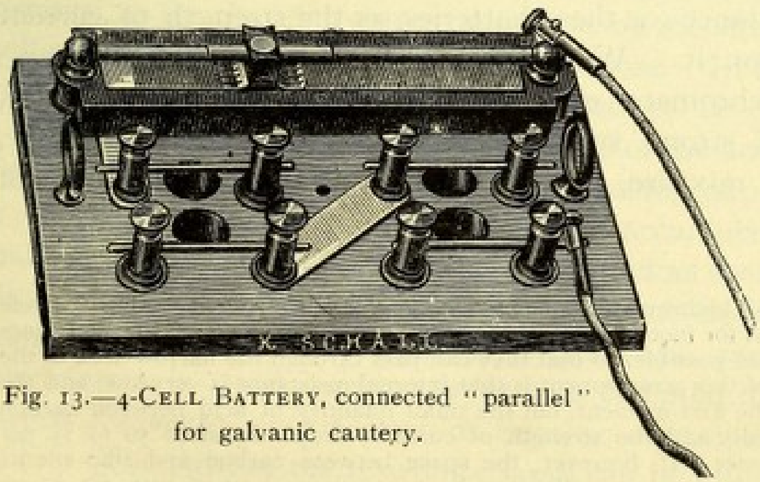


Fig. 13.—4-Cell Battery, connected "parallel" for galvanic cautery.

batteries are constructed with more than 4 cells, this is partly done in order to be able to connect the cells parallel in the way above mentioned, and partly to use them for the production of a strong light as well. We shall refer to this later on under the section for electric light.

Which are the most suitable Elements ?—There is no great variety of cells with a sufficiently small internal resistance. Cells with two different acids, such as Bunsen and Grove cells, are certainly very powerful and constant, but as they have to be emptied and cleaned each time after having been used, they have long since been put aside as too troublesome for surgical purposes.

Bichromate Cells.—Bichromate elements are most frequently used for cautery. The chief objection to them is their want of constancy. If, however, the cells are not made too small,* they are sufficiently constant for all cautery operations ; for a cell of 3 by 5½ by 6½ inches, will keep a burner requiring 12 ampères incandescent for, approximately, twenty minutes. They are powerful, their E.M.F. being 2 volts, and they are easily put in action. And especially they can very quickly be re-filled, and can be easily kept in order by anybody, so that they are very suitable for medical men who do not wish to be dependent on the electrician's help. They are portable, as far as this is possible for a battery of 23 lbs. weight filled with acid. Plates of india-rubber, floating on the surface of the acid, as well as properly constructed vessels, prevent spilling and evaporation. The zincs in bichromate batteries should be well amalgamated, and for this reason the zincs in our batteries consist of an alloy of 10 parts of zinc and 1 part of mercury, and, moreover, the acid contains some mercury too. The zinc plates last from two to five years, according to their use, and can be replaced easily without tools. It is necessary to clean and refill the bichromate batteries once in three to six months, according to their size and use, but it is very important to remove at least once in every six months the crystals adhering to carbons, zincs, and especially to the acid vessel. The quality of the acid is also of great importance for these batteries, as the strength of current depends very much on it. We recommend the following solution : *Dissolve* 1 lb. of bichromate of potassium in 8 lbs. of hot water, add *slowly* 2½ lbs. of strong sulphuric acid, while stirring constantly, and dissolve in this mixture, while it is hot, 3 ozs. of bisulphate of mercury.

* The peculiar type of bichromate cells known as "bottle elements" have made bichromate batteries famous for inconstancy. In these bottle elements, carbons and zincs are put together as closely as possible, so that they can pass through the narrow neck of the bottle. The consequence of this arrangement is that internal resistance is very low, and the current very powerful for the first moment, but the small quantity of acid between carbon and zinc gets used up rapidly and the strength of currents drops therefore 50 to 75 per cent. within the first minutes. If, however, the space between carbon and zinc admits *a sufficient quantity of acid*, bichromate cells may heat a cautery burner even for hours constantly.

Accumulators.—Compared with primary batteries, the advantages and disadvantages of the accumulators are as follows :

They are smaller, more constant and more portable than bichromate batteries of similar capacity ; and they need not be plunged in and out.

On the other hand, they are more easily damaged and cannot so easily be re-charged as primary batteries, and if anything goes wrong with them, they have to be returned to the makers. The great secret seems to be, that they are re-charged *frequently*. If re-charged once or twice a month, or oftener, they are likely to be perfectly reliable, convenient and a success, but if left for months without being re-charged, they are bound to prove a failure, because if left half empty or quite empty for any length of time, chemical changes take place which reduce their capacity for storing electricity permanently, and make the plates unfit to be charged again. The plates have then to be replaced by new ones by the makers before the accumulators can be used again.

It follows from this, that only those doctors should use accumulators who have either got the electric light (continuous current) laid on to their house, and can re-charge the accumulators themselves, or who have got an electrician within convenient reach who will undertake to re-charge the accumulators regularly about once a month.

They may be re-charged from primary batteries too (Daniell, Bunsen or Grove cells) but this requires attention and care. It is easier to re-charge them from thermopyles. The simplest plan, however, is to re-charge them from the current supplied for lighting houses ; it must be a continuous and not an alternating current.

The following hints about charging and discharging them may be useful. First of all, the size of the accumulators should be such that they do not get damaged if a current of 15 ampères is taken out of them. In other words, they ought to have a capacity of not less than 20 ampère hours. If a smaller size is chosen for cautery they will soon get damaged. Between the main and the accumulators there has to be a resistance, as the charging current must not be too strong. A 32 or a 50-candle lamp is most suitable for this purpose. In order to charge the accumulators the + pole of the main has to be connected with the + pole of the accumulator, and the − pole of the accumulator with the − pole of the main. By means of pole-finding paper the + and − of the main can easily be found out ; on the accumulators the + pole is usually painted red. The charging is finished as soon as the acid turns milky. It takes about 20 hours to charge an empty 20 ampère hour accumulator, if a 32-candle lamp is used as resistance. To keep accumulators in good working order it is essential that they should be charged *frequently*, once a week at least, or even once a day for a little while. (The light of the resistance lamp can be utilized for lighting up a room or a lavatory, etc.) Under such circumstances accumulators will give no trouble. While they are being charged there is a strong smell, and it is therefore preferable not to keep them in the consulting room, but rather in a lavatory or surgery, and to connect them with the consulting room by two stout insulated cables. 2 to 4 cells are quite sufficient for cautery. There has to be an adjustable rheostat in the circuit for regulating the discharging current for the cautery burners. The wires and fuses which lead to the accumulators which have to be charged need only have the minimum diameter allowed by the Electric Light Companies (No. 16 B.W.G., 3 ampères).

Dry Leclanché Cells.—One kind of Leclanché cell invented about four years ago has so small an internal resistance, and is so constant, that it can be used for *small* cautery operations. Six elements of 4 by 4 by 7 inches, three of which are connected parallel, and the two groups in series, are able to keep a burner requiring up to 12 ampères incandescent for about two hours altogether—not continually, as the battery requires some rest for recovering; but constantly for about 5 minutes at a time. Two hours seems but a short time, but if we consider that the greater part of cautery operations takes less time than one minute, we find that such a battery is sufficient for over 100 operations. These batteries are not to be recommended for regular use in the consulting room of a busy throat specialist, but they are convenient for eye and ear specialists, who require small burners only, and are good for those doctors who use cautery only occasionally, and do not care to clean and re-charge acid batteries. They are suitable for portable batteries on account of the absence of any liquid. If the cells are no longer strong enough to heat a cautery burner, they will still do for surgical lamps, bells, etc. They cannot, however, be refilled, but have to be replaced by new cells, which can easily be put in the battery boxes.

Rheostats for Batteries.—A rheostat is most convenient with every battery for regulating the strength of current for cautery. A bichromate battery, without a rheostat, cannot be plunged in deeper than is necessary for just making the wire red hot; on account of polarisation, etc., the current diminishes pretty quickly, and the battery ought to be gradually immersed deeper, in order to keep the burner at the same temperature; this would necessitate frequent attention to the battery. A rheostat, however, enables you to immerse the battery completely from the beginning, and to reduce the current to the proper dimensions by inserting an artificial resistance. As the cells have a larger surface by the deeper immersion, the strength of current remains constant for a much longer time, so that the operator can give his whole attention to the patient. Rheostats are quite indispensable for accumulators, as without them all burners would be destroyed at once.

Rheostats for cautery cannot be made with thin wire, as such wire would get incandescent too; hence for a current of 10 to 15 ampères, we employ German silver wire of 2 to 3 mm. diameter, and about 6 ohms total resistance. This wire is wound in a spiral, and a longer or shorter piece of it can be inserted, by means of a sliding spring. It is best to begin by inserting the whole resistance, and after the circuit has been closed, to diminish it gradually, by moving the spring, until the platinum has the proper temperature for operations. A bright red or yellow heat is best ; white heat, or dark red heat, causes bleeding.

Faults.—In order to rectify any fault, it is necessary with these batteries too, to find the seat of the defect, and it will then be easy to remove it. The burners are apt to fail because the two copper wires may touch at the end near the platinum, so that the current can pass directly from one wire into the other without reaching the platinum at all. This is a frequent fault, and can be recognised by the copper wires getting very hot. They should be separated with a finger nail so far that you can see between them all along. If the platinum of a burner has been fused by too strong a current, a new platinum wire must be soldered on with silver by the electrician. If the battery fails, in spite of the burner being all right, you should take off the handle, and let the two ends of the connecting cords touch each other. If they yield a strong, crackling spark, the fault is in the handle—the place of contact is oxidised, and has to be cleaned with fine emery paper ; but if the connecting cords yield but a weak spark, or none at all, the fault lies further back. A weak spark shows that the connections, etc., are in good order, but that the battery is too weak. In this case, accumulators have to go back to the electrician, and the exhausted cells of dry batteries must be removed and replaced by new cells. With bichromate batteries, however, the fault can be easily removed. If the solution has turned green, it is exhausted, and the battery must be cleaned and refilled. If the fluid is still red or brown, a cell has been short circuited by carbon and zinc touching one another, *or else the zincs are covered with a coating of oxide,* which can be best removed if they are screwed off and cleaned under a water tap with an old nail brush, until the bright zinc reappears. If there is no spark at all, although the battery can hardly be exhausted, you should remove the connecting cords and see whether the cells yield a spark, if the end terminals are connected with a short wire ; if this gives a spark, the rheostat or the cords are at fault. A fault in the cords is indicated by excessive flexibility on the broken place. A rheostat may get burned through under unfavourable circumstances—both faults have to be remedied by the electrician. If, however, there is no spark, either the connection amongst the cells is at fault, or the arrangement of the cells is incomplete ; which shows, if each element is tested singly at first, and afterwards groups of two or more cells; or the battery is exhausted, and you have to clean and re-charge it as already stated.

CURRENT SUPPLIED FROM DYNAMOS FOR LIGHT INSTALLATIONS.

We have finally to mention the instruments which enable us to regulate the current supplied for illuminating houses, so that it can be used for cautery. Such a current of 100 or more volts would immediately fuse a burner; but it can be regulated in two ways—either by rheostats, or by transformers.

In order to utilize the 100-volt *continuous* current for cautery, you have either to use a rheostat, or else accumulators must be charged with the current. Neither of these methods is very economical, as about 80 per cent. of the electricity is destroyed again, but as electricity generated in a dynamo is much cheaper than that produced by batteries, it is not more expensive to use such a rheostat than to use a bichromate battery, and the rheostat is certainly more convenient.

If rheostats only are being used, the fuses and cables in the house which lead to the rheostat must be of such a size that they can carry a current of about 20 ampères without getting hot. The material of the artificial resistance, too, must be of such a diameter that 20 ampères will not make it unduly hot. If, for instance, platinoid wire is used, the wire should be of No. 10 B.W.G. (3·2 millimetres), and some 175 yards of it are required to obtain the desired resistance of 5 to 6 ohms for a 100-volt current.

When a current of 100 volts and 20 ampères is interrupted, there is a very strong spark, which would not only frighten the patient and operator, but would immediately destroy the cautery handle, by setting up an arc light in it. To avoid this spark, a shunt circuit must be arranged, that is to say, there must be two ways open to the current : one through the cautery handle, and another parallel to it through a shunt. The resistance in the shunt should be about ten times as great as the resistances in the cautery cords, handle and burner together. While contact is made in the handle, nearly the whole current will pass through the burner, as the current always chooses the way on which it finds least resistance. If the contact in the handle is interrupted, the current is not broken, but passes through the shunt. The making and breaking of the contact in the cautery handle does, therefore, not make or break the current, it only shunts it into another channel, and if the proportion of the resistances in shunt and burner is correct there will be no sparks at all in the handle.

With this arrangement, however, a heavy current passes through the rheostat as long as the switch connects it with the main, whether the cautery burner is being used or not. To prevent unnecessary waste, a lamp is added, the light of which reminds the operator that the rheostat is connected with the main, and that he ought to turn off the switch as early as possible. Fig. 14 shows the circuit in a rheostat which allows of varying the current between 8 and 18 ampères without any jumps. P are spirals of platinoid wire with which a shunt is connected near *a* and *b*. A small rheostat, R, with a sliding spring regulates the strength of the current in the shunt circuit, of which the cautery burner also forms a part. There are some 50 of these rheostats already in use, and up to now they have worked without a hitch.

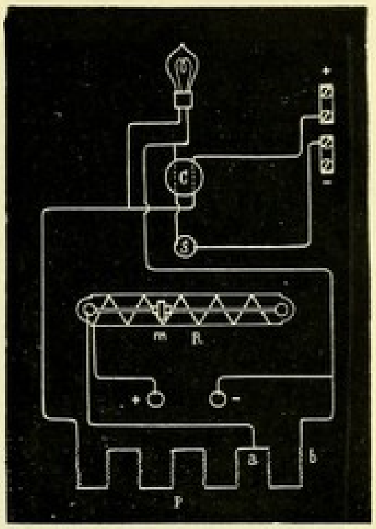


Fig. 14.

Rheostats of this kind are very convenient, but they are rather large and do not look very ornamental (size and illustration will be found under No. 1052 and 1054 in the price list).

If a combination of a rheostat and 2 accumulators are used, a smaller, neater, and less expensive switchboard can be utilized for controlling the charging and discharging current, and moreover, the wires leading to this switchboard can be of the smallest size allowed in a house. For these reasons, this combination may be welcome to many medical men.

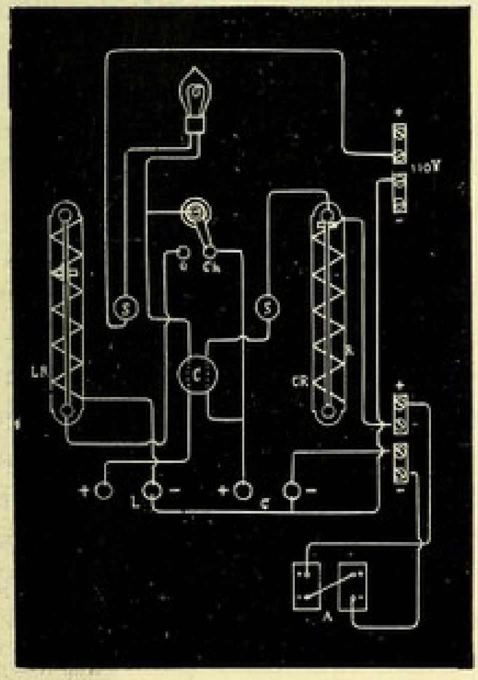


Fig. 15.

Fig. 15 shows the connections of an apparatus for charging accumulators from the main and discharging them for cautery, with the necessary switches, lamps, rheostats, etc.

This illustration shows also the connections required for utilizing small surgical lamps in connection with the 100-volt current. We shall refer to this part of the diagram later on. About the charging, etc., of accumulators, see page 29.

Where *alternating current* is available, it is very easy to utilize it for cautery and surgical lamps; a rheostat might be used, but the most economical and convenient method is to use transformers, which we introduced some five years ago at the suggestion of Mr. A. B. WOAKES.

A Transformer is an Induction coil, which converts currents of high tension and small strength into currents of small tension and great strength, and *vice versa*. In this way you can, for instance, transform a current of 100 volts and 2 ampères into one of 10 volts and 20 ampères, etc. As the strength of current required for the various cautery burners varies between 8 and 25 ampères, according to the size of the platinum wire, there should be an arrangement for regulating the strength of the current. There are several ways of doing this: either the transformer is constructed after the manner of the sledge coils, as in Woakes' transformer, or else the construction is so that the maximum current obtainable for cautery measures about 8 volts and 25 ampères, and the current for the surgical lamps 15 volts and 2 ampères, and by means of two small rheostats the current can be adapted for the various sizes of burners and lamps. This latter method is shown in Fig. 16, and utilized in transformer No. 1049.

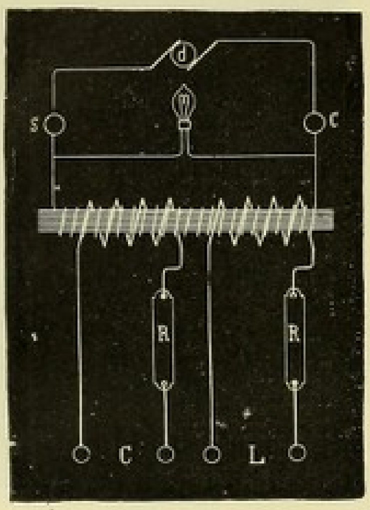


Fig. 16.

If a lamp is added, and connected with the apparatus in such a way that it burns as long as the switch is turned on, the doctor is reminded that the apparatus is connected to the main, and that it ought to be switched off. But as little current passes through the primary coil as long as the cautery burner is not switched on, the lamp is not absolutely necessary.

Galvanometers.—Galvanometers are not necessary for cautery, for it is not important to know how many ampères are required for obtaining the proper temperature of the platinum. They are convenient only for controlling the battery and for experiments.

Cords.—Connecting cords for cautery ought to be thick, because, if thin, they would either get too warm, or else weaken the current considerably. Their resistance should not be more than 0·02 ohm.

Handles.—There exist many different shapes of handles for holding the burners. All of them are fitted with a trigger, mostly like the trigger of a pistol, in order to enable the operator to introduce the platinum wires cold, and to heat them at the desired moment only, by closing the circuit through a pressure on the contact. Many handles have an arrangement for drawing a wire loop together, for the removal of polypi, tumours, etc., with the incandescent platinum or steel loop.

Burners.—The platinum burners which are made pointed, knife, cup, or ball shaped, are soldered on to copper wires of different lengths and curves, according to whether they are meant to be used in the nose, larynx, mouth, ear, etc. The copper wires are partly insulated from one another with silk, which is wound round them in the shape of an 8, but where the copper touches the platinum they grow so warm that the silk would get black, and, therefore, they are for a short distance insulated with shellac varnish only.

BATTERIES AND INSTRUMENTS FOR ELECTRIC LIGHT.

Advantages of the Electric Light.—The electric light is whiter and more intense than any other kind of light. It develops less heat, and the lamps need not be held upright, as oil lamps, for instance, and can, therefore, be brought much closer to the object which has to be examined. All these facts help to make incandescent lamps most useful for medical purposes, in the consulting room, but more especially in the patient's house, where often a wax candle is the only other available light which might be used. The electric light is, moreover, the only kind of light which can be introduced into the human body, either for examinations of cavities like the bladder, or else to discover bleeding arteries during operations, or to make part of the body transparent (antrum) for diagnostic purposes. It is, moreover, a most convenient night light for medical men, who are often called out at night; for a turn of the switch, which may be fixed on the bedstead, is sufficient to light up the whole room. Finally, it is useful as a reading lamp in carriages, for invalids, etc., although in these latter instances, the fact that the electric light produced by batteries costs still about 3d. to 5d. an hour for a 2½-candle lamp is a drawback.

Specialists for eye, ear, throat and nose diseases, whose houses have the electric light laid on, can use the current also for focus lamps, *i.e.*, incandescent lamps, the carbon filament of which is not horseshoe shaped, but fitted in the centre of the lamp, so that the lamp can very well be used with a lens. These lamps give a good light of 25 to 100 candle-power, according to the lamp chosen. If properly arranged, the lamps do not show light and dark spots, and as to convenience and cleanliness, they are superior to any other lamp.

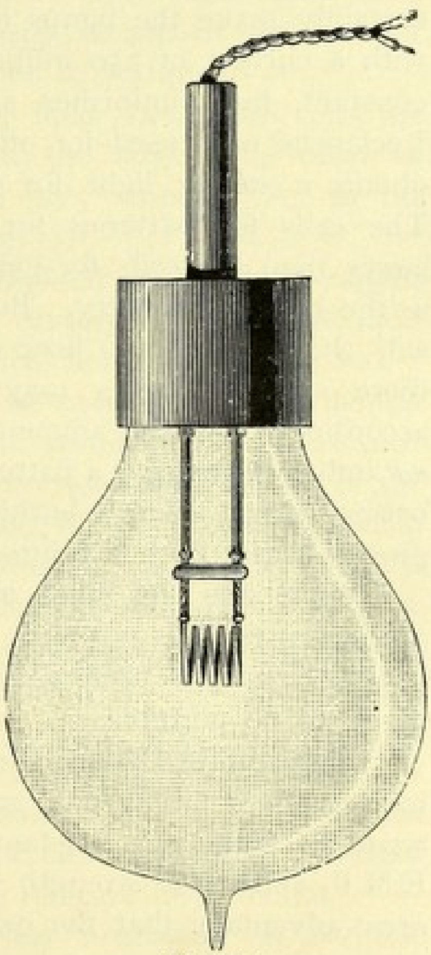


Fig. 17.

Resistance of the Lamps, and Strength of Current required.—The resistance of the incandescent lamps used for medical purposes varies from 7 to 25 ohms. The strength of current required for rendering the carbon filaments of the usual lamps incandescent is 0·3 to 1·6 ampère; 0·75 ampère is about the average. The longer and thinner the carbon filament, the more resistance it has, and the less current is wanted to bring it to white heat, and *vice versa*. Lamps requiring 0·75 ampère, or less, remain so cool that they can always be touched. Lamps which require 1 ampère and more, however, grow pretty warm if they burn in the open air. In order to obtain this strength of current with the resistances mentioned before, 7 to 11 volts are required, and therefore batteries of four to eight cells, connected in series, are necessary, according to the E.M.F. and the internal resistance of the cells.

The carbon filaments have a much higher resistance than the platinum burners used for cautery, but require considerably less current to get incandescent; but all cautery batteries with four and more cells can very well be used for surgical lamps too. Most of the lamps require, however, more milliampères than the small portable cells, constructed for galvanisation and electrolysis, are able to keep up for any length of time. These batteries of many small cells certainly make the lamps incandescent, but they polarise too quickly with a current of 750 milliampères, and consequently the light is not constant, but diminishes after a very short time; only the large Leclanché cells used for office batteries depolarise quickly enough to obtain a steady light for some minutes at least with these lamps. The cells for batteries for the electric light ought therefore to be larger than the cells for galvanization, but they need not be as large as the cells for cautery. But of course the larger they are, the longer will they be able to keep a lamp incandescent, and the more cells there are, the longer may the carbon filament be, and the larger accordingly will the amount of light be. The *number* of cells does *not* influence the *time* a battery can keep a lamp incandescent; a 6-cell battery keeps a lamp burning for the same time as a 10-cell battery, provided that both are fitted with the same kind and size of cells.

What are the most suitable Cells? The variety of cells for producing light is not very great, because no cells with high internal resistance can be used, and because nearly all the batteries have first of all to be portable.

Bichromate Cells.—Bichromate batteries (about their treatment, mixing the solution, etc., see page 28), *provided that the cells are not made too small*, are constant enough, and quite apart from their high E.M.F. and great strength of current, they have, moreover, the very great advantage that the owner is quite independent of the electrician for some years at least, as he can easily keep them in order himself, a most important point for doctors, who live far from the manufacturer. They have, however, to be refilled every three or four months, and as far as convenience and cleanliness go, they have certainly been surpassed by other batteries, suitable for doctors living within reach of the manufacturer.

Accumulators.—As to accumulators, we can only repeat what has been said on page 29.

Leclanché Dry Cells.—These can be put by for a long time, *i.e.*, for about two years or so, without getting injured, and they remain in good condition for years (if their contents do not get exhausted previously by actual use). They have an E.M.F. of 1·5 volt, and an internal resistance of 0·3 ohm. They are small enough to be very portable, and as they contain no liquid whatever, they can be sent charged as ordinary luggage all over the world. They are, owing to their peculiar construction, more constant than fluid elements of the same size. The dry cells, if exhausted, can still be used for house bells, etc., but they cannot be refilled. These batteries are the only ones which are really reliable for eighteen to twenty-four months, without requiring re-charging or any other attention during this time, but the cells have to be replaced by new ones—even if the battery has not been used—after about two-and-a-half years. New cells have to be supplied by the makers, but these can easily be put in place of the old ones, so that the battery itself need not be returned.

If the battery need not be portable, fluid Leclanché cells are very suitable for incandescent lamps; but the large cells must be used, at least for lamps requiring 0·4 to 0·75 ampère. As to the refilling of liquid Leclanché cells, see page 11.

Transformer.—The transformers mentioned on page 33 can be used for surgical lamps as well as for the cautery, and what we have said there about them and their convenience, holds good here, too.

The 100-volt Continuous current can be used for surgical lamps. In this case an incandescent lamp is most suitable as a resistance. If the carbon filament of the surgical lamp happened to be of the same diameter as the carbon filament of the 100-volt lamp, this lamp alone would be quite sufficient as resistance; as, however, it is impossible to get these little lamps so exactly to order, the resistance lamp should be chosen a little larger, say of 32- or 50-candle power, and a variable rheostat should be added as well. The current can then be accurately adapted to the small lamp. Fig. 15, page 33, shows the connections for charging and discharging accumulators, as well as the connections required for utilizing surgical lamps. The variable rheostat (LR) is placed in a shunt circuit, in order to avoid any sparks on breaking the current in the delicate instruments.

Rheostat.—Rheostats are not absolutely necessary for surgical lamps, but they are most convenient, and the small expense of obtaining one will be made up in a short time, because less lamps get destroyed by using them. The rheostat had best be fixed on the battery, as in this way it may be used for several instruments. Rheostats for electric light batteries ought to have about 30 ohms total resistance, which can be inserted in small portions. They are best made of German silver wire, which ought to be thick enough to allow a current of $1\frac{1}{2}$ ampère to pass without getting hot.

Galvanometers are not necessary, as a bright light only is required, but there is no need for knowing how many ampères are wanted for each lamp.

The cords need not be as thick and heavy as those used for cautery, and as the difference between the positive and negative poles is of no consequence in this case, they are generally so twisted, that there seems to be only one cord leading from the battery to the instrument.

Normal rate of Burning.—The amount of light which a lamp can yield may not be increased to any extent by increasing the strength of current, without damaging the lamp. The carbon filament should be a little more than yellow, just white hot, but not more than that. If this degree of incandescence is exceeded, the lamp can certainly give twice as much or even more light than under ordinary circumstances, but its life gets considerably shortened, as the carbon filament evaporates by being over-heated. If the current used is very much in excess of what the lamp requires for becoming white hot, the lamp will stand it but for a few minutes, or give only one momentary flash. If the current which the lamp requires is not known, the whole resistance of the rheostat should be inserted, and only a few cells used to begin with. The number of elements can then be increased one by one till the carbon filament gets red or yellow, and the current can then be increased by diminishing the resistance, until white heat is obtained. The life of small surgical lamps varies between twenty and one hundred lighting hours with ordinary use, and the candle power is $\frac{1}{2}$ to 8 normal candles.

Faults.—If the instrument fails, examine first of all the lamp. The lamps are mostly provided with an arrangement allowing them to be exchanged easily—in most cases they are fitted with a screw, which has to be well screwed home. Other lamps, which are only stuck in, should stick fast in their holder. The lamps may get loosened by shaking, heating, etc., and this, of course, would break the circuit, and when the light fails this ought to be seen to first of all. The carbon filament may be burned through, and this frequently shows itself by the glass looking grey. In this case the lamp has to be replaced by a new one. But if the lamp and its connection with the instrument are in good order, and still there is no light, the fault is likely to be in the battery, and may be found out in the way mentioned already under galvanic cautery; for experience shows that, with the exception of the lamps, the illuminating instrument itself is hardly ever in want of repair. The sparks obtained from batteries for the electric light are not nearly as strong as those yielded by the cautery batteries, and therefore it requires more attention, especially in the daylight, to find out whether the battery or perhaps only a single cell gives a spark or not. With plunge batteries, the fault may be easily set right, but accumulators have to go back to the electrician. For Leclanché dry batteries new cells have to be bought, but they can easily be put in place of the old ones and reconnected, so that there is no need of sending the batteries back.

ROENTGEN X RAYS.

In December '95 the scientific world was startled by the news of a discovery made by Professor Roentgen of Wurzburg. He found that Crookes tubes emanate rays, which, although invisible to the human eye, have the peculiarity of affecting photographic plates and fluorescent salts. Many things through which ordinary light cannot penetrate, like paper, wood, ebonite, flesh, etc., are transparent to these so called X rays, while other substances, like glass, most metals, bones, etc., remain more or less opaque.

A great number of scientific men all over the civilised world experimented at once with the X rays, and it was soon evident that this discovery would be of great importance for surgical purposes, as malformations and diseases of the bones, foreign bodies, etc., could be detected by its help. The difficulty at first seemed to be, that fairly good shadowgraphs could be obtained with very large Rhumkorff coils only, and at least ten minutes' exposure for hands, arms, legs, etc., were required, whereas chest and abdomen seemed to be too thick altogether to be penetrated by the X rays. Experiments showed, however, that good results depended considerably more on the quality of the tubes, than on the mere length of the sparks, and that therefore the size and cost of the apparatus, as well as the time of exposure could be reduced by improving the tubes; the chest proved to be penetrable, and the whole skeleton of the human body, as well as the movements of the heart, larynx, the liver, calcification of arteries, etc., can now be made visible on the fluorescent screen, a fact which of course infinitely increases the value of this discovery for medical and surgical purposes.

The necessary apparatus for producing the X rays consists of—

(1,) The Electrical Apparatus.

(2,) The Crookes Tube.

(3,) Photographic Plates or a Fluorescent Screen.

The Electrical Apparatus.—The sparks are most frequently produced by means of a Rhumkorff coil, the size of which depends on the individual requirements and means. A coil giving sparks 2-inches long is sufficient for taking a shadowgraph of hands, arms, legs, etc., but a coil which gives a spark of 4-inches length, enables you either to reduce the time of exposure, or else with the same exposure to obtain negatives with much more detail. If the coil is to be useful for the fluorescent screen as well, or if it is intended to photograph the spine, etc., a larger apparatus, capable of giving 6-inch sparks, is needed, and specialists and large hospitals will find an even larger coil most useful.

The coils must be fitted either with a platinum or else with a mercury interrupter. The platinum interrupter is cleaner, and gives more rapid interruptions, which is of some advantage, for the quicker the interruptions, the shorter the exposure. On the other hand, there is no doubt that the mercury interrupters yield longer and more intense sparks, and they too can be so constructed as to give a continuous stream of sparks; the only drawback is, that the mercury has to be filtered after a few hours use, in order to cleanse it, and that takes a few minutes time. There is no doubt that the smaller apparatus, up to the 4-inch spark coils, are best fitted with a platinum interrupter, and the large ones from 10-inch sparks upwards, with a mercury interrupter. Whether the 6- or 8-inch coils are to have platinum or mercury interrupters is a matter of taste, for our own part we prefer mercury interrupters even for the 8-inch spark coils.

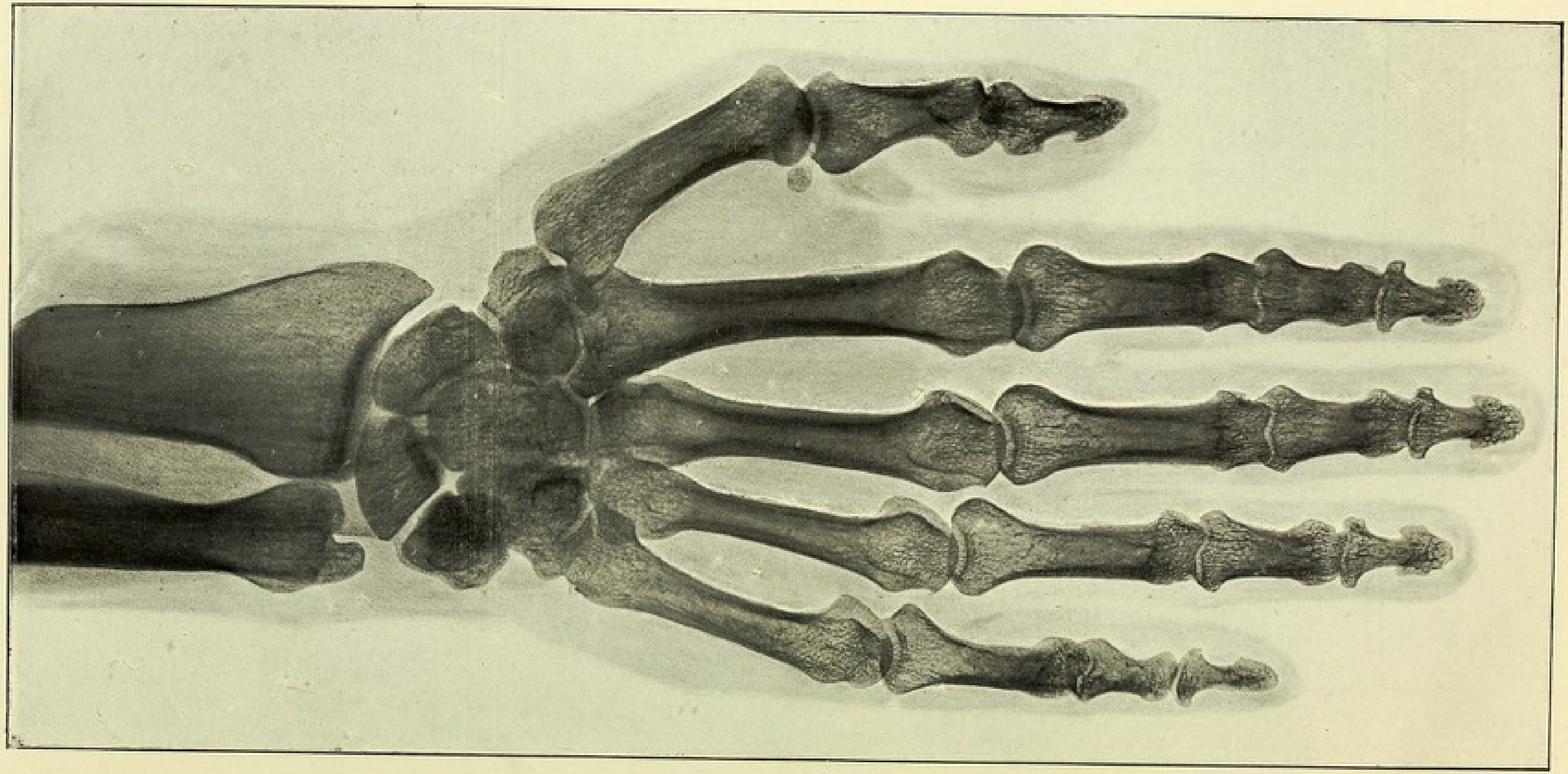
A Powerful Battery is required for working a coil. Accumulators, Bunsen or Grove cells or *large* bichromate cells may be used. As to the advantages and drawbacks, and the treatment of these various batteries we refer to pages 28—30, on cautery batteries. To those who doubt the suitability of bichromate cells, we beg to add that a battery with six *large* bichromate cells is quite sufficient for working an 8-inch spark coil for over two hours continuously, without requiring re-charging; 4-cell batteries suffice for working coils up to 4-inch sparks; 6-cell batteries are strong enough for 8-inch spark coils, and 8 to 10 cells for coils up to 16-inch sparks. A rheostat for controlling the batteries is always very convenient; for the larger apparatus it is necessary.

The 100-volt Continuous Current from Dynamos, if available, is of course infinitely more convenient than batteries, but the coils cannot be connected directly with the main; a rheostat, such as described on page 32 for cautery has to be inserted into the circuit.

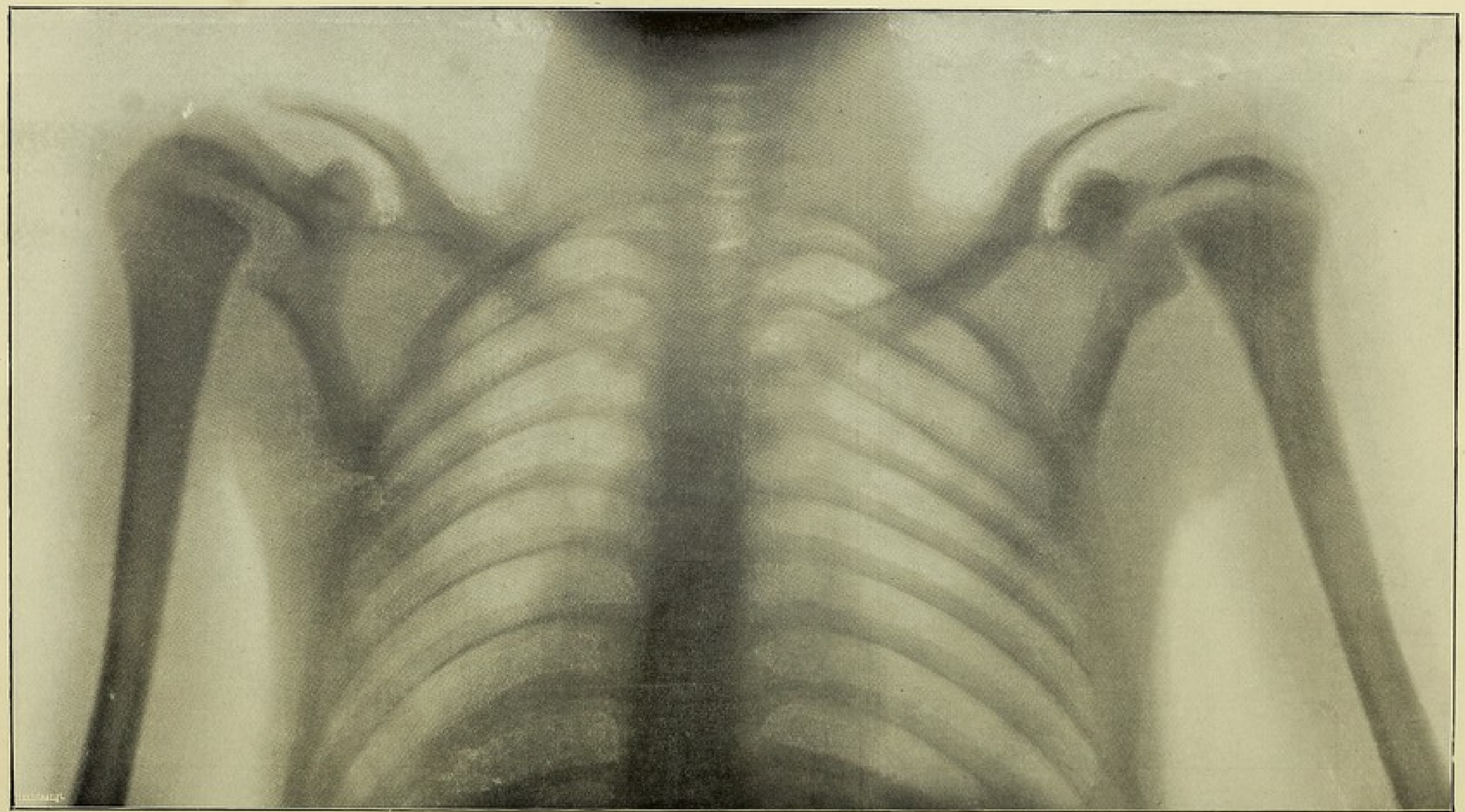
One has to be very careful not to overexert the coils; a discharger, or a Crookes tube should always be connected with the poles, and the length of the sparks which the coil is warranted to yield should not be exceeded, as there is the danger that a spark might pierce the insulators, and thereby permanently damage or even destroy the coil.

Sparks from **Static machines** may be used, but the machines ought to have at least 6 plates or more, otherwise the intensity of the sparks would be insufficient.

Lastly, the **Alternating Current from Dynamos** can be used directly without any Rhumkorff coils. Its E.M.F. is first raised to about 6000 volts by means of a transformer. The terminals of the transformer are connected with a condenser and a spark gap, which



A Normal Hand, 38 years old. The Negative was taken by us in June, 1896, on an Edwards Isochromatic *Medium* Plate; exposure five minutes with a 6-inch spark from a Rhumkorff Coil. Distance of tube from plate 8 inches.



Taken with a 6-inch spark; exposure eighteen minutes; distance of tube from object 30 inches.

discharges through the primary wire of a Tesla coil; the secondary wire of the Tesla coil yields then an amazing supply of sparks; their length depends on the construction of the Tesla coil, and the strength of the primary current. This way of producing X rays is undoubtedly by far the most convenient, and will replace the Rhumkorff coils, wherever the alternating current is available. Several Crookes tubes may be used simultaneously with this arrangement.

Crookes Tubes.—As mentioned before, a good result depends much more on a really suitable Crookes tube, than on the mere length of the sparks. The tubes mostly in use at present are the so called focus tubes. With a good tube a shadowgraph of the hand similar to our illustration can be obtained in less than 5 minutes with a 3-inch spark; in about 2½ minutes with a 6-inch spark, and in a few seconds with a 10 to 16-inch spark. To get a good shadowgraph of the spine and ribs, an exposure is required of 8 to 30 minutes, according to the length of the spark, the thickness of the chest, and the quality of the tube. With an exceptionally good tube the time of exposure will be shorter still, but in autumn '96, when this pamphlet was being printed, such tubes were very rare.

If, however, the vacuum is too high or too low, or if the tube is deficient in any other respect, a clean sharp negative even of those parts, such as the hand, cannot be obtained with any length of sparks and time of exposure. The vacuum of the tubes tends to get higher after they have been used for some time; for a 6-inch coil for instance it would therefore be advisable to select a tube which would give good results with 4-inch sparks already, and to use 4-inch sparks only, so long as the tubes work well with it; by and by the length of the spark may be increased. If the vacuum is too high, the tube ought to be warmed a little with a spirit or gas flame before being used. The tubes are held on a stand, so that the platinum reflector shows towards the object; the distance between it and the object should be 3 to 30 inches, according to the size of the object and of the plate. If the current reverser of the coil is in its correct position, the green fluorescence gets evenly diffused inside the tube, and only the part behind the platinum reflector is less luminous, whereas a wrong position of the current reverser causes a patchy fluorescence on the walls of the glass only. The current reverser should not be allowed to remain in this false position for any length of time, as this might damage the tube. A vigorous supply of sparks causes the platinum reflector to get red hot, and in this case the current should be frequently interrupted for a few seconds, in order to give the platinum time to cool down.

Fluorescent Screens.—In order to utilize the X rays, and make them visible to the human eye, we want either a fluorescent screen, or else photographic plates or films. The screen is the simplest, and consists of cardboard covered with crystals of potassium or barium platino-cyanide. Tungstate of calcium gives good results too, and has the advantage of being considerably cheaper than the first named materials. The fluorescent screen can be used in a perfectly dark room only, the Crookes tube even ought to be covered, so that the green light does not show. The screen is preferable to photographic plates for observing all things that are in motion, like the heart, etc. By means of the screen foreign bodies like bullets, needles, etc., can be detected ; it shows whether fractured bones are properly set, and even the movements of the heart, the larynx, the liver, etc., can be seen very clearly. For using a fluorescent screen, sparks of 5 to 10 inches length are required.

Photographic Plates have the drawback that they must be developed like ordinary photographs (instructions for this can be found in "Burton's Modern Photography," pages 32 and 90, or any other handbook on photography). Their great advantage, however, is, that they show finer details than can ever be obtained on the screen, and therefore are more suitable for investigating diseases of the bones, and moreover they leave a permanent record.

The plates should, by deep ruby light, be wrapped up in black paper, or in a bag of specially prepared ruby silk, and thus protected against ordinary light, and may afterwards be exposed in any room. If glass plates are used, care should be taken to place them, *film upwards*, under the tube, as glass is opaque to the X rays and there would be no result whatever, if the glass plate intervened between the sensitive film and the tube. If thicker objects are to be photographed, it is of some advantage to use films, and place them on a fluorescent screen during the exposure, as the rays are more economically used in this way. The object should always be as near to the photographic plate as possible. There is some difference of opinion about the most suitable plates ; all kinds can be employed, and the most rapid ones are generally preferred ; we, however, have invariably obtained our best negatives with comparatively slow plates. Medical men who have no experience in developing, printing, etc., of the negatives, and no time to learn it, will have no difficulty in obtaining the help of a professional or amateur photographer for this most interesting process.

FARADISATION.

The genius of Faraday taught the world another way of producing electricity. He found out that in a closed circuit a current is induced as often as a magnet is approached to this conductor, or withdrawn from it or as often as a current is closed or interrupted in the neighbourhood of the closed circuit. This discovery was the first step towards producing electricity by mechanical power—towards the dynamo, telephone, and all the marvellous acquisitions of the last thirty years.

Origin of the Induced Currents.—If the two ends of a wire are connected with a sensitive galvanometer, and a magnet is approached to the wire, the needle of the galvanometer declines *as long as the magnet is approaching*, and returns to 0 if we cease to change the distance between wire and magnet. If we *withdraw* the magnet, the needle declines again, but in the opposite direction. If in the neighbourhood of the closed conductor a second wire is drawn parallel to the first one, and the ends of

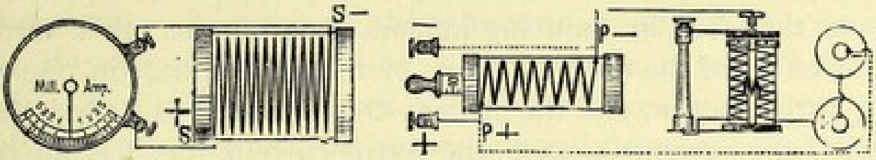


Fig. 18.

this second wire are connected with a galvanic cell, the needle deflects the moment the circuit is closed, although there is no connection whatever between the two wires; but it returns to 0 immediately afterwards, and remains there, although the galvanic current continues to circulate in the second wire. If we diminish or interrupt the current, the needle deflects again, but in the opposite direction. This shows, that the approaching and the withdrawing of a magnet, or the making and the breaking of a current in a conductor close by, induces currents in a closed circuit, which, however, are of very short duration only, and which pass in opposite directions.

Alternating Currents.—The currents induced by *closing* a galvanic currrent pass in the direction *opposite* to that of the inducing current; the currents induced by *breaking* the inducing current pass in the *same* direction as the inducing current. If we make and break the inducing current very often consecutively, we induce each time a momentary current in another conductor, but the directions of these induced currents keep changing, and for this reason we call them *alternating* currents, in contrast to those currents which keep their polarity.

Wagner's Hammer.—Wagner's hammer (see diagram, p. 47) is most frequently used for rapidly making and breaking the current. The current passes through the electro-magnet, through the hammer, the contact screw, and back to the battery; or else it can be made to pass from the contact screw through the inducing wire and then back to the battery. As soon as this arrangement is connected with a cell, the electro-magnet becomes magnetic and attracts the hammer, which consequently leaves the platinum point of the contact screw. This, however, interrupts the current, the electro-magnet ceases to be magnetic, and a spring causes the hammer to fly back; as soon as it touches the platinum point again, the current is again closed, the hammer again attracted, and this play lasts as long as the apparatus is connected with a cell giving a current. The wire through which the inducing current passes is called the *primary* wire, and the wire in which currents are induced is called the *secondary* wire; the induced current is called the *secondary* current.

Self-Induction Extra Currents.—For various reasons we do not draw the primary and secondary wires in a straight line, but wind them in spirals on cylinders of wood, paper, etc., which are made of such sizes that the primary coil can be pushed into the secondary coil. In a spiral each turn of the wire is parallel with the previous and following turns of the same spiral, and a current which passes through a turn of the spiral must have, therefore, an inducing influence too on the other turns close by. This effect of the different turns of the same spiral on one another is called *self-induction*, and the current thus induced is called the *extra current*. If the current is made, the extra current too, has an opposite direction to the inducing current, and thereby retards and weakens the inducing current, and consequently the secondary current too; but if the inducing current is interrupted, the extra current flows in the same direction as the inducing current, and increases thereby the latter current very considerably, and consequently the secondary current too. The shocks which are induced by making and breaking the inducing current are, therefore, of very unequal strength; those induced by breaking the inducing current predominate very much, and the signs + and − which are near the terminals of the better induction coils are intended to show the direction of the currents induced by *breaking* the inducing current. The signs would have no meaning if the currents induced by making and breaking the inducing current had an equal strength, as they follow one another in opposite directions.

Primary Currents.—If we connect one or two galvanic cells with a Wagner's hammer, which is provided with a small electro-magnet only, and connect the cells by means of two further wires with two electrodes, which we hold in our hands, we shall not feel the making or breaking of the current. But if the current has to pass a primary coil with several hundred turns of wire besides the Wagner's hammer, each breaking of the current gives us a decided shock, the strength of which, amongst other things, depends upon the number of turns of the coil; this shock is caused by the extra current. This is the *primary* current, which we obtain from medical induction apparatus; it is an *intermittent galvanic current*, very considerably increased by the extra current, but it is *not an alternating current*. We shall come back to a further difference between primary and secondary currents later on.

Iron Core.—The inducing effect of a current is considerably increased by letting it act simultaneously with a magnet, and this can be arranged easily if the primary wire is wound round an iron core, or better, if it is wound round a cylinder into which an iron core can be pushed. It is, however, preferable, that the iron core should consist of a bundle of soft iron wires, as these take and lose magnetism much quicker than solid iron. In this way two powers act, inducing in the same direction and exactly at the same time, the making and breaking of the inducing current, and the sudden appearance and disappearance of a strong magnet; this increases the inducing effect on the primary as well as the secondary current very considerably.

E.M.F. of the Induced Current.—The E.M.F. of the induced current depends on the number of turns of wire which a coil has; the more turns the higher the E.M.F. Secondly, on the strength of the inducing current; the stronger the latter, the higher the E.M.F. of the induced currents. Thirdly, on the presence or absence of an electro-magnet; its presence increases the E.M.F. of the induced current very materially. And ultimately the E.M.F. of the secondary current depends too on the distance between the secondary and primary coils; the closer they are together, the higher is the E.M.F., and *vice versa.*

Strength of the Induced Current.—The strength of the induced current depends too on Ohm's law. If, for instance, an induced current has 70 volts, and the resistance of the secondary coil is 610 ohms, and the resistance of the patient 2300 ohms, the strength of the current would be

$$\frac{70 \text{ volts}}{610 + 2300 \text{ ohms}} = 0{\cdot}024 \text{ ampères} = 24 \text{ milliampères.}$$

Measuring the strength of Induced Currents.—The strength of the induced currents cannot be measured with an ordinary galvanometer, partly because the secondary current is alternating, and would, therefore, make the needle deflect one moment to the right, and the next moment to the left. There are certainly some galvanometers without permanent magnets, which might be used, but the chief obstacle is that the currents are intermittent, *i.e.*, as the shocks last but a very short time, the galvanometer remains for a time without any current, until a second impulse occurs. If the interruptions follow one another very quickly, such a galvanometer would indicate more current than if the interruptions were slow, although in both cases the strength of current would be exactly the same. The only possibility for measuring medical induction currents in absolute units consists in measuring their E.M.F., and later on we shall describe an apparatus for this purpose.

Chemical Action of the Induced Current and Mechanical Effect.—The chemical action of faradic currents is small, principally on account of their very short duration, and moreover because they are partly alternating, so that each following impulse in the secondary current neutralises partly the effect of the preceding impulse. The mechanical effect of these suddenly appearing and disappearing currents on the human body, however, is very intense. If we place electrodes on the body, the muscles contract each time the current is made, and much more so when it is broken, so that the muscles can be excited with these currents to a great extent.

Difference in the Effects produced by Primary and Secondary Currents.—The effect produced by the secondary current depends a great deal on the diameter of the wire which is used. Very fine wires (0·1 millimetre, or finer) produce a pricking local pain, but not very strong muscular contractions ; if we increase the diameter of the wire, the contractions get more powerful ; if the secondary coils are wound with thick wire (No. 18 to 22 B.W.G.) they produce exactly the same effects as a primary current, *i.e.*, less local pain, but powerful contractions of the muscles near the electrodes, or even in the whole body. The primary, or the secondary current produced in a coil with thick wire, will mostly be applied if the deeper lying organs, such as, for instance, the bowels, etc., are to be treated, whereas the secondary current produced by a coil with fine wire is chiefly used for the treatment of muscles and nerves which are near to the skin. This is the practical difference between primary and secondary currents. It is no doubt only due to the great difference in the resistance of the coils and in the E.M.F., but it is impossible to draw a sharp line between them, and to define accurately in what cases the one, and in what cases the other should be applied. For the electric bath the primary current, or a secondary coil, with thick wire only can be used.

Construction of Medical Coils.—The shape and external appearance of the coils used for medical purposes vary very much, but still (if we except the magneto-electric machines, which, on account of several deficiencies, are rarely used now) they are all constructed on the same principle. The primary coils have between 100 and 600 turns of wire. The resistance of the primary coils is made small, 5 to 15 ohms, so that one or two cells can produce a strong current in them already, and the diameter of the wire ought therefore not to be too small. Insulated copper wire, No. 22 B.W.G., is mostly used for the primary coils. The E.M.F. of the primary current varies under these circumstances between 5 and 50, or more volts, according to the number of turns, and chiefly according to whether the iron core is drawn out or pushed in.

How to Regulate the Primary Currents.—The E.M.F. of the primary current can be regulated in different ways ; for instance, by inserting a larger or smaller number of turns of wire by means of a crank, etc. The simplest and almost only method practically used, however, is to regulate the E.M.F. by pushing the iron core in and out. The primary current is weakest if the iron core is drawn out, and gets stronger the more it is pushed in. Instead of drawing the iron core out, a damper in the shape of a brass or copper tube can be slipped over it with the same effect. If the iron core is entirely covered with the tube, its inducing power ceases to act, but the E.M.F. increases the more the brass tube is withdrawn. The position of the secondary coil has *no* influence on the strength of the primary current.

How to Regulate the Secondary Current.—The secondary coil is generally constructed with a large number of turns of wire, about 2,000 to 6,000 turns, for in most cases it is desired to obtain a high E.M.F.

The wire used for it is generally thin copper wire, about No. 36 B.W.G. The resistance of the secondary coil varies under these circumstances between 100 and 900 ohms, and the E.M.F. between 10 and about 300 volts. The strength of the secondary current can be regulated in different ways. If the apparatus has a small primary coil, it is sufficient for all purposes of treatment to regulate the strength of the secondary current too, merely by pushing the iron core in and out, for a current which is hardly to be felt when the iron core is drawn out can be increased quite gradually to painful strength by pushing it home. The more complete coils, however, are so arranged, that the distance between the primary and secondary coil can be easily changed. In this case the secondary coil slides on a sledge, and can be pushed over the primary coil, or be drawn away from it, an arrangement which allows an exceed-

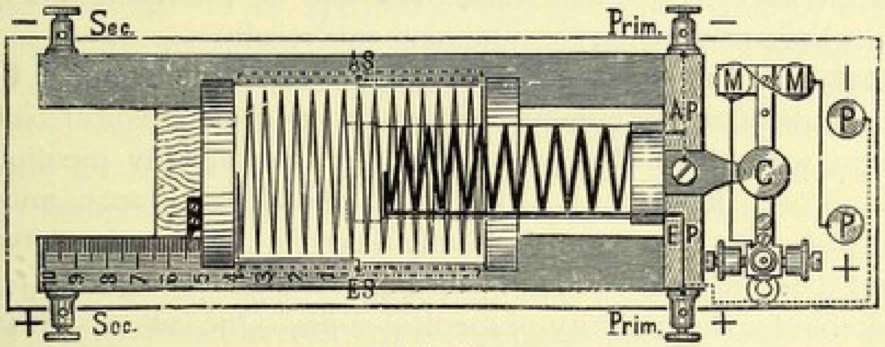


Fig. 19.

ingly fine regulation of the current. These sledge coils, which were first suggested by Dubois Reymond, are decidedly preferable to any other coils for diagnostic, and for physiological purposes. The strength of current in this apparatus can be further regulated by pushing the iron core in and out. The secondary current might also be regulated by means of a crank which inserts more or less turns of wire, but this does not allow as fine graduations as the moving of the iron core or the coils —or it might be regulated with rheostats ; but this is not very practical, as high resistances would be necessary, and is therefore seldom used.

Rapidity of Interruptions.—The Wagner hammer of an induction apparatus can be regulated within certain limits, so that the interruptions follow one another slower or quicker. The sooner the hammer meets the platinum point again after having been drawn away from the electro-magnet by the force of a spring, the sooner the current is closed, and the hammer attracted again. The further we screw this contact screw home therefore, the quicker will be the vibrations, but if we screw

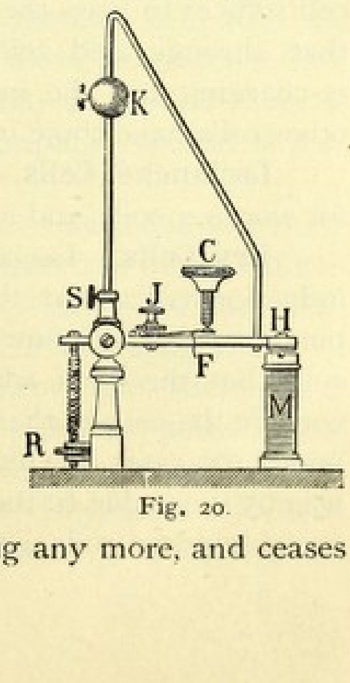


Fig. 20.

it too tightly, the hammer has no room for moving any more, and ceases to work. The more we unscrew the contact screw, the slower will the interruptions follow one another, but we must not unscrew it too far, as the hammer must make good contact with the platinum point in flying back, else it would also cease to vibrate. The power of the spring, as well as the strength of the inducing current, have, however, something to do with the rapidity of the interruptions. In order to make the interruptions even slower, the hammer can be lengthened with a bar, on which an aluminium ball can be raised or lowered. The longer this pendulum is, the slower are the interruptions; they can be reduced to fifty or even less per minute. A few apparatus are fitted with a clock work, which can be made to run at any speed, but the interruptions produced per minute are accurately registered by the clock work. Slow interruptions produce more powerful and painful contractions than quick ones. If the number of interruptions is very great, anæsthesia can be produced, and special apparatus have been made for obtaining this result.

What are the most suitable Elements? Bichromate Cells.—Various kinds of elements may be used for working medical coils; we will begin with the bichromate cell. We have already mentioned its advantages, *i.e.*, its high E.M.F., small internal resistance, and, more especially, the fact that it can be easily kept in order without technical help, and these qualities, added to its small size and cheapness, render it very suitable for the majority of medical coils. One cell is sufficient for supplying a strong inducing current. The vessels for the elements are best made of strong glass, as all ebonite vessels leak after a time. The cells are closed with india-rubber stoppers to prevent spilling in carrying the apparatus. The acid consists of 1-oz. bichromate of potassium or soda, dissolved in 10 ozs. of water to which are added 2½ ozs. strong sulphuric acid, and 1 oz. bisulphate of mercury. As the acid does not decompose, it is best to mix about a pint or more at a time. If the acid turns green, the cells should be emptied, rinsed out and re-filled with fresh solution. With most of the portable apparatus one charge of the cell suffices to keep the hammer going for about two hours. The fact that chromic acid cells are troublesome on account of the frequent re-charging and the inconstancy of the cells, has been the cause that other cells have come into use for working the coils as well.

Leclanché Cells.—Large Leclanché cells are also very well suited for working coils, and are used for them in all office batteries.

Dry Cells.—Leclanché dry cells are so very well suited for portable induction coils, that they are sure to supersede all other cells for this purpose in a short time. They are much more constant than the acid cells, but the chief advantage is that they contain no acid to spill and corrode the coil, clothes, carpets, etc. It is no exaggeration to say, that under 100 cases in which coils went out of order and required repairs, it was 95 times due to the spilling and evaporation of acid. We have sold many hundred coils with dry cells during the last few years, and *none of* *them* has come back for any other purpose except the renewal of the cells. An Obach R. cell, measuring $1\frac{3}{4} \times 1\frac{3}{4} \times 4\frac{1}{2}$ inches, will work for instance a Spamer coil for 30 to 70 hours (according to whether the iron core is withdrawn or pushed home) and when exhausted, it costs 2/6 to replace this cell by a new one. The acid and zinc required for working the same coil for a similar length of time would cost more,—not reckoning the damage done by the acid to the coil, the temper, clothes, etc. After the 5 years' experience, which we have got now with our coils with dry cells, we would cease to make coils with acid cells altogether if the latter had not still some advantages for the Colonies and out-of-the-way places, where the dry cells cannot so easily be replaced. New dry cells can easily be put in the place of the old ones without returning the coil to the maker.

Thermopiles.—If an apparatus need not be portable, or if experiments have to be made where absolute constancy of the inducing current, eventually for years, is of importance, thermopiles are most suitable, as their E.M.F. changes less than the E.M.F. of any other source of electricity. They are started by lighting a small gas, oil, or spirit flame. They are convenient and reliable for all induction coils which have not to be portable, and they are not likely to require repair, unless they get damaged by a fall or some such misadventure.

The Continuous Current from Dynamos may be used for working coils, if an 8 or 16-candle lamp is inserted as a resistance between the main and the coil. This is very convenient in installations where the continuous current is used for galvanisation as well as for fixed coils; for instance, emergency coils in the operating rooms of Hospitals, but of course for portable coils a dry cell is preferable.

The Alternating Current from Dynamos can be used for Faradisation only to a very limited extent. The alternations are so extremely rapid (12,000 per minute) that the muscles have not got time to contract or relapse completely, they remain in a semi contracted state, and the effect is totally different from that produced by a medical coil, with its comparatively very slow vibrations. But in cases where it is intended to give a few shocks only, the alternating current may be used, if either a transformer or else an incandescent lamp and a graphite rheostat is put between the patient and the main.

The Currents from alternating dynamos are sinusoidal currents, which have been strongly recommended by d'Arsonval and other writers. They are not so jerky as the currents from medical coils, and may perhaps in the future play an important *rôle* in electro-therapeutics.

Faults.—If an induction coil fails, you should see first whether the element is exhausted. As most cells are made small for portability's sake, they require pretty frequent refilling or renewing—acid cells about once in a fortnight, if the apparatus is in daily use. If you are sure that the cell is all right and gives the necessary current, you should see whether the interrupter is in order. The interrupter, however, is the most delicate part of the induction coil, and therefore you should be careful not to interfere with the contact screw if it is not strictly necessary, for very often apparatus which were in quite good order have been spoiled by playing with this screw. The interrupter does not always start of its own account, and has to be put in vibration by being slightly touched with a finger. The hammer has to stand so that its distance from the electro-magnet is about the $\frac{1}{16}$th part of an inch, and the platinum point of the contact screw should yet just touch it. Those apparatus in which the hammer is fastened to a rigid bar, as in Nos. 6, 7, 8, 16, and all sledge coils, are less liable to get out of order and to require readjustment than those whose hammer is attached on to a watch spring, as coils 1 to 5, 9 and 14. The interruptions of these latter apparatus are also frequently less regular. If an interrupter has not the proper distance from the electro-magnet, it has to be unscrewed and carefully bent, till it keeps the proper distance. The spark on the interrupter attracts dust, and the little platinum sheet should be cleaned occasionally with fine emery paper. Oil should on no account be allowed on the interrupter.

If the apparatus fails although cell and interrupter are in order, see whether the connecting cords, etc., are in order. We should like to repeat here, that it is of no use to test an apparatus by touching the terminals or the connecting cords with two fingers. An apparatus can only be tested with well soaked and properly connected electrodes. If the apparatus gives no current, although all these things are in order, either the coil or else the connections are damaged, but as they are very well protected, this can happen only by spilling a good deal of acid ; the connections get oxidised in this case, or the wires may even be eaten through. An apparatus damaged in this way has to be sent back to the manufacturer.

Faradimeter.—Before closing this section, we have yet to describe the apparatus with which it is possible to measure the faradic current. Experiments have shown that currents of very short duration produce the same physiological effects, whether they are produced by a galvanic battery, a condensator, or an induction coil. Based upon this experience, Drs. v. Ziemssen and Edelmann have constructed induction coils, the scales of which are not graduated in millimetres, but in volts. In order to get always exactly the same number of volts out of the secondary coil, with a given distance between the primary and secondary coil, it is necessary to keep the inducing current on quite equal strength. For this purpose the apparatus is fitted with a rheostat and a galvanometer. By pressing a key, the inducing current may be sent through the galvanometer and a resistance, which is equal to the resistance of the primary coil, and further through a variable resistance, with which the strength of current can be regulated. By leaving the key the current passes through the variable resistance and the primary coil. In this way the strength of the inducing current can be conveniently ascertained and regulated. The number of volts marked on the scale along which the secondary coil slides is correct as long as the strength of the inducing current is exactly 300 milliampères. The scale is graduated from 5 volts to 200 volts. In this way it is made possible to measure the induced current, like the galvanic current, in absolute units.

FRANKLINISATION.

Static electricity is now used very frequently for nervous and hysterical diseases, sleeplessness, etc., in America, Austria, Germany, and especially in France, but in Great Britain it is yet seldom used. The reason for this is, no doubt, the climate, which is unfavourable for static machines here, but as there are now machines which can be started even in the dampest weather, a few words about them will not be amiss. As far as the origin of static electricity is concerned, and about the construction of the machines, we must refer to larger works on electricity. Static machines are considered by many physicists the most ingenious of all physical instruments, and as the process is rather complicated, it seems to us useless to attempt to describe it in a few words only. The electricity yielded by static machines is of a very high E.M.F. The number of volts can be estimated according to the length of the sparks.

For sparks of	0·18	0·7	5	15·6	18·8	mm. length,
have approximately	1000	2000	5000	12000	15000	volts.

Sparks of 100 millimetres' length being nothing uncommon with such machines, we may suppose that the tension amounts frequently to 100000 volts and more. The strength of current, however, is exceedingly small, and the chemical effects are 0 for all practical purposes.

The manner of application is about as follows: For general franklinisation the patient is placed on an insulating chair, and connected with one pole of the machine for some twenty minutes. For local applications he is also mostly placed on the chair, and an electrode connected with the other pole is brought near the spot which is to be franklinised. If this electrode is fitted with a point, the so-called electrical wind appears, which, according to Charcot and Boudet, is specially valuable for neuralgic pains, etc. If the electrode is fitted with a ball, sparks appear, which are used to excite paralysed and unsensitive organs. With Morton's electrode the spot of application can be localised exactly, and with such an arrangement the sparks can also be applied internally.

According to different authors it seems to be of special importance with this kind of electricity, which pole is applied to the patient. According to them (for instance, Dr. Stein), the negative pole has a depressing influence on many patients, whereas the positive pole has an invigorating influence; and this seems to be in accordance with the fact, that, under normal conditions, the air is always charged with positive electricity (of 100 days the air electricity is positive on about 95 days, and negative only on about 5), and only under abnormal conditions, during thunderstorms, or hail and heavy storms, etc., it changes to negative electricity. We must leave it to our readers to find out how far these statements are correct, but we will give a few hints which will make it possible to tell the negative pole from the positive one. In a dark room the poles can be easily distinguished. The pole on whose comb brushes of light appear, is charged with negative electricity, and the pole on whose comb points of light appear, is charged with positive electricity. If a burning candle is placed between the poles of a machine in action, the flame points towards the positive pole.

Static machines are turned either with the hand, or else, and this is much more convenient, with small motors. In towns where the electric light is laid on, these will mostly be electro-motors, but in other places they may be small water motors, gas motors, etc., or else electro-motors which are driven by batteries. About the treatment of these machines, we must refer to the directions for use sent with the different machines.

Before concluding, we have yet to refer the reader to a few of the many books in which he can study electricity thoroughly, and find good directions about the ways and means of applying it for various diseases.

BOOKS ON ELECTRICITY.

AYRTON, W. E., F.R.S. Practical Electricity. 1887.

JENKIN, F., F.R.S. Electricity and Magnetism. 1881.

THOMPSON, S. P., F.R.A.S. Elementary Lessons in Electricity and Magnetism. 1884.

BOOKS ON ELECTRO-THERAPEUTICS.

The books marked (*) can be supplied by us.

*ALTHAUS, JULIUS, M.D., M.R.C.P., M.R.I. The Value of Electrical Treatment. 3rd edition. 1896. 2/-.

*BEARD AND ROCKWELL. A Practical Treatise on the Medical and Surgical Uses of Electricity. 1891.

BENNETT, A.H., M.D. A Practical Treatise on Electro-Diagnosis in Diseases of the Nervous System. 1882.

*CARDEW, H. W. D., M.R.C.S. Charts for Registering the Results of Electro-Diagnosis. 2/-.

*DOWSE, T. S., M.D. Massage and Electricity in the Treatment of Disease. 1891. Price 7/6.

*ERB, W., M.D. Handbook of Electro-Therapeutics, translated by A. de Watteville, M.D. Price 18/-.

*FENWICK, E. H., F.R.C.S. The Electric Illumination of the Bladder and Urethra. 2nd edition 1889. Price 6/6.

*HEDLEY, W. S., M.D. The Hydro-Electric Methods in Medicine. 2nd edition. 1896.

KEITH, Th., M.D. On the Treatment of Uterine Tumours by Electricity. Brit. Med. Jour., June 8th, 1889.

*JONES, L., M.D. Medical Electricity. A Practical Handbook for Students and Practitioners. 2nd edition. 1896. 9/-.

PARSONS, T., M.D. The Arrest of Growth in Four Cases of Cancer by a powerful interrupted voltaic current. Brit. Med. Jour., April 27th, 1889, and June 8th, 1889.

*TURNER, D., M.D. A Manual of Practical Medical Electricity. 1892.

DE WATTEVILLE, A., M.D. A Practical Introduction to Medical Electricity. 2nd edition. 1884. (Out of print).

*VON ANTAL, Prof. Dr. Specielle chirurgische Pathologie u. Therapie der Harnrœhre u. Harnblase. 1889.

*Elektro-therapeutische Streitfragen. Verhandlungen der Elektrotherapeuten Versammlung zu Frankfurt. 1891.

*ERB, W. Handbuch ker Elektrotherapie. 1886.

*LEWANDOWSKY. Elektrodiagnostik und Elektrotherapie, einschliesslich der physikalischen Propädeutik. 1887.

*REMAK E. Elektrotherapie. 1886.

*ROSENTHAL und BERNHARD. Elektrizitätslehre für Mediziner. 1884.

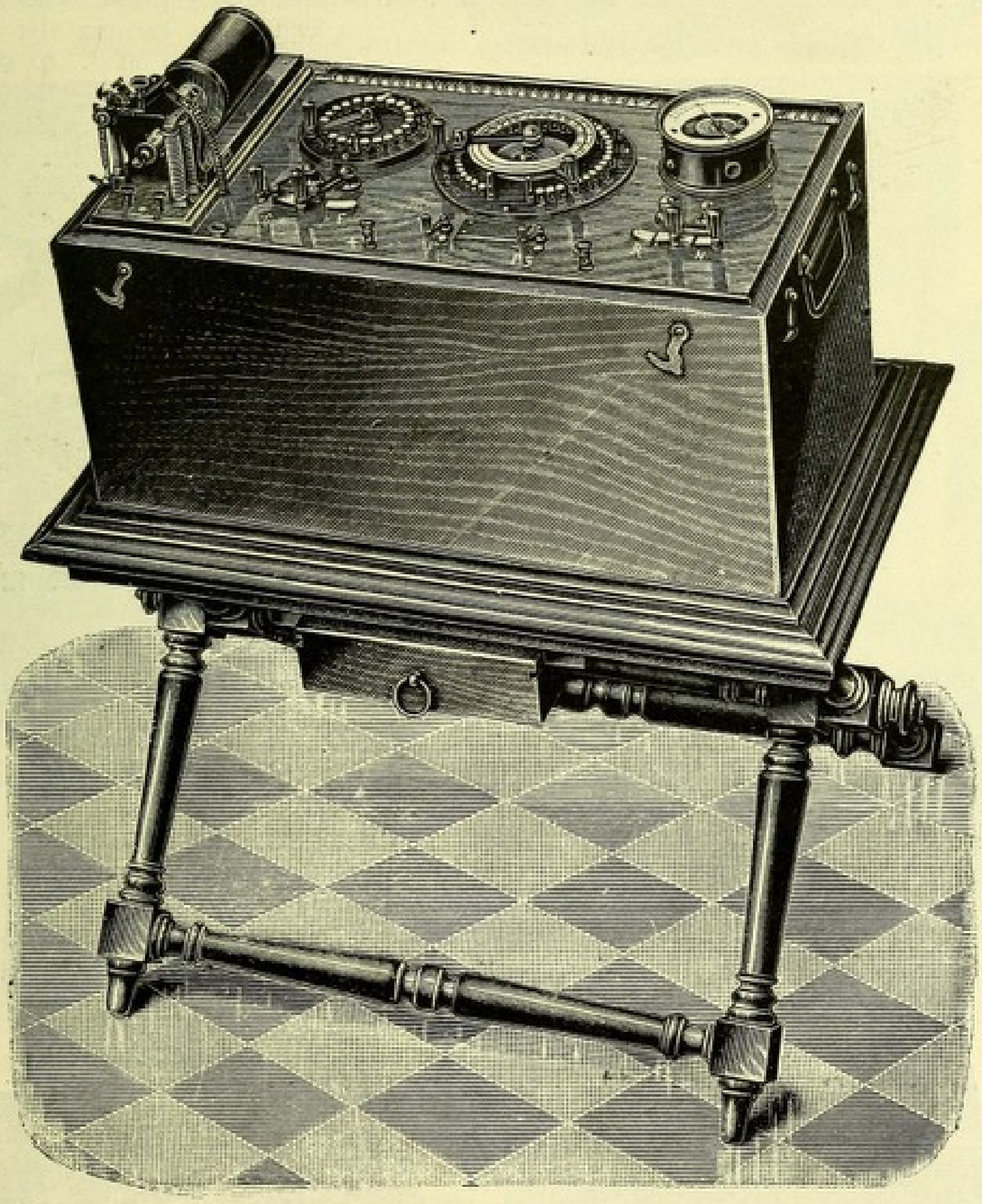
*VON ZIEMSSEN. Die Elektrizität in der Medizin. 1887.

K. SCHALL'S

Illustrated Price List

OF

ELECTRO-MEDICAL APPARATUS.



55, WIGMORE STREET,

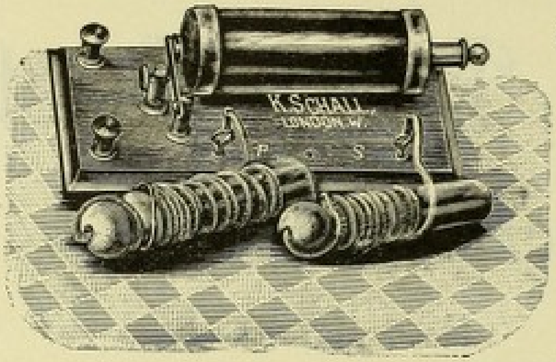
LONDON, W.

Registered Telegraphic Address - - - "SCHALL, LONDON."

FIFTH EDITION. OCTOBER, 1896.

ENTERED AT STATIONERS' HALL

FARADISATION.

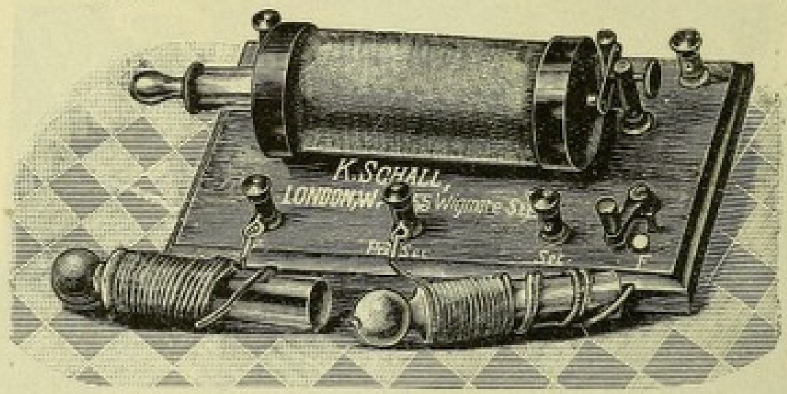


No. 1

ON INDUCTION COILS, REGULATION OF STRENGTH OF CURRENT, &c.,
see also pages 42—50.

No. 1. Single Coil, with cords and two electrodes, in cardboard box . £0 7 6

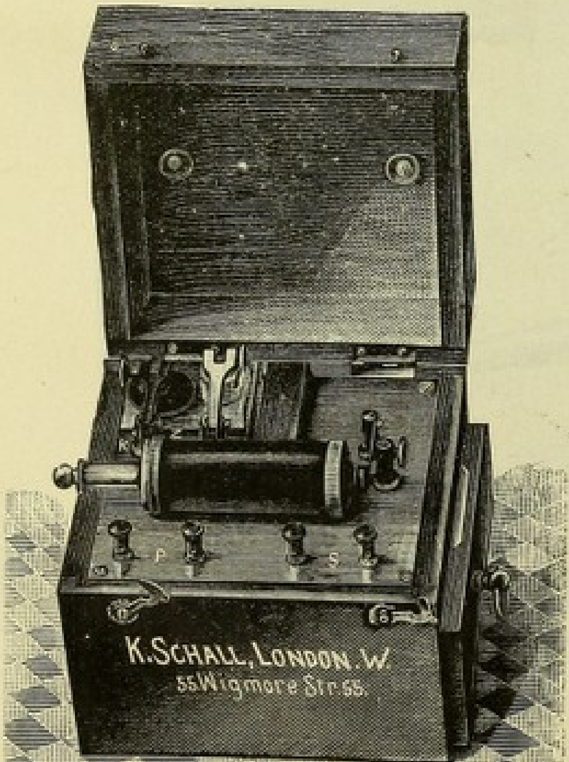
No. 1A. Similar Coil, but with a switch for turning the current on and off . 0 9 0



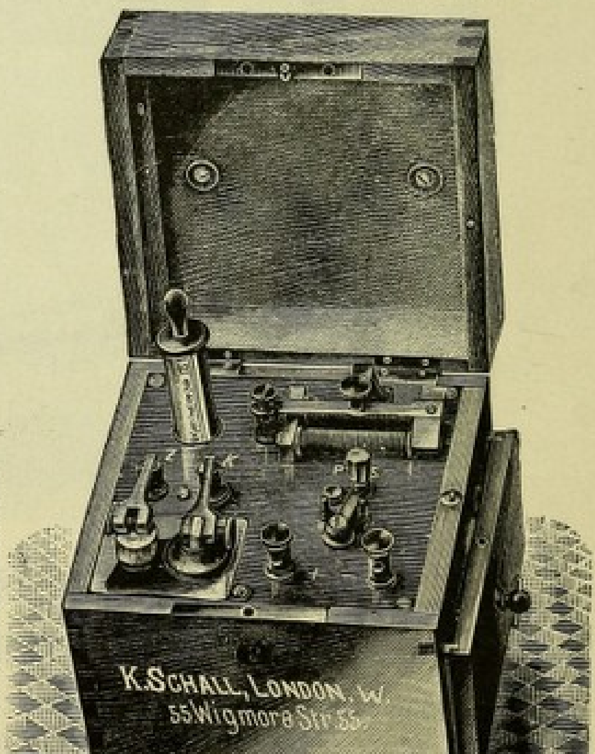
No. 2.

No. 2. Similar Coil, but larger size, and better finish, with crank to switch the current on and off. £0 12 6

Separate dry cell 2½ by 2½ by 6 inches, for working coils No. 1 and No. 2 . . . . 0 2 6



No. 5.

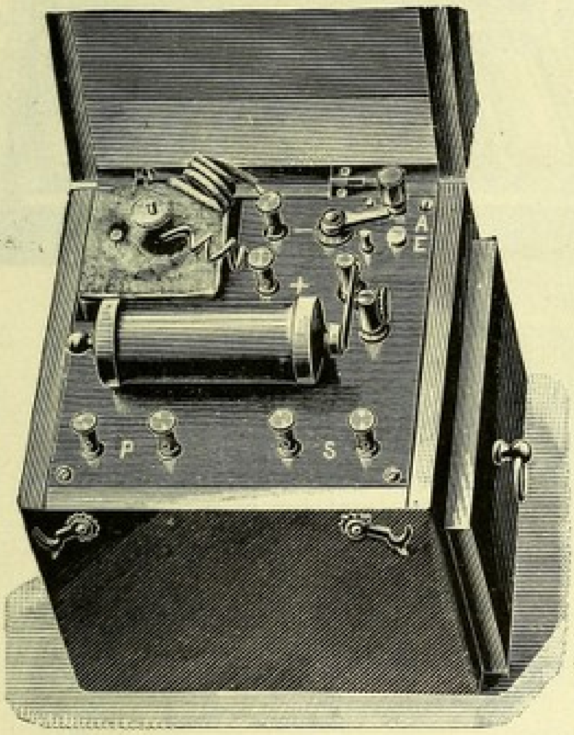


No. 6.

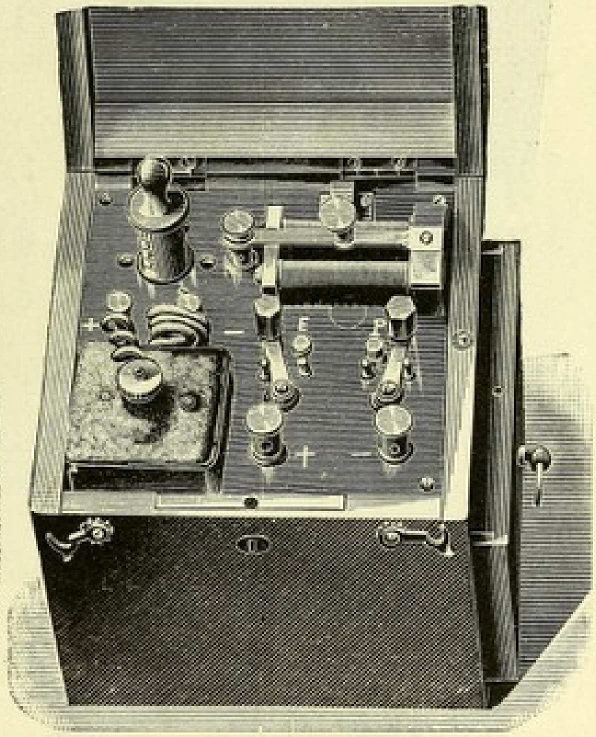
No. 5.	Dr. Spamer's Coil, in polished mahogany case, cheap form for patients, with bichromate cell in strong glass vessel, cords, handles, and five electrodes	£1 0 0
No. 6.	Dr. Spamer's Coil, in polished Mahogany or Walnut case, with bichromate cell, commutator for primary and secondary current, cords, handles and six electrodes .	1 18 0

This is a very convenient and powerful coil, which answers every purpose for treatment. It allows a fine and gradual regulation of the current's strength, and experience shows that this kind of coil comes less frequently back for repair than other patterns of coils, in which acid is being used, though there are tens of thousands in use.

No. 7.	The same apparatus with two cells instead of one . . .	£2 4 6



No. 5A.



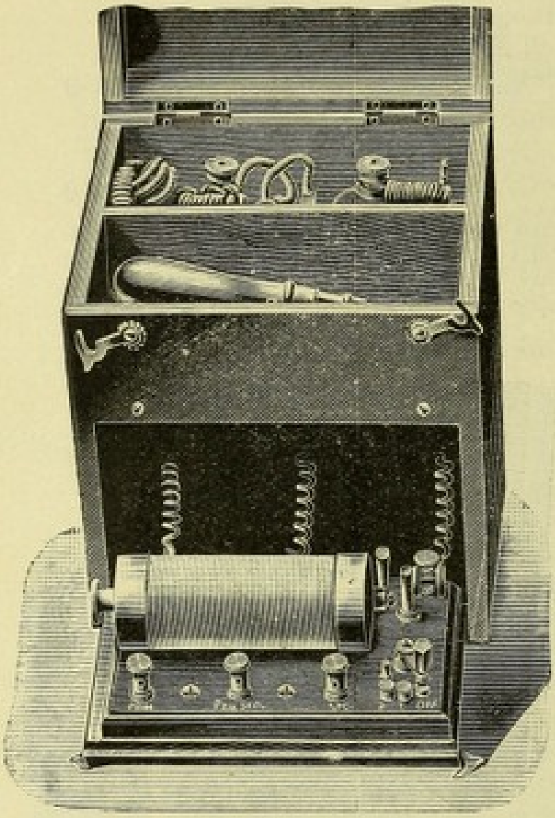
No. 6A.

Coils with Dry Cells.—These coils have got the great advantage that there is no liquid required to work them. As it is only the spilling of acid which makes a coil go out of order, these coils require practically no repairs and less attention, and are cleaner, more reliable and convenient than the old acid coils. They have been tried now some four years, and we have no doubt that they will supersede most acid coils in a short time (see also page 48).

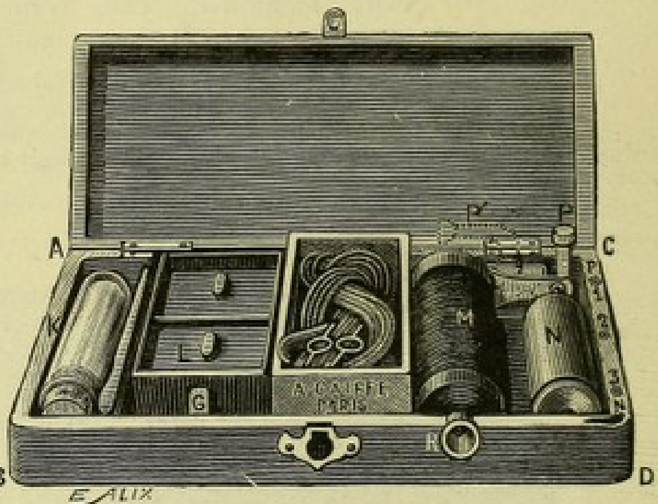
The size and quality of the cells chosen is such, that one cell will work a coil for more than fifty hours before it gets exhausted, or with an average use of ten minutes every day, the cell has to be renewed only once in a year.

Price of new Cells, including postage, 2/6.

No. 5A.	Same Coil as No. 5, but with dry cell instead of the acid cell	£1 2 6
No. 6A.	Same Coil as No. 6, but with dry cell instead of the acid cell	2 0 0
No. 7A.	Dr. Spamer's Coil, with two dry cells	2 7 6



No. 8.



No. 9.

No. 8.	Coil, with two *large* dry cells, working the coil for over 100 hours	£2 2 0
No. 9.	Gaiffe's Coil, with two bisulphate of mercury cells, cords, handles, and two electrodes	1 1 0
No. 10.	The same apparatus, larger size	2 5 0

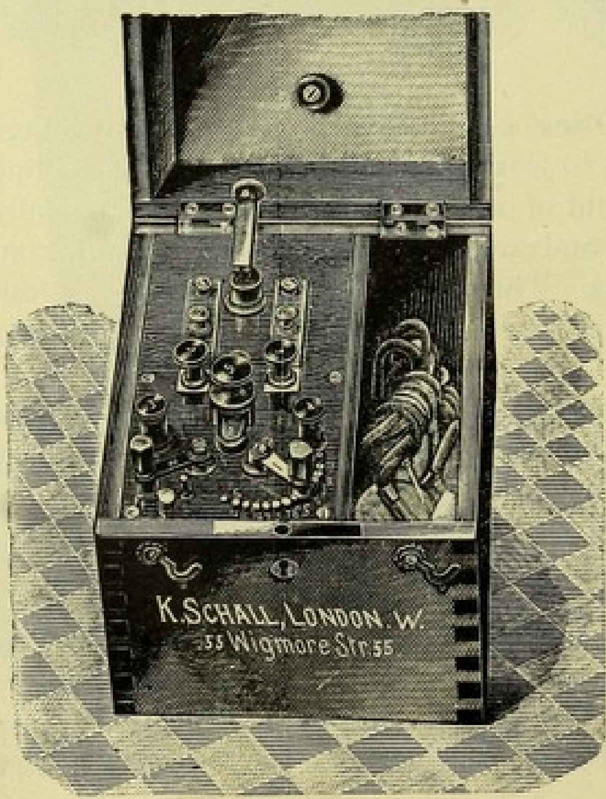


Fig. 14.

No. 14. Coil, with large bichromate cell, in polished mahogany case, commutator for primary and secondary current, and crank for regulating the strength of current; cords, handles, and six electrodes . . 2 5 0

Ready-made Acid, in bottles with glass stoppers, containing acid for about nine charges, per bottle . . . 0 1 6

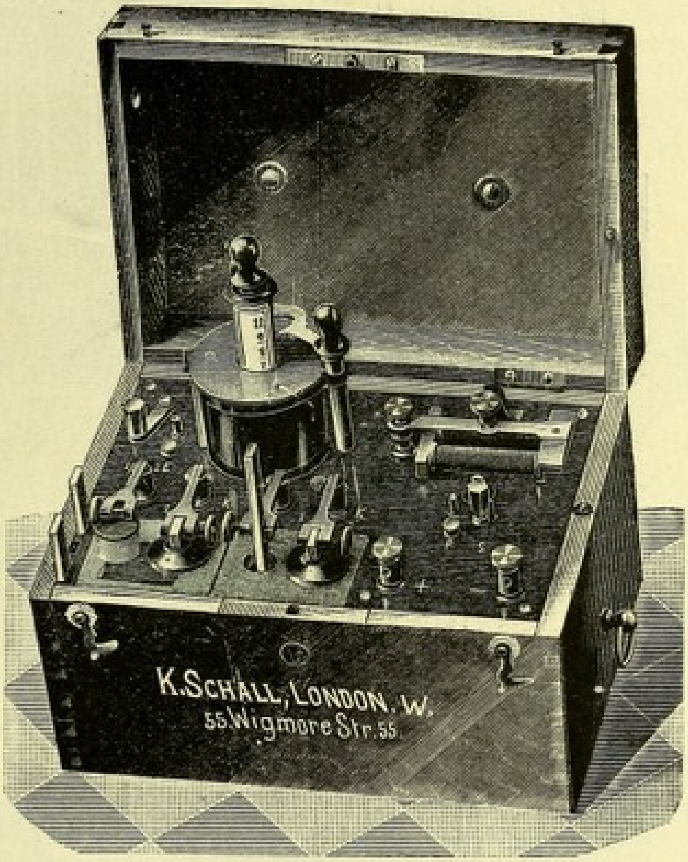
SLEDGE COILS.

If not otherwise ordered, the diameters of the copper wires used in the apparatus, Nos. 16—32, are 0·8 millimetre (No. 21 B.W.G.) for the primary coils, and 0·2 millimetre (No. 36 B.W.G.) for the secondary coils, but, if desired, any other size may be used.

Additional Secondary Coils, for any of the following Sledge Coils, cost each 15/-

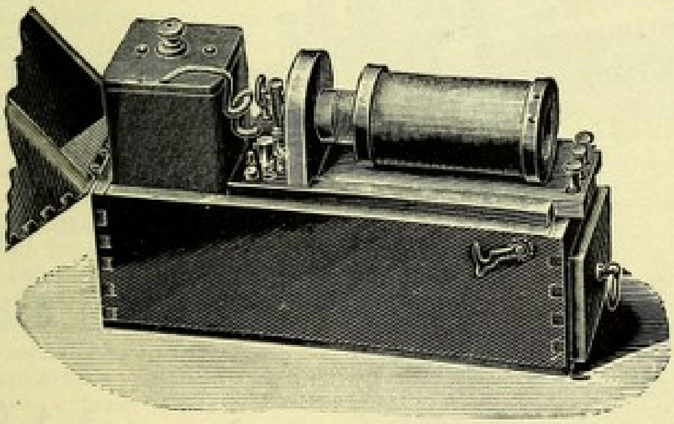
No. 16. Dr. Taube's Sledge Coil, with two bichromate cells . . £3 7 0

What has been said about coils Nos. 6 and 7, on page 57, refers to this apparatus also. Of all the coils with acid cells, this is the most complete one.



No. 16.

No. 17. Dr. Taube's Sledge Coil, with two dry cells £3 10 0

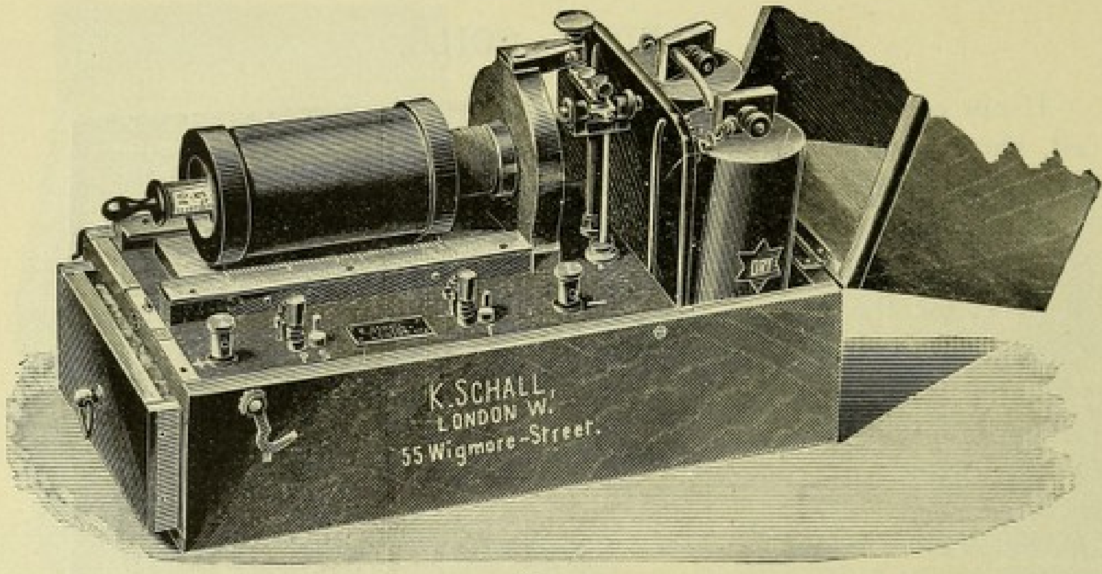


No. 19.

No. 19. Dr. Lewis Jones' Sledge Coil, with one large dry cell, working the coil for about 80 hours altogether . £1 17 0

No. 21. Dubois-Reymond's Coil, with two dry cells, in polished mahogany case, commutator for primary and secondary current, cords, handles, and six electrodes . . . £4 10 0

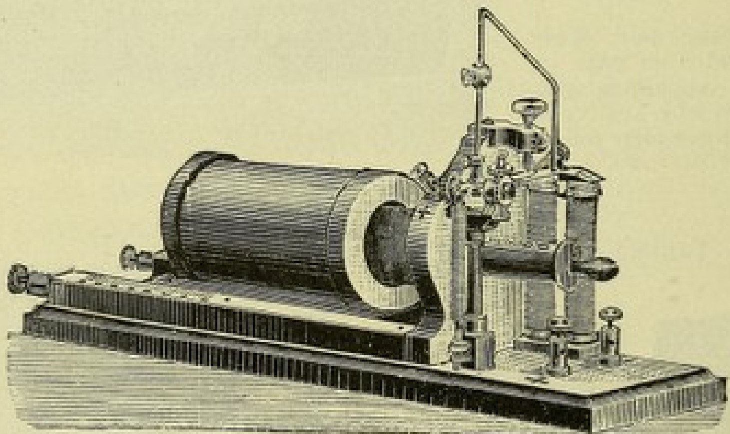
This is the most complete and convenient of all the portable coils, for diagnosis as well as for treatment. The rapidity of the interruptions may be regulated by means of a weight, which can be fixed higher or lower. The cells will work the coil for 80 hours altogether.



No. 21.

Spare Cells for the coils No. 19 and No. 21, 2/6 each.

No. 25. Dubois-Reymond's Coil, with scale and simple interrupter £2 0 0



No. 27.

No. 27. Dubois-Reymond's Coil, with metal scale and adjustable interrupter (for slow or quick vibrations); primary coil 700 turns, secondary coil, 5000 turns 3 0 0

No. 28. The same apparatus, with 10,000 turns on the secondary coil 4 4 0

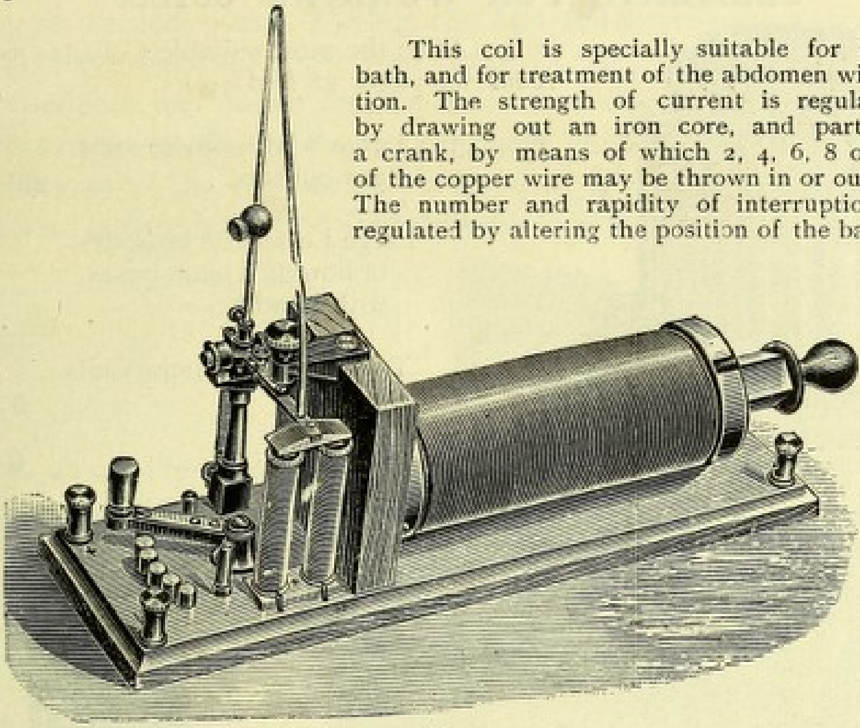
INDUCTION COILS FOR SPECIAL PURPOSES.

No. 30. Dubois-Reymond's Coil, 4 feet long, with scale and Helmholtz's modification for physiological experiments £4 10 0

(As supplied to University College, King's College, Guy's, Charing Cross, Westminster, and other Hospitals.)

No. 35. Dr. de Watteville's Coil, for primary current only . . £3 5 0

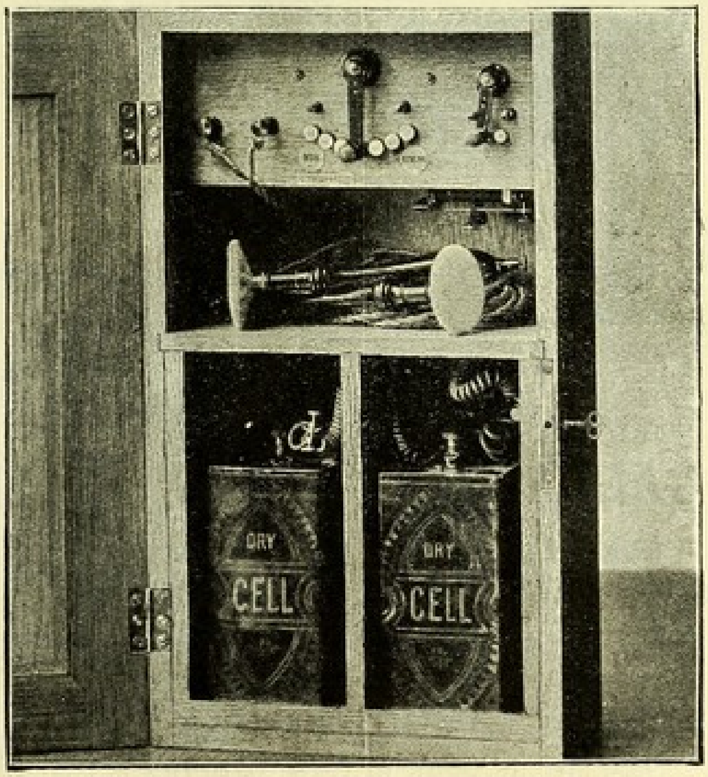
This coil is specially suitable for the electric bath, and for treatment of the abdomen with faradisation. The strength of current is regulated partly by drawing out an iron core, and partly through a crank, by means of which 2, 4, 6, 8 or 10 layers of the copper wire may be thrown in or out of circuit. The number and rapidity of interruptions may be regulated by altering the position of the ball.



No. 35.

No. 40. Schall's Emergency Coil for Operating Theatres, Casualty Wards, etc. £4 4 0

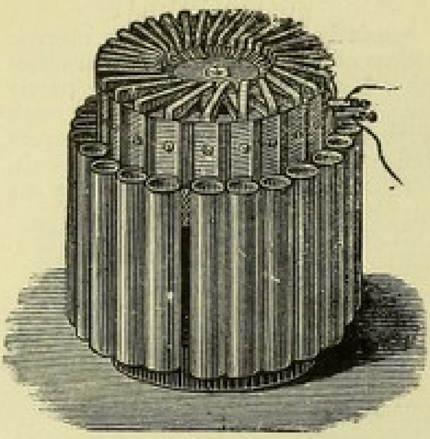
This apparatus (Fig. 40) has been specially constructed for casualty rooms and operating theatres in hospitals, for police stations, life-saving stations, etc., and is so constructed that it requires as little time as possible to set it in action in urgent cases, that persons not accustomed to electric apparatus can work it, and, moreover, it will not easily get out of order nor require repair. It contains either an incandescent lamp—if the electric light is available in the hospital, or else two large dry cells, which, even after standing for years without being used, supply a current strong enough to work the powerful induction apparatus. Two electrodes are permanently connected with the apparatus by means of long and strong cords, so that they have not to be screwed on at the moment of need. The strength of the current can be regulated up to a certain point only by means of a crank, and can be given in seven degrees, the weakest of which even causes pretty strong muscular contractions.



No. 40.

For Condensers, and Keys for charging and discharging them automatically, apply for special quotations.

ELEMENTS FOR WORKING COILS.

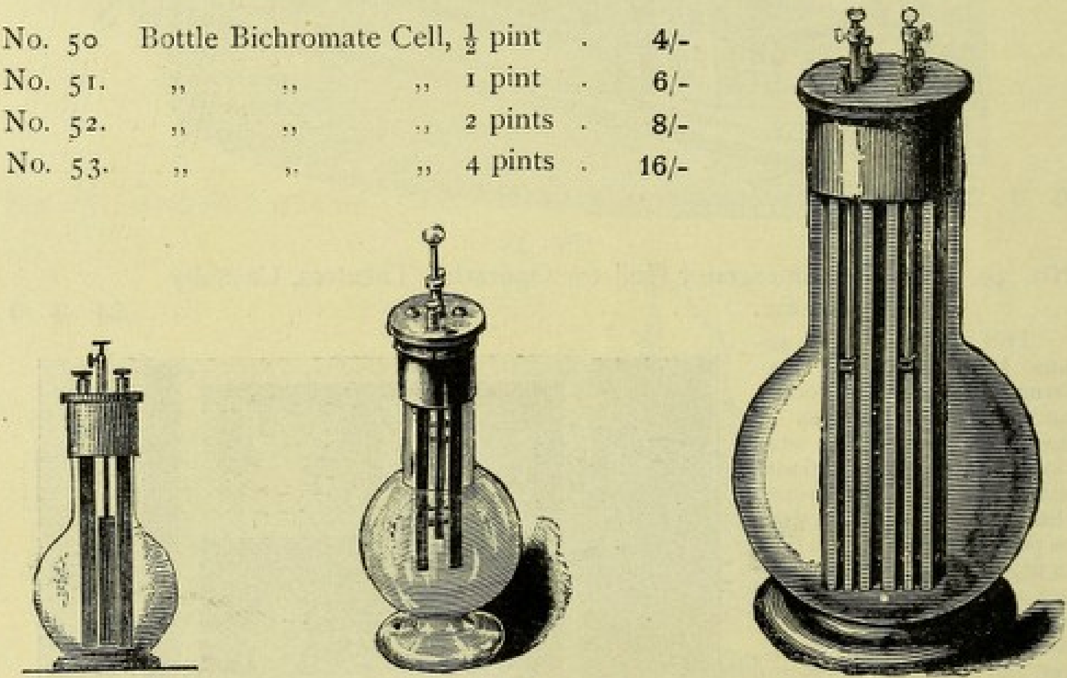


No. 43.

(As to the most suitable Cells for working coils see pages 48 and 49.)

No. 43.	Large Thermopyle, with gas burner . . .	£2 5 0
	Large Leclanché cells, dry or liquid, in plain boxes, with handle :—	
No. 46.	Two large Leclanché Cells, in box . . .	0 10 0
No. 47.	Four ,, ,,	0 17 0

No. 50	Bottle Bichromate Cell, ½ pint .	4/-
No. 51.	,, ,, ,, 1 pint .	6/-
No. 52.	,, ,, ,, 2 pints .	8/-
No. 53.	,, ,, ,, 4 pints .	16/-



Nos. 50—53.

GALVANISATION AND ELECTROLYSIS.

(As to Batteries and Accessories for Galvanisation and Electrolysis, see also pages 9—26.)

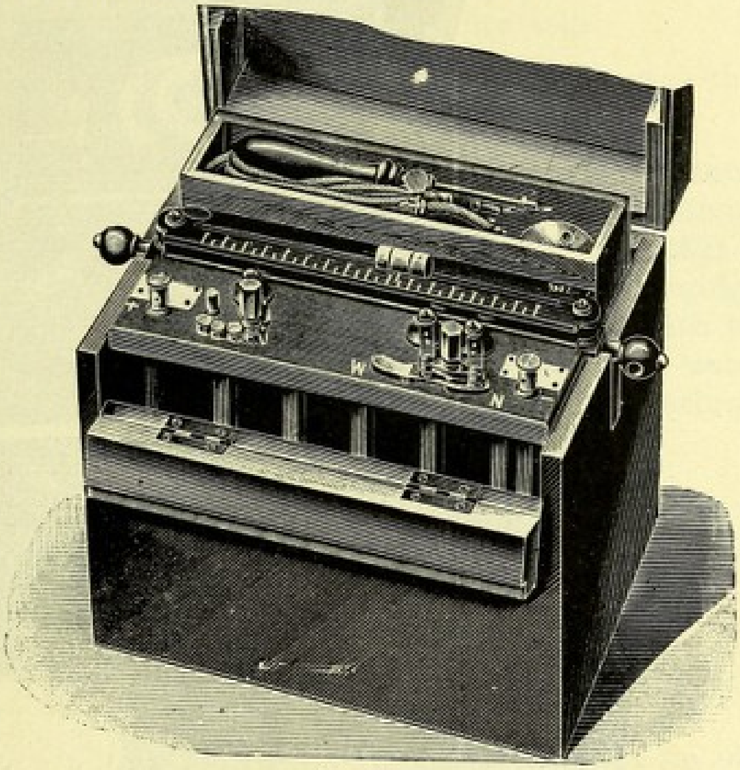
PLUNGE BATTERIES.

(About Plunge Batteries, see also page 12.)

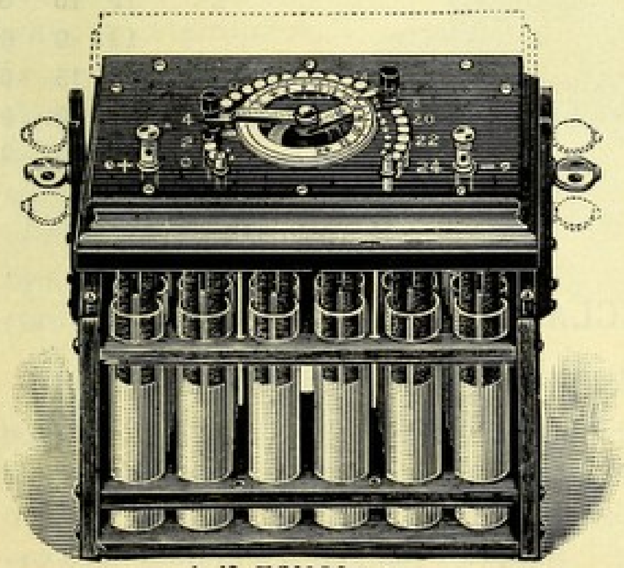
The special point in these batteries is that the carbons and zincs are cast together, thus ensuring a good connection, since the breaks of contact which not unfrequently occur in elements that are screwed together, cannot possibly happen. Furthermore, the elements, when the zincs have been used up, can be very easily renewed, even by the most inexperienced. India-rubber floats prevent the spilling, unless the battery is turned over. During the last ten years over 1500 of these batteries have been sold, the best proof of their practical construction, and experience has shown that on account of their great simplicity they require fewer repairs than any other acid batteries. The strength and the constancy of the current are about equal to a Stoehrer battery.

These batteries are specially suitable for electrolysis.

No. 80. 24-cell Plunge Battery, in polished oak case, with current collector, inserting the cells 8 by 8, current reverser, graphite rheostat, cords, handles and 2 electrodes . **£4 0 0**



No. 80.



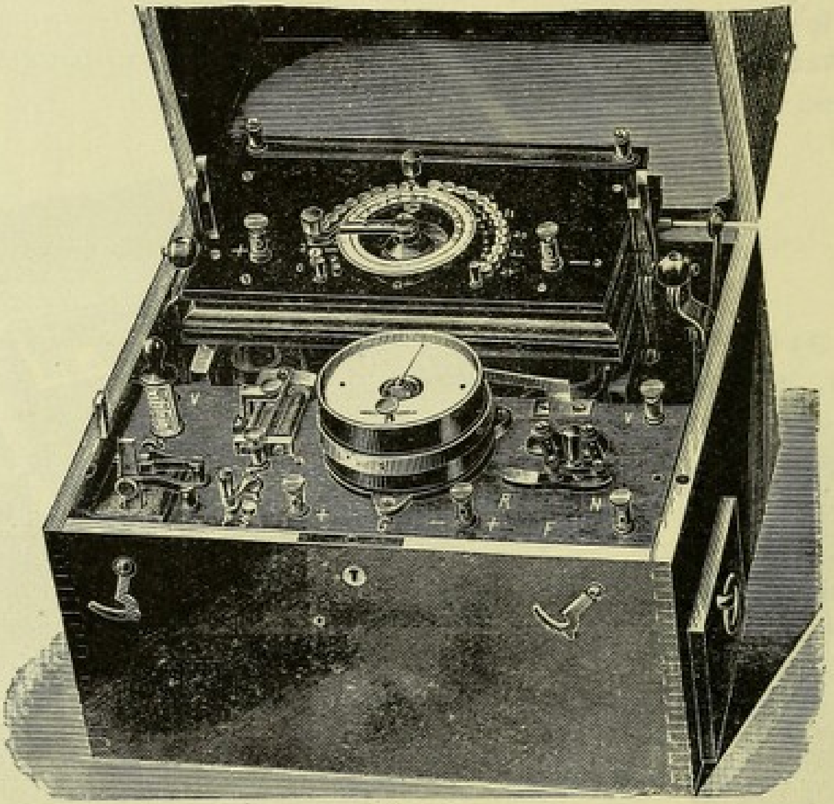
No 83.

No. 83, 24 cells with double collector, cords, handles, and 3 electrodes . . . **£4 10 0**

No. 84, 32 cells . . **5 10 0**

Plunge Batteries in polished mahogany case, with automatic lifting and lowering arrangement, double collector, current reverser, cords, handles, 5 electrodes and 3 spare cells.

No. 86, 24 cells		£7	0	0
No. 87, 32 ..		8	10	0
No. 88, 40 ,,		10	0	0



No. 90.

No. 90, 24 cells, with coil		£9	0	0
No. 91, 32 ,, ,, ,,		10	10	0
No. 92, 40 ,, ,, ,,		12	0	0
Fitted with galvanometer No. 271	extra	2	15	0
Spare elements for these batteries	,,	0	0	9
,, glasses ,, ,, ,,	,,	0	0	3

PORTABLE LECLANCHÉ BATTERIES.

(About Leclanché Batteries, see also pages 10 and 11.)

If not otherwise ordered, the batteries Nos. 108—115 will be charged with dry Leclanché cells (No. 66); the batteries Nos. 116—140 with liquid cells, if remaining in or near London, but with dry cells if they have to be sent away a greater distance. Batteries charged with liquid cells can be sent by rail in the care of the guard only. Batteries charged with dry cells can be sent as ordinary freight all over the world.

The recharging of the batteries costs 9d. per cell if they are filled with liquid cells, and 1/9 per cell if they are filled with dry cells.

Provided the batteries are not short circuited, batteries Nos. 108—133 are guaranteed to last with average use for two years before requiring re-charging.

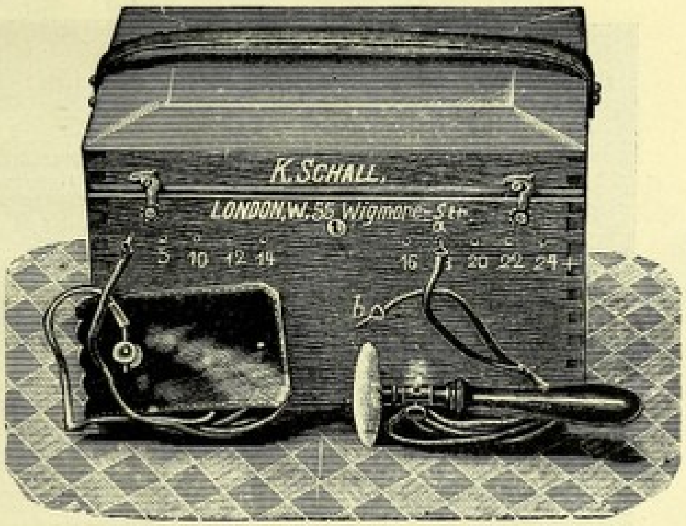
Provided the cells are not short circuited, *the batteries* Nos. 137—140 *are guaranteed to last with average use more than 2½ years before requiring re-charging.* The two cells working the coil may require re-charging earlier. The re-charging of batteries Nos. 137—140 costs 9d. per cell if charged with liquid cells, 2/- per cell if charged with dry cells.

There are now about 2500 of our Leclanché batteries in use—the best proof of their practical construction and good quality.

Of the many unsolicited testimonials we have received about batteries Nos. 108—140, we will mention one only. DR. MILNE MURRAY, of EDINBURGH, writes :—**"The Combined battery (No. 132) I bought some three or four years ago will soon want re-charging. It has done me splendid service, and I am greatly pleased with it. I have never had any trouble with it, and though I have used it now steadily all these years, and made thousands of applications wit h it, it is still giving a good current."**

Schall's batteries for Patients and Nurses, in oak cases, with cords, handles, and three electrodes.

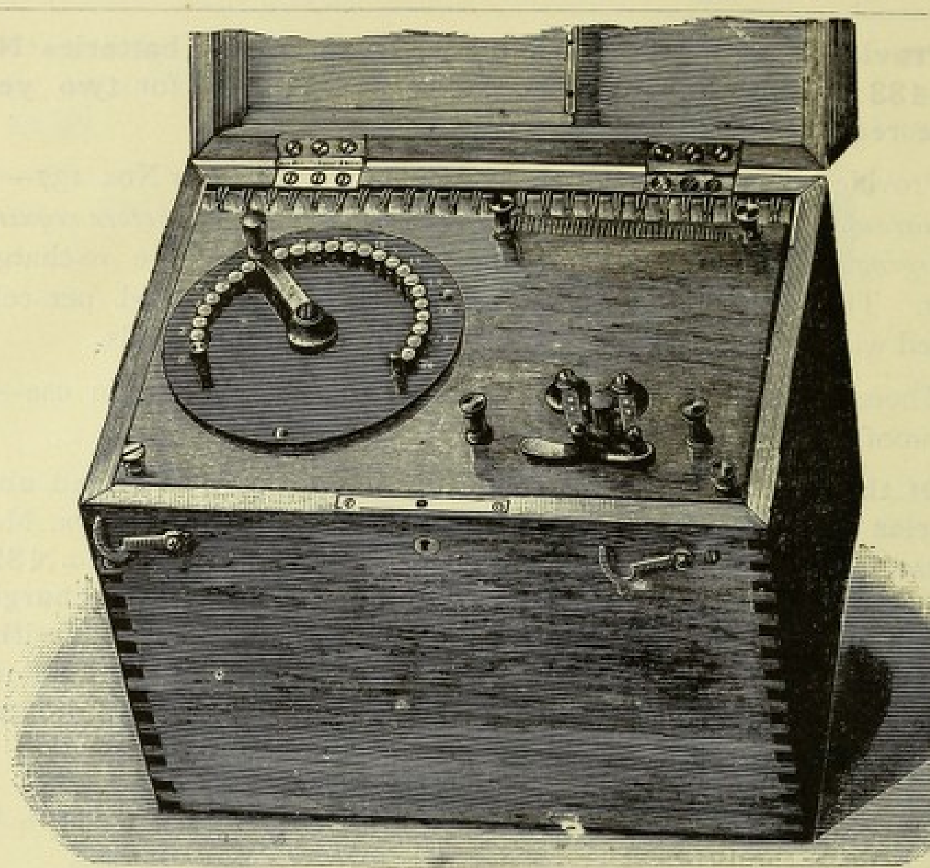
These batteries are very simple in construction. The strength of the current can be regulated without interruption, *i.e.*, without giving shocks to the patient, by increasing or diminishing the number of cells (two at a time) by means of the forked cord *a b*.



No. 113.

*No. 108,	4 cells				£0	17	0
*No 109,	6 ,,				1	1	0
†No. 110,	8 ,,	3½×5 × 6½ inches,	weight	6-lbs.	1	12	0
†No. 111,	12 ,,	5 × 5 × 6½ ,,	,,	9½-lbs.	2	2	0
No. 112,	18 ,,	5 × 9½ × 6½ ,,	,,	12½-lbs.	2	15	0
No. 113,	24 ,,	7½×10 × 6½ ,,	,,	18 -lbs.	3	5	0
No. 114,	32 ,,	8 ×14 × 6½ ,,	,,	24 -lbs.	4	2	0
No. 115,	40 ,,	8 ×17 × 6½ ,,	,,	30 -lbs.	5	0	0

* Suggested by Mr. Cardew, for treating exophthalmic goitre. (Graves's disease.)
† For throat, ear and eye diseases, for removing hairs by means of electrolysis, etc.



No. 117.

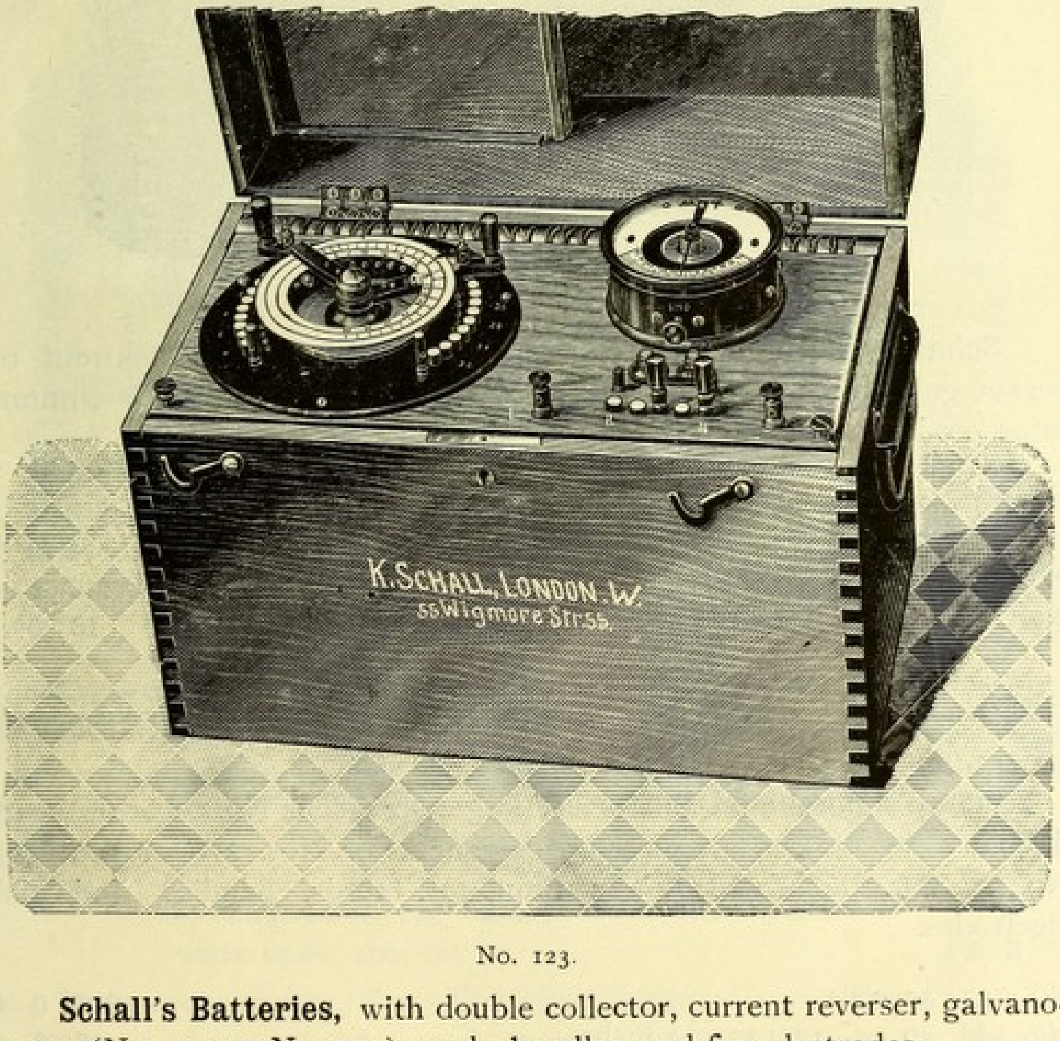
No. 117A.

Schall's Batteries, with current collector, current reverser, cords, handles, and four electrodes (oak case).

No. 116,	18 cells,	$4\frac{1}{2}$ ×	$9\frac{1}{2}$ ×	11 inches,	weight	16-lbs.	. . .	£4 10 0
No. 117,	24 „	7 ×	11 ×	11 „	„	21-lbs.	. . .	5 10 0
No. 118,	32 „	7 ×	$13\frac{1}{2}$ ×	11 „	„	29-lbs.	. . .	6 12 0
No. 119,	40 „	7 ×	16 ×	11 „	„	37-lbs.	. .	7 12 0

Schall's Combined Batteries.—With current collector, current reverser, coil No. 6, and large dry cell, working the coil for over 100 hours, cords, handles, and 4 electrodes.

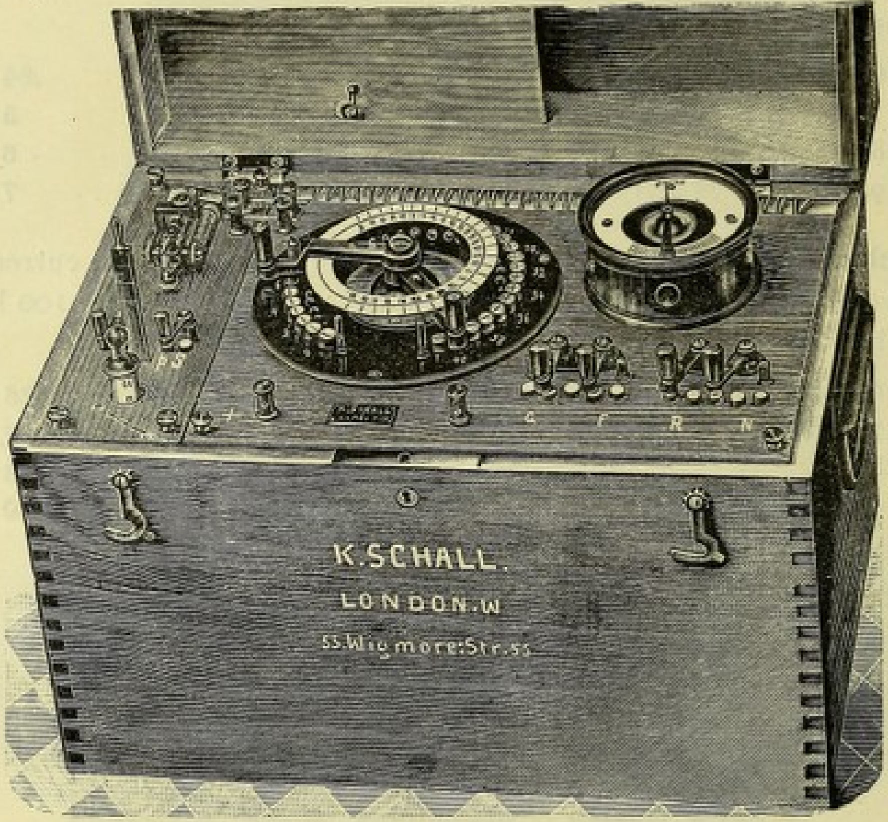
No. 116A,	18 cells	£6 10 0
No. 117A,	24 „	7 10 0
No. 118A,	32 „	8 12 0
No. 119A,	40 „	9 12 0



No. 123.

Schall's Batteries, with double collector, current reverser, galvanometer (No. 270 or No. 271), cords, handles, and five electrodes.

No. 122,	24 cells,	7 ×	11 ×	11 inches,	weight	22-lbs.	. . .	£10 0 0
No. 123,	32 „	7 ×	$13\frac{1}{2}$ ×	11 „	„	30-lbs.	. .	11 0 0
No. 124,	40 „	7 ×	16 ×	11 „	„	38-lbs.	. . .	12 0 0
No. 125,	50 „	$8\frac{1}{2}$ ×	$16\frac{1}{2}$ ×	11 „	„	47-lbs.	. .	13 0 0



No. 132.

Schall's Combined Batteries, with double collector, current reverser, galvanometer No. 271, coil No. 27, Dr. de Watteville's commutator, cords, handles, and seven electrodes.

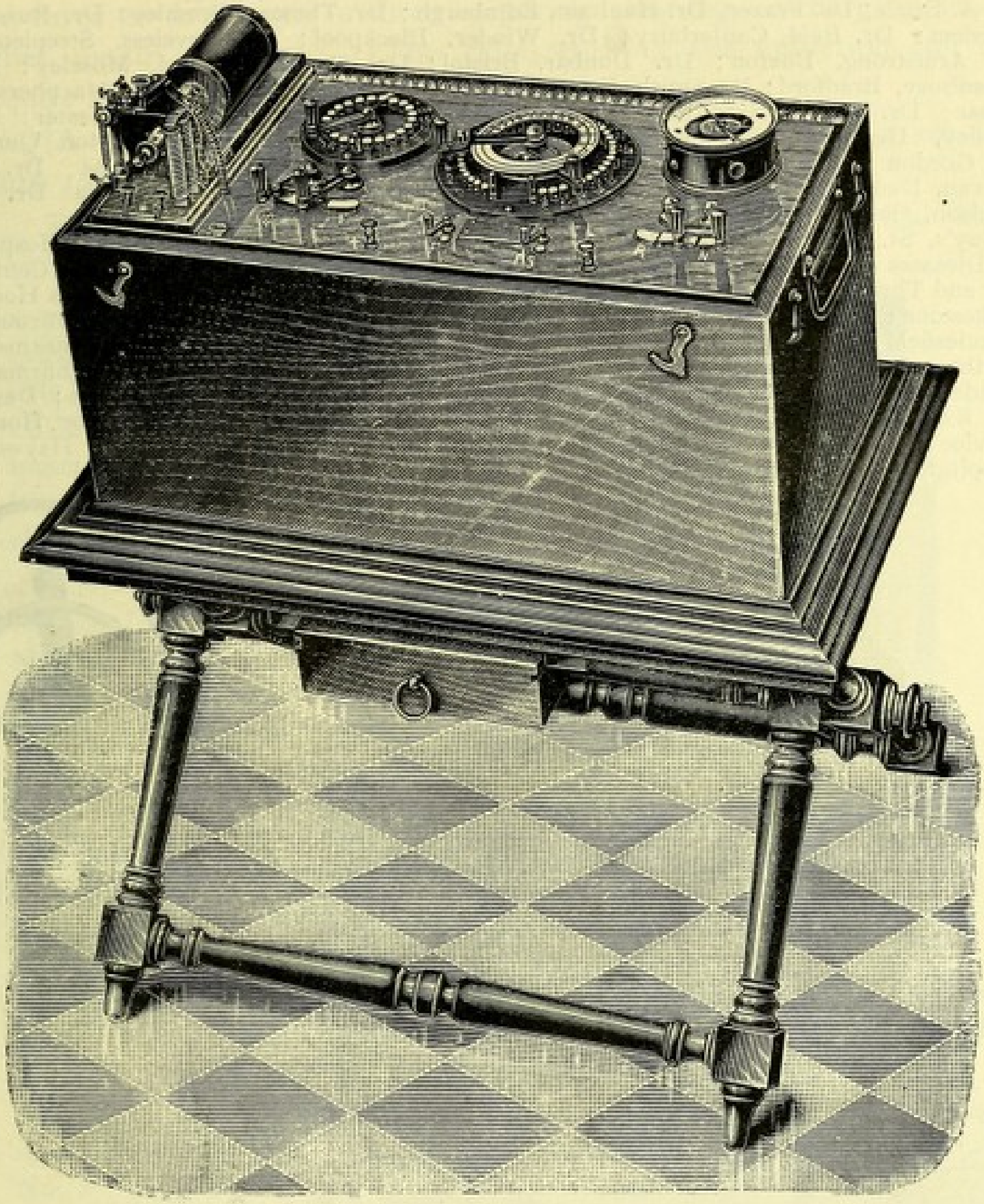
No. 130, 24 cells,	$7 \times 13 \times 11$	inches, weight	34-lbs.	£12 15 0
No. 131, 32 ,,	$7 \times 15\frac{1}{2} \times 11$	,, ,,	42-lbs.	14 10 0
No. 132, 40 ,,	$9 \times 16\frac{1}{2} \times 11$	,, ,,	48-lbs.	16 5 0
No. 133, 50 ,,	$10\frac{1}{2} \times 16\frac{1}{2} \times 11$	,, ,,	57-lbs.	18 0 0

To save space, the Coil No. 27 is arranged vertically in the batteries 130—133, but, if preferred, it can be mounted in the same manner as Fig. 139 shows, without alteration in price.

Schall's Combined Batteries, larger size (cells No. 63 or 68), with double collector, current reverser, galvanometer Nos. 270 or 271, coil No. 27, Dr. de Watteville's commutator, cords, handles, and nine electrodes.

No. 137, 32 cells		£16 0 0
No. 138, 40 ,,	$12 \times 23 \times 14$ inches	18 0 0
No. 139, 50 ,,	(Illustration next page)	20 0 0
No. 140, 60 ,,		22 0 0

The addition of a rheostat (No. 310) increases the price of the batteries by £1 each.



No. 139.

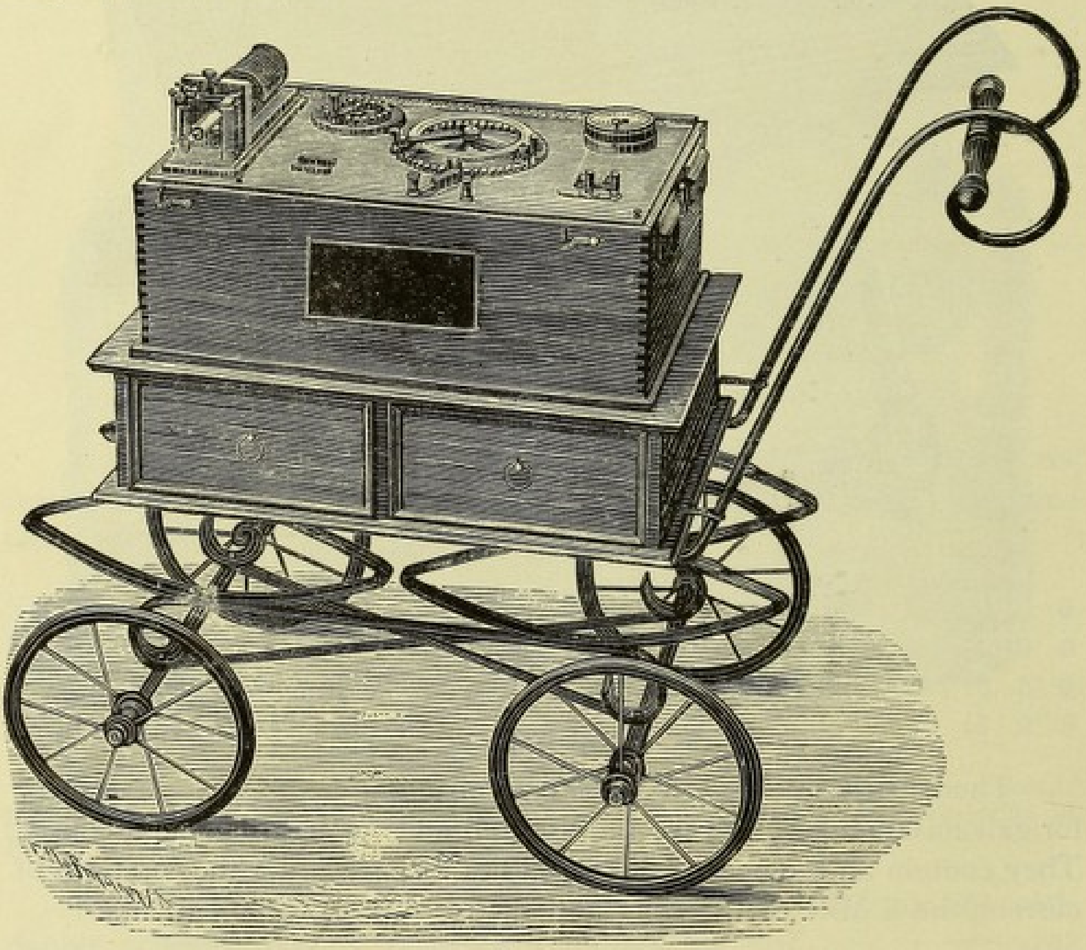
These batteries are excellent for consulting rooms, hospitals, etc., for galvanisation, electrolysis, faradisation, and for lighting small lamps. They contain all the necessary accessories for measuring the strength of current, the E.M.F. of the cells and the resistance of the patient.

No. 142. Stand, with drawer for the reception of the electrodes, and two movable shelves, to put a water basin, etc., on **£2 2 0**

There are over 200 of our Combined batteries in use already.

They have been supplied amongst others to Dr. A. H. Bennett, Dr. Buzzard, Mr. Butler-Smythe, Dr. Cagney, Mr. Andrew Clark, Mr. Cardew, Mr. Juler, Mr. Maddick, Dr. Mott, Dr. Montague Murray, Mr. Nunn, Mr. Morrisson, Dr. Pitt, Dr. Shuldham, Dr. Stowers, Dr. Scanes Spicer, Dr. Pasteur, Dr. T. H. Jackson, Dr. Swan, Dr. Miller, Dr. Hickman, Dr. Harvey, Dr. Skinner, Dr. Turney, Dr. Sang, Dr. Richardson, Dr. Lauder Brunton, Dr. Wallace, London; Dr. E. Browne, Dr. Hayward, Liverpool; Dr. Cremin, Dr. Cummins, Cork; Dr. Hedley, Brighton; Dr. Gamgee, Dr. Huggard Davos, Dr. Green, Sandown; Dr. Milne Murray, Dr. Taylor, Dr. Turner, Dr. Ronaldson, Dr. A. Bruce, Dr. Frazer, Dr. Haultain, Edinburgh; Dr. Thomas, Bromley; Dr. Russell, Burslem; Dr. Reid, Canterbury; Dr. Winder, Blackpool; Dr. Loveless, Steepleton; Dr. Armstrong, Buxton; Dr. Dunbar, Bristol; Dr. C. Myers-Ward, Moseley; Dr. Greenbury, Bradford; Dr. Smith, Ingatestone; Dr. Macintyre, Glasgow; Dr. Macpherson, Bonar; Dr. Major, Bradford; Dr. Rayner, Malvern; Dr. Sinclair, Manchester; Dr. Shelley, Hertford; Dr. Macgregor, Aberdeen; Dr. Moberley, Bridlington Quay; Dr. Gordon Price, Calcutta; Dr. O'Neill, Sydney; Dr. E. Edwards, China; Dr. H. Teevan, Dunedin; Dr. Withers, Canterbury, New Zealand; Dr. Tother, India; Dr. M. Goldson, Oakland, California; Dr. Hardie, Brisbane; Dr. Matas, San Felon.

Guy's, St. Mary's, and London Hospitals, St. Thomas's Hospital, National Hospital for Diseases of the Heart, London County Lunatic Asylum, Hanwell (2 batteries); Central Ear and Throat Hospital; Marylebone General Dispensary, London; St. Andrew's Home, Folkestone; Manchester Southern Hospital; Aberdeen Royal Infirmary; Infirmary, Macclesfield; St. Anne's Hill Hydropathic Establishment; Dispensary, Exeter; Infirmary, Northampton; Miller Hospital, Greenwich; The Hospital, Keightley; Royal Infirmary, Dundee; Sidmouth Hydropathic Co.; Waterside Hydropathic Co., Eastbourne; Devon and Exeter Hospital, Exeter; County Asylum, Whittingham; Combination Poor House, Dundee; Whitworth Hospital, Dublin; Hospital for Sick Children, Aberdeen; Haywood Hospital, Burslem, etc., etc.



No. 143.

No. 143. Trolley, for hospital use £2 16 0

STATIONARY BATTERIES.

For physicians who have to apply electricity frequently, and whose batteries need not be portable, as well as for hospitals and other establishments, etc., the stationary batteries have great advantages, because cells of large type can be used for them. They are far more constant than the small cells used for portable batteries, and last on an average for three or four years without requiring cleaning, re-charging, or any other repairs whatever. (The cells working the induction coil may require re-charging oftener, if strongly used.)

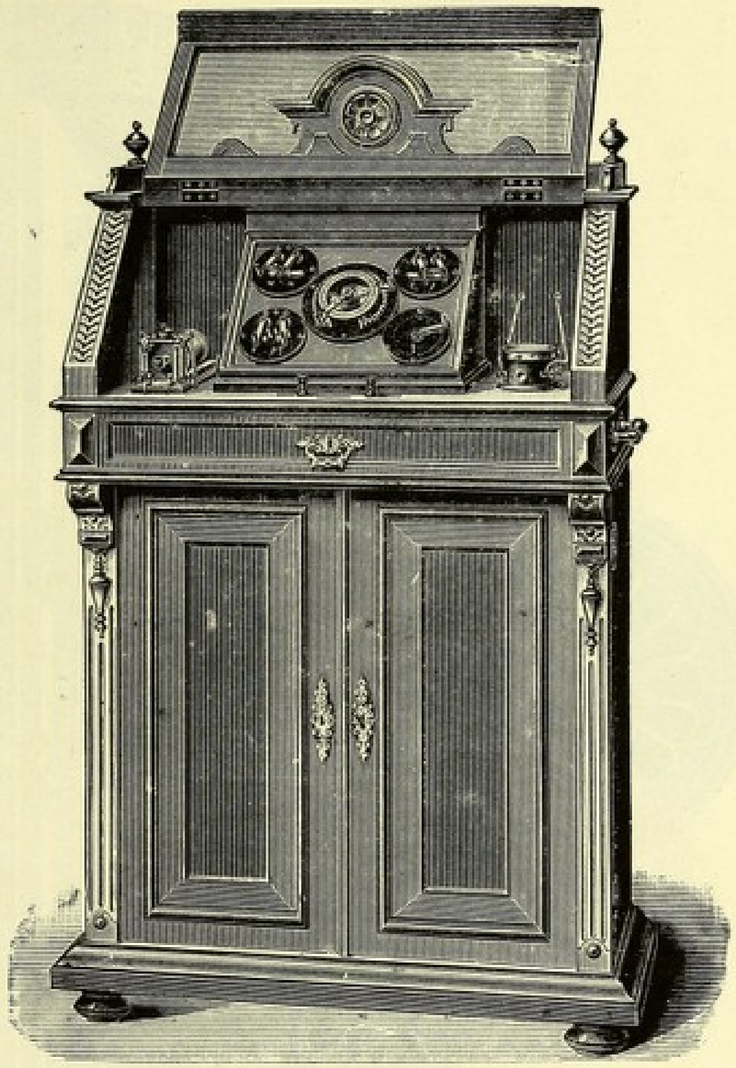
(As to the cells used for these batteries (No. 64) see also page 11.)

The batteries Nos. 160—180 may be used for surgical lamps requiring not more than 0·8 ampère.

No. 160. 40 Leclanché cells, in oak cabinet, (Fig. 170), double collector, galvanometer No. 277, cords, handles, and six electrodes **£23 10 0**

No. 162. The same battery, but with coil No. 27, commutator for primary and secondary current, and Dr. de Watteville's commutator in addition **£27 10 0**

No. 170. 44 Leclanché cells, in oak or walnut cabinet, with double collector, galvanometer No. 278, rheostat No. 321, current interrupter and current reverser, coil No. 27, Dr. de Watteville's commutator, cords, handles, and nine electrodes **£37 0 0**



No. 170.

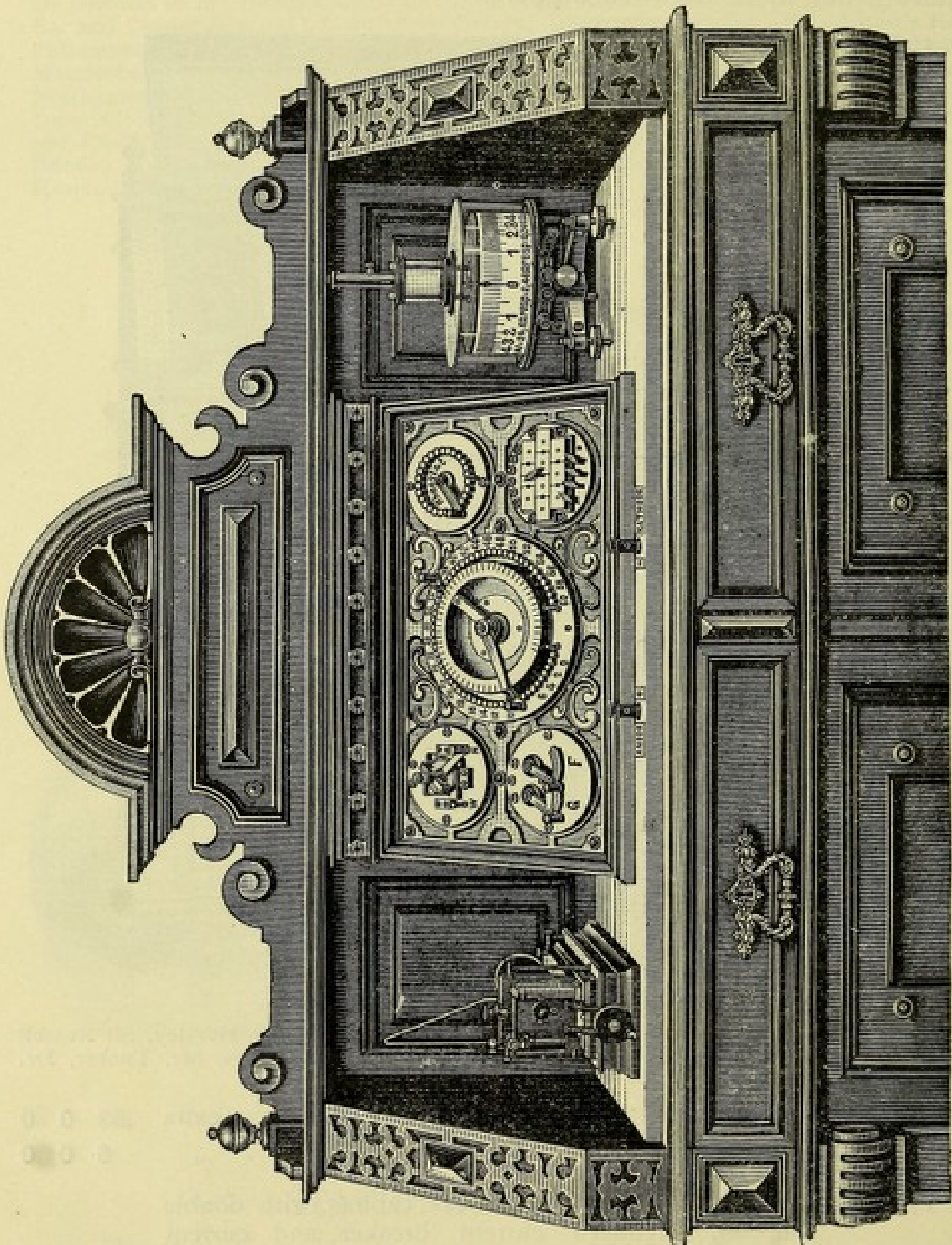
(As supplied to St. Mary's Hospital, Dr. E. Blake, Mr. Victor Horsley, Sir Russell Reynolds, Dr. Lloyd Roberts, Dr. M. M. Sharpe, Dr. C. H. Haines, Mr. Tucker, Dr. Lauder Brunton, and others.)

Batteries Nos. 160, 162, and 170, with 50 cells . .	extra	**£3 0 0**
" " " " 60 "	"	**6 0 0**

No. 175. 60 Leclanché cells, in carved oak cabinet, with double collector, Brenner's current breaker and current reverser, graphite rheostat, galvanometer No. 290, large coil, No. 28, and Dr. de Watteville's commutator, handles, cords, and nine electrodes . . **46 0 0**

(As supplied to Dr. Gamgee, Dr. Macvail, Dr. Macintyre, St. Mary's Hospital, Dr. Levellyn, Dr. Knight, Dr. Bachelor, and others.)

No. 180. 66 Leclanché cells, in carved oak or walnut cabinet, with marble top, double collector, Brenner's current reverser and interrupter, galvanometer No. 290, metal and graphite rheostat, commutator for single or derived circuit, Dr. de Watteville's commutator, coil No. 28, with three secondary bobbins, two pairs of cords, four handles, and twelve electrodes £60 0 0



No. 180. The illustration shows the battery without glass cover.

Nos. 160 to 180 show the most frequently used combinations of apparatus. There are, however, many other combinations possible. The apparatus can be fixed on tables instead of on cupboards, as described by Dr. Macintyre, or can hang on the wall in order to take up less room. We are prepared to meet the wishes of medical men as to special combinations, size and shape, to send estimates, and make plans, if photographs of similar apparatus do not already exist.

It is sometimes more convenient to place the cells in another room, in the cellar, for instance. Under such circumstances, the collector, galvanometer, and other accessories must be fixed on a table or on a board in the consulting room. Instead of employing a current collector, which requires numerous wires leading from the battery to the consulting room, it may be more convenient in such cases to use rheostats for regulating the strength of the current. The resistance the rheostats should have depends upon the E.M.F. of the battery; for instance, 45,000 ohms are required to reduce the current of 30 Leclanché cells (45 volts) to 1 milliampère, etc.

No. 190. Polished walnut, or oak board, with four graphite rheostats of a total resistance of 100,000 ohms, current reverser and interrupter, galvanometer No. 290, fixed on a zinc bracket, coil No. 27, Dr. de Watteville's commutator, switch for primary and secondary current, cords, handles and six electrodes **£27 10 0**

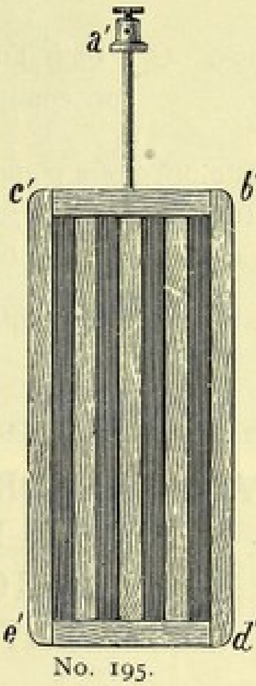
(As supplied to Dr. Blake; Western Infirmary, Glasgow; Dr. Hamilton, New York; and others.)

ELECTRIC BATH.

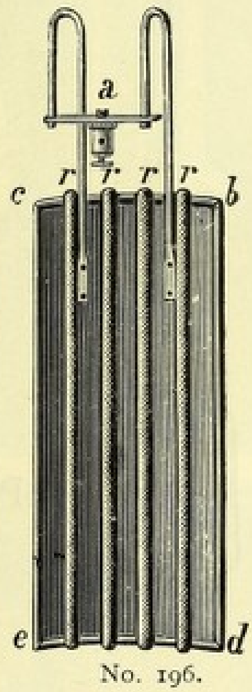
Any wooden or enamelled bath tub is fit for an electric bath, and any metal tub can be insulated by means of bath enamels, so that the electric current can therein be applied to the patient. Tin electrodes, about ten inches square, are immersed in the water at the upper and lower ends, sometimes at both sides as well, or else the electrodes shown in Nos. 195 to 198 can be used.

No. 195. Large bath electrode . . **£0 12 6**

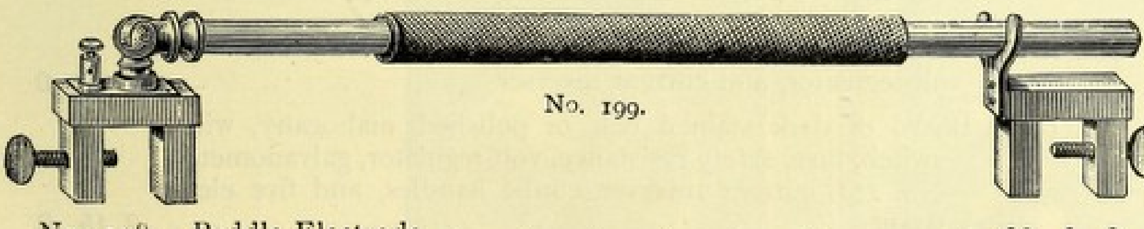
No. 196. The same, bent for the head or foot end of the tub **0 15 0**



No. 195.



No. 196.


No. 199.

No. 198. Paddle Electrode **£0 9 0**

No. 199. Electrode for monopolar bath **1 0 0**

For Tin Electrodes, see Nos. 480 to 497.

In this way any bath tub can, without trouble or serious expense, be made fit for the treatment of a patient with the electric current. The Induction Coil No. 35 is specially recommended, if the Faradic current is used. The Batteries Nos. 116 to 140, or Nos. 160 to 192 are suitable for applying the Galvanic, Faradic, or Combined currents.

No. 198.

For complete Electric Baths in hydropathic establishments or in hospitals, we recommend a specially constructed Bath Tub, at the bottom and sides of which six or eight electrodes are fixed, so that the patient does not come in contact with them. A commutator makes it possible to make the Galvanic, Faradic, or Combined current circulate between any pair of electrodes.

If it is desired, the douche may be connected with the current, and be applied as one pole or electrode.

The battery and commutator can be placed in the same room as the bath, or in an adjacent room. In either case complete control over the direction and strength of the current in the bath is possible. The commutator has to be connected with the bath tub by as many wires as there are electrodes in the bath.

No. 205. Oak Bath Tub, with eight fixed electrodes and commutator £12 10 0

The price of a complete installation of an Electric Bath with extra tub is £17 to £70; without special bath tub from £4 to £60, according to the battery chosen.

Estimates and Photographs will be sent on application.

APPARATUS FOR UTILIZING THE CURRENT SUPPLIED FROM DYNAMOS FOR GALVANISATION, ELECTROLYSIS AND FARADISATION.

(See also pages 23—26 about these apparatus.)

No. 181. Board of polished mahogany with switch, fuse, safety resistance, volt-regulator, and current reverser £5 0 0

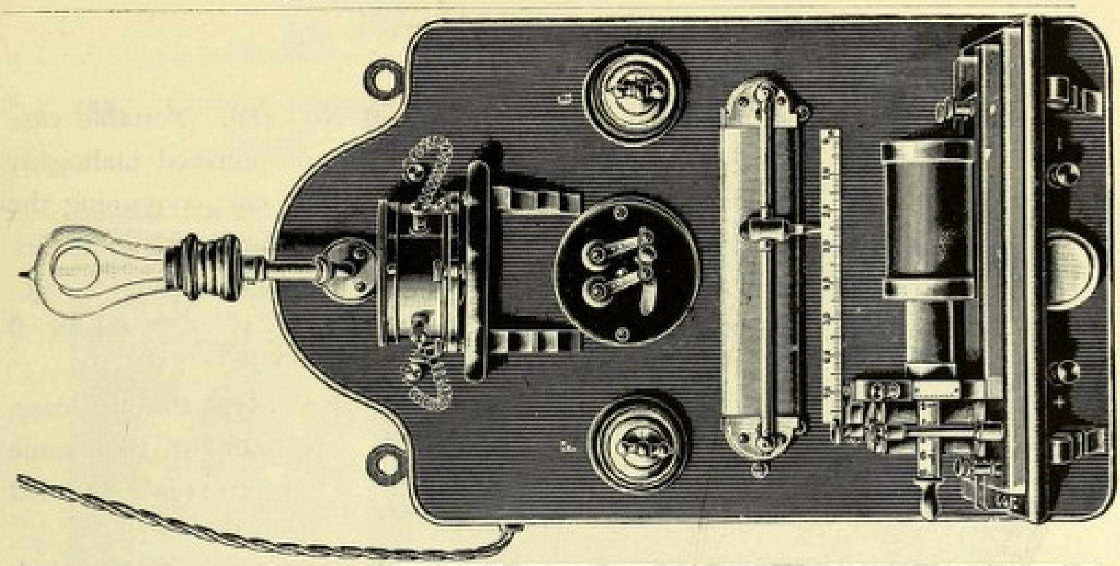
No. 183. Board of dark stained oak or polished mahogany, with switch, fuse, safety resistance, volt-regulator, galvanometer No. 271, current reverser, cords, handles, and five electrodes 9 15 0

No. 184. Similar board, but fitted in addition with an induction coil, No. 6, and switch for primary or secondary current . 12 0 0

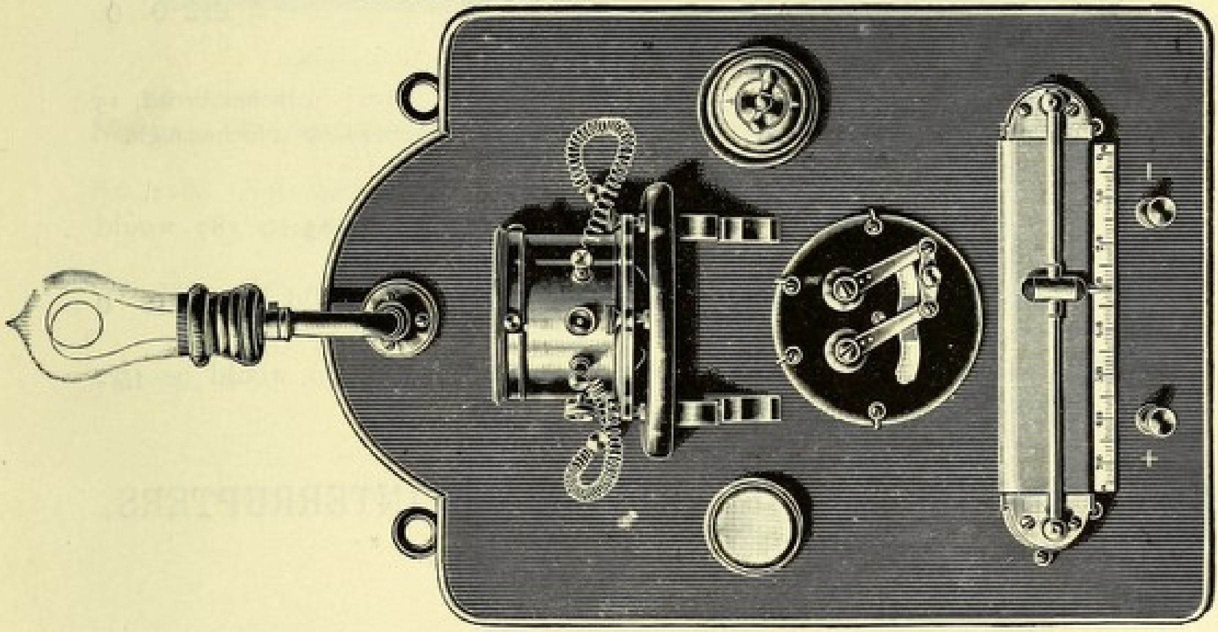
Size: 12 inches wide, 19 inches high, 6 inches projecting from wall.

No. 185. Similar Board, but fitted with a sledge coil instead of the ordinary coil 13 10 0

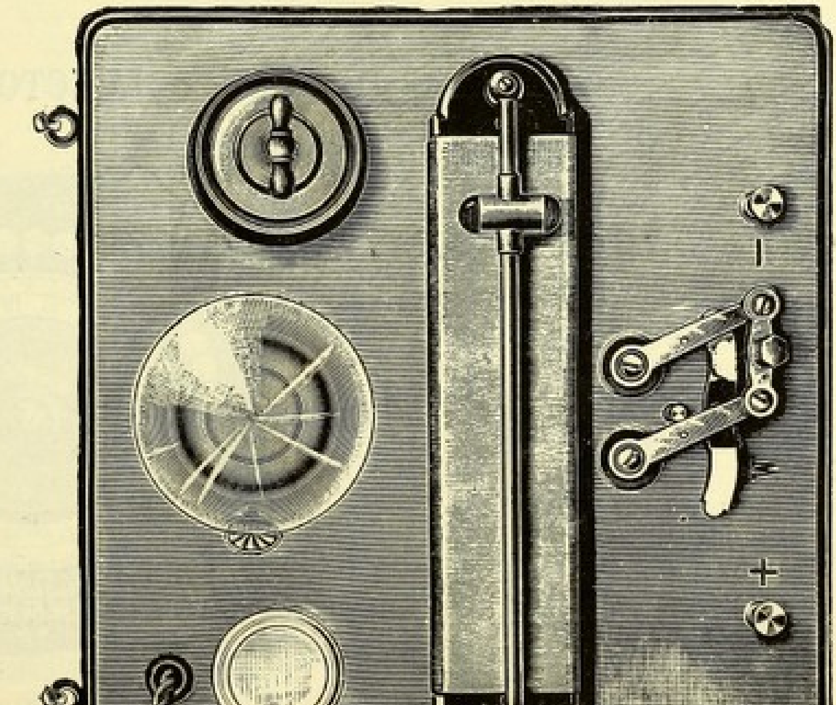
A cabinet with glass door, increases the price by . 1 10 0



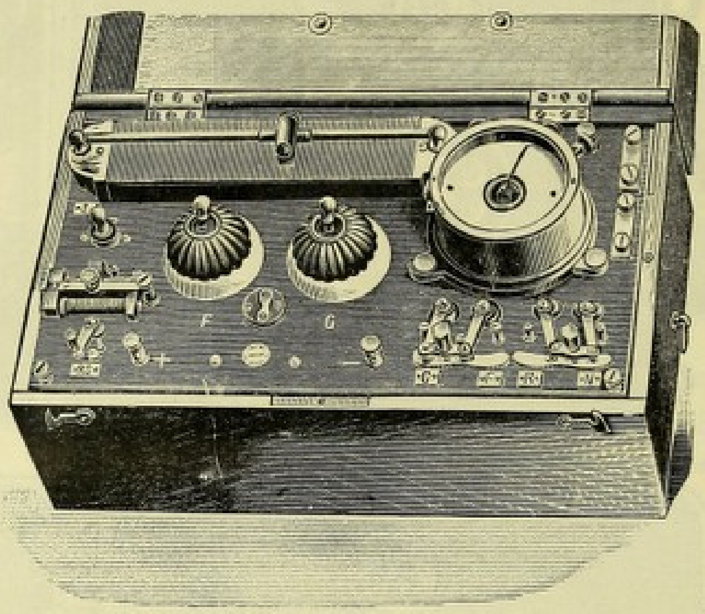
No 185.



No. 183.



No. 181.



No. 187.

No. 186. Portable case of polished mahogany or oak, containing the same apparatus as described under No. 183 £9 18 0

No. 187. Portable case, containing the same apparatus as mentioned under No. 184 £12 0 0

Size: 9 inches broad, 15 inches long, 9 inches high.

With a galvanometer No. 265, instead of No. 271, Nos. 183 to 187 would be £1 3 0 less each.

Without galvanometer the apparatus Nos. 183 to 187 would be £2 10 0 less each.

Nos. 184 and 187 with a Dr. de Watteville key in addition, would be 15/- extra each.

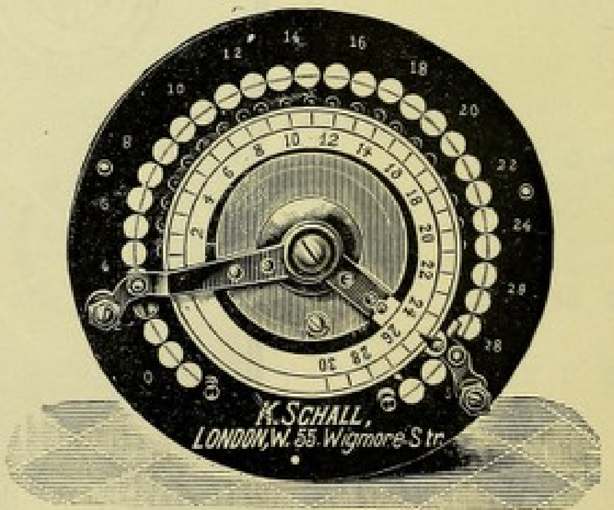
CURRENT COLLECTORS, REVERSERS INTERRUPTERS, AND COMMUTATORS.

(See also pages 13—19.)

SCHALL'S DOUBLE COLLECTORS.

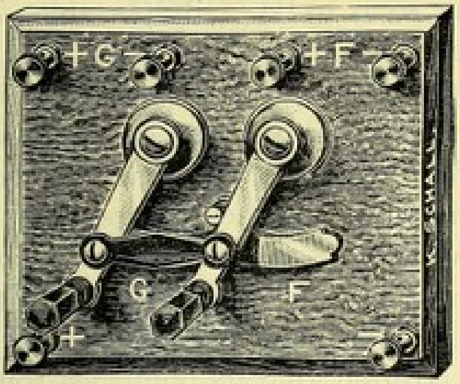
(See also page 14.)

No. 209. Double Collector, mounted on polished ebonite, for 20 cells		£1 18 0
No. 210.	30 cells	2 5 0
No. 211.	40 „	2 14 0
No. 212.	50 „	3 3 0
No. 213.	60 „	3 10 0

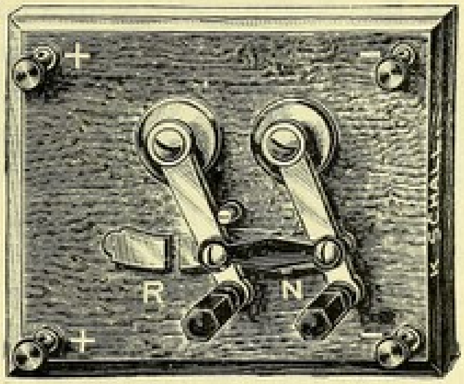


No. 210.

No. 222. Current reverser and interrupter, mounted on polished board £0 14 0



No. 232.



No. 222.

No. 224. Dr. Brenner's current reverser and interrupter £1 15 0

No. 226. Automatic current reverser and interrupter, with adjustable rapidity of the interruption 5 10 0

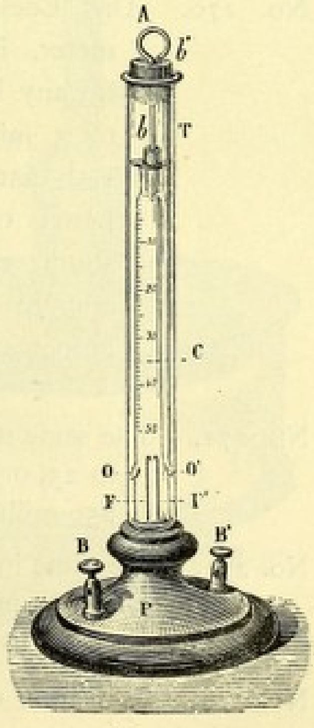
No. 232. Dr. de Watteville's commutator, for the use of Galvanic, Faradic, or Combined currents 0 16 0

GALVANOMETERS.

(See also pages 16—18.)

No. 240. Coulombmeter . . . £0 10 0

It consists of two glass tubes of different diameters, the narrower one is inside the other and graduated in Coulombs, *i.e.*, degrees corresponding with the amount of gas generated by one ampère in one second, and communicates with the other by means of two apertures. The one at the top can be closed with a stopper. The lower part of the narrower tube contains two platinum wires, between which the current passes as soon as the tubes are filled with water. The gas developed in consequence of the decomposition soon rises in the inner tube, and its quantity may be read from the scale. The stopper of the inner tube being removed for a moment, the tube refills itself with water, and can be used for a second trial at once. In order to learn how many milliampères the current had which passed through the instrument, the amount of gas generated *per minute* has to be divided by 60; for instance, if a current passed through the instrument for 5 minutes, and the amount of gas generated was 4·50 degrees, the strength of the current was 15 milliampères.

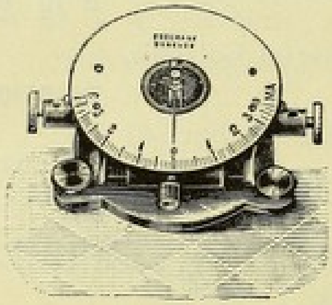


No. 240.

POCKET GALVANOMETERS.

The instruments Nos. 264—275 are called *pocket galvanometers*, because they are provided with a cover, so as to be easily portable. The magnet oscillates inside a solid copper block, to make it dead beat. If the point on which the needle oscillates has become blunt, this point—which consists of an ordinary sewing needle, No. 10—can easily be taken out and replaced by a new needle by anybody. But the new needle should project just as far as the old one did when the galvanometer was being graduated or else the division would become inaccurate. To get the correct projections of the needle, the galvanometers 264—272 are provided with a black T-shaped gauge. It is held against the horse shoe and the new needle is fixed in such a position, that its point just touches the top of the gauge.

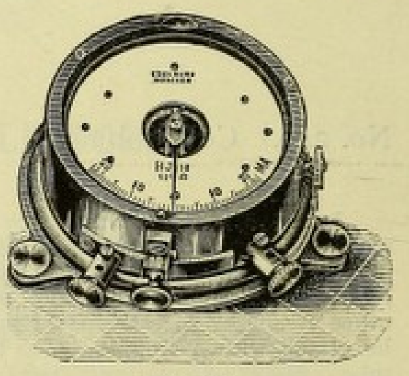
The galvanometers Nos. 264—275 are divided to meet the horizontal intensity of London, and the greatest error is guaranteed not to exceed 2 per cent.


No. 264.

No. 264. Dr. Edelmann's galvanometer, in cardboard box, showing up to 6 milliampères each $\frac{1}{10}$th part of a milliampère . . . £1 8 0

No. 265. The same instrument, showing up to 30 milliampères each single milliampère . . . 1 8 0

No. 270. Dr. Edelmann's galvanometer, in polished mahogany box, showing up to 5 milliampères every $\frac{1}{10}$th part of a milliampère; or by using the shunt, each single milliampère up to 50 milliampères . . . £2 15 0


No. 271.

No. 271. The same instrument, showing each single milliampère up to 25, or by using the shunt, every 10 milliampères up to 250 milliampères 2 15 0

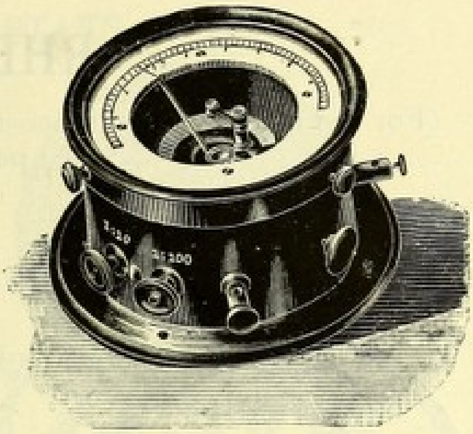
No. 272. The same instrument, with two shunts, showing up to 5, 50, or 500 milliampères 3 15 0

Other divisions can be supplied to order.

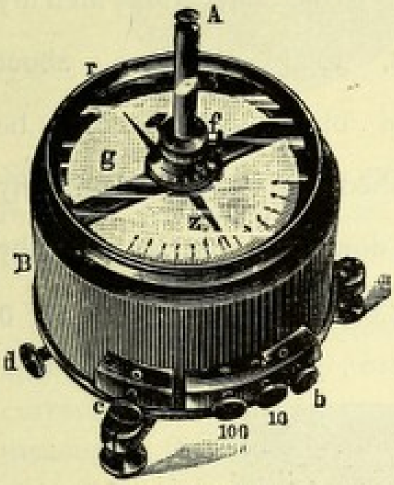
No. 276. Resistance coil of 1000 ohms, to use any of the galvanometers 264—275 as a voltmeter. 0 12 6

GALVANOMETERS WITH MAGNET SUSPENDED ON COCOON.

No. 277. Galvanometer, with two shunts, showing up to 5, 50, or 500 milliampères . £4 10 0



No. 277.



No. 278.

No. 278. Dr. Edelmann's Universal galvanometer . . £7 12 0

Nos. 277 and 278 indicate every $\frac{1}{10}$th part of a milliampère from 0 to 5, each single milliampère from 0 to 50, and 10 by 10 milliampères from 0 to 500 milliampères.

No. 278 is used, amongst others, by Drs. Althaus, Blake, Cardew, Dowse, Gamgee, Horsley, Jones, Macintyre, Murray, Sir Russell Reynolds, Steavenson, Sharkey, Turner, de Watteville; in Guy's, St. Bartholomew's, St. Mary's, St. George's, Charing Cross, and many other Hospitals, and Royal and Western Infirmary, Glasgow.

No. 279. The same instrument, but with an additional resistance, allowing the instrument to be used also as a voltmeter . £8 16 0

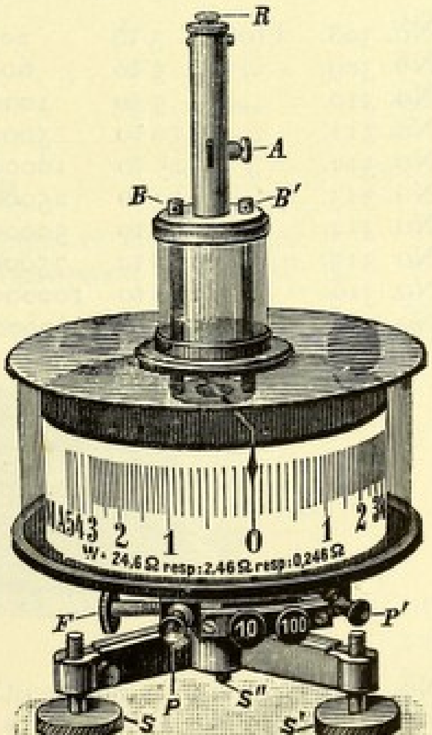
In order to read horizontal galvanometers more conveniently, instruments Nos. 270—279 can be supplied with a mirror, fitted to a movable ring.

No. 281. Mirror for the instruments Nos. 270—275 £0 12 0

No. 282. Mirror for the instruments Nos. 278 and 279 . . . 0 18 0

No. 290. Large horizontal galvanometer, with vertical scale . 10 10 0

No. 292. The same instrument, with voltmeter. . 11 15 0



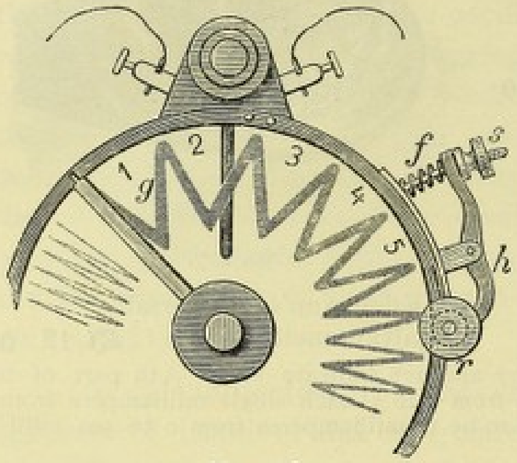
The internal arrangement, accuracy, etc., of this apparatus are exactly the same as in No. 278. The scale, protected by a glass cover, has, however, a diameter three times larger, in consequence of which the divisions are much more distinct, and can be read at a distance of some yards. The instrument is not portable, and is best placed upon a zinc bracket, fixed to the wall, in a good light and convenient position. It shows up to 5 M.A's. each $\frac{1}{10}$th part of a M.A., up to 50 M.A's. each single M.A., and 10 by 10 M.A's up to 500 M.A's.

No. 294. Zinc Bracket for same . 18/-

No. 290.

RHEOSTATS.

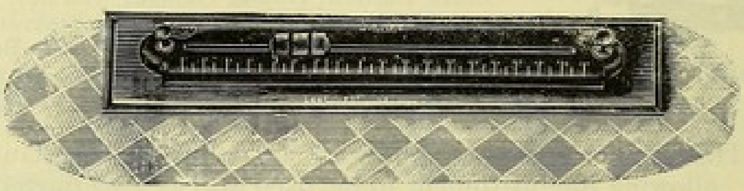
(For the most suitable Rheostats for Galvanisation and Electrolysis, see pages 14—16.)



No. 306.

GRAPHITE RHEOSTATS.

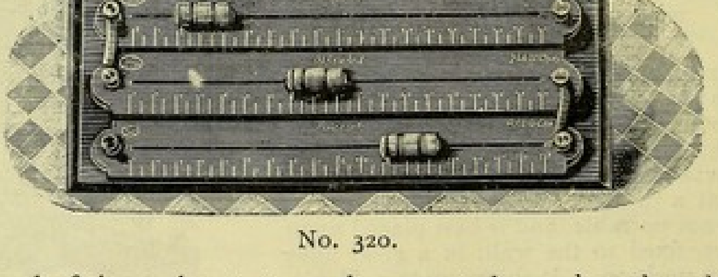
No. 306. Rheostat, with Mercury contact, total resistance about 100,000 ohms, which can be diminished *gradually*, without any jumps, down to about 20 ohms, by turning the glass dial . **£1 17 0**



Nos. 308—319.

Rheostats with sliding spring; the resistances can be varied *gradually*, without any jumps.

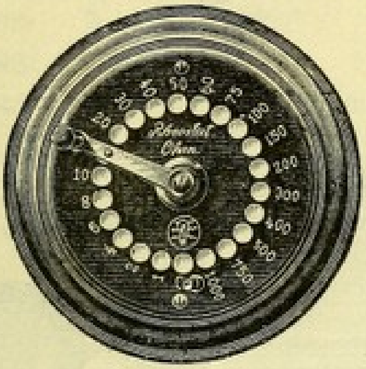
No. 308.	From	3 to	200 ohms	. . . .	**£0 18 0**
No. 309.	,,	5 to	600 ,,	. . . .	**0 18 0**
No. 310.	,,	5 to	1000 ,,	. . . .	**0 18 0**
No. 311.	,,	10 to	5000 ,,	. . . .	**0 18 0**
No. 312.	,,	25 to	10000 ,,	. . . .	**0 18 0**
No. 313.	,,	50 to	25000 ,,	. . . .	**0 18 0**
No. 314.	,,	50 to	50000 ,,	. . . .	**1 0 0**
No 315.	,,	100 to	75000 ,,	. . . .	**1 0 0**
No. 316.	,,	100 to	100000 ,,	. . . .	**1 0 0**
No. 319.	,,	500 to	1000000 ,,	. . . .	**1 5 0**

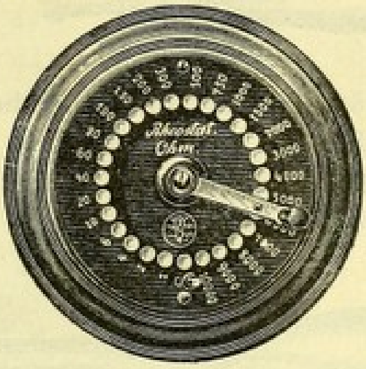


No. 320.

No. 320. Several of these rheostats can be mounted on a board, and be connected in series, so as to have, for instance, one rheostat with a low, one with a medium, and one with a high resistance. Price of the board, with 3 rheostats, including terminals and connections . **£2 12 0**

METAL RHEOSTATS.


No. 320.


No. 321.

No. 320.	Metal rheostat, with crank, 1000 ohms, in 26 sub-divisions	£2 16 0
No. 321.	The same rheostat, with 5000 ohms total resistance .	3 12 0
No. 325.	Large metal rheostat, with 2 cranks, with 21000 ohms total resistance, in 70 sub-divisions	6 0 0

The number of ohms indicated on these metal rheostats is only approximately correct (within 10%), but the 1000 and 10000 ohms are correct (within 1 %), so that the rheostats can well be used for measuring the E.M.F. of batteries.

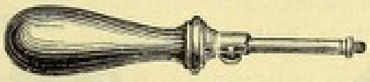
CONNECTING CORDS.

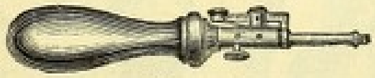
No. 329.	12 yards insulated copper wire		1/6
No. 330.	One pair of cords, for galvanisation, faradisation, or electrolysis, with ball joint covered with cotton,	1½ yards long	3/6
No. 332.	Covered with silk	,, ,,	3/9
No. 333.	Ditto	2 ,,	4/3
No. 334.	Covered with india-rubber tubes . .	1½ ,,	3/9
No. 335.	Ditto ditto . .	2 ,,	4/3

ELECTRODES.

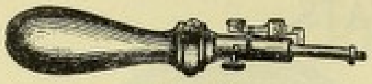
No. 365.	Dr. Herschell's handle, for the reception of large sponges, diameter 4 inches, for general galvanisation and faradisation, without sponge	7/-
No. 366.	Ditto ditto ditto with sponge	10/-

The sponges can easily be exchanged in Handles Nos. 360 and 365; or can be replaced by any other material, flannel, leather, amadou, etc.


No. 372.


No. 376.

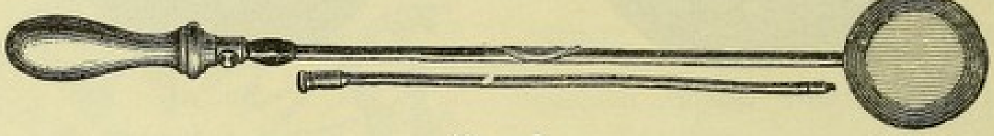
No. 370.	Simple handle, 3 inches long	1/6
No. 371.	,, 4 ,, ...	2/6
No. 372.	,, 5 ,, ...	3/-
No. 376.	Handle for *interrupting* the current, 5 inches long . .	5/-
No. 377.	,, ,, ,, 6 ,, . .	5/-
No. 378.	,, ,, ,, for throat electrodes	6/-



No. 381.

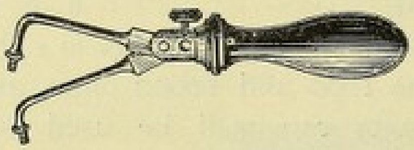
No. 385.

No. 381. Handle for *making* the current, 5 inches long 5/-
No. 382. " " " 6 " 5/-
No. 383. " " " for throat electrodes . . 6/-
No. 385. Connecting piece for fixing the electrodes at a right angle to the handles 2/-

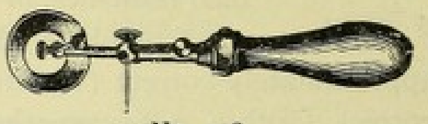


No. 398.

No. 398. Handle, with long insulated shaft, for introducing electrodes under the clothes 9/-

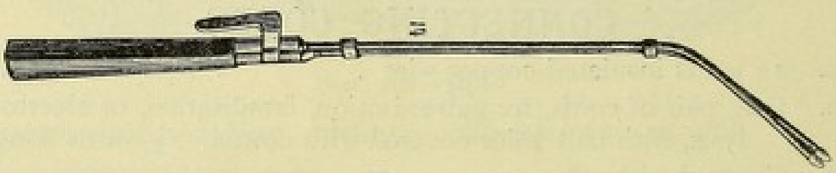


No. 400.

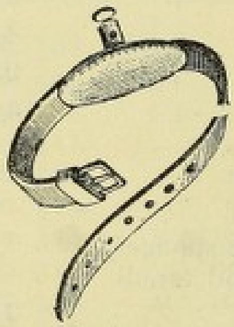


No. 408.

No. 400. Double handle, by Dr. Althaus 10/-



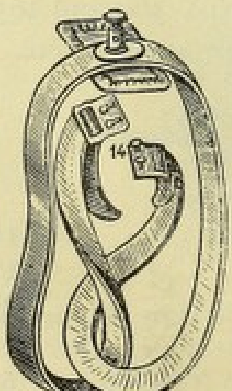
No. 405.



No. 412.

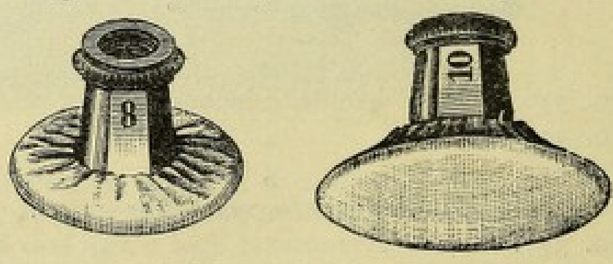
No. 405. Double electrode for larynx, by Ziemssen 18/-
No. 408. Dr. Boudet's handle, with electrode for localised electrization, with 4 electrodes of different size 15/-
No. 412. Bracelet for fixing electrodes to the arms or wrist 4/-

No. 418. Belt electrode, by Beard and Rockwell 6/-
No. 430. Button shape electrodes, small 1/3
No. 431. " " " medium 1/6
No. 432. " " " large 1/6



No. 418.

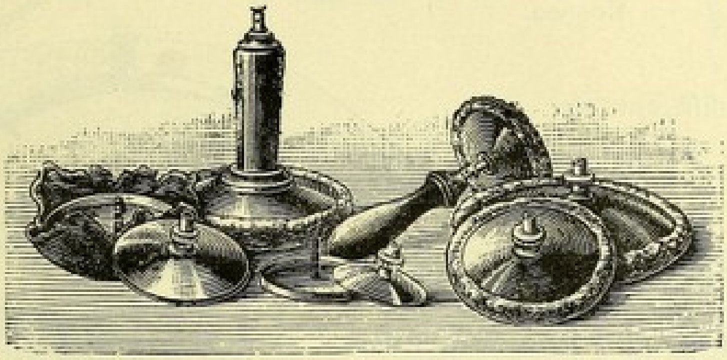
Nos. 430—32.



Nos. 440—49.

Round Tin Plates, covered with leather.

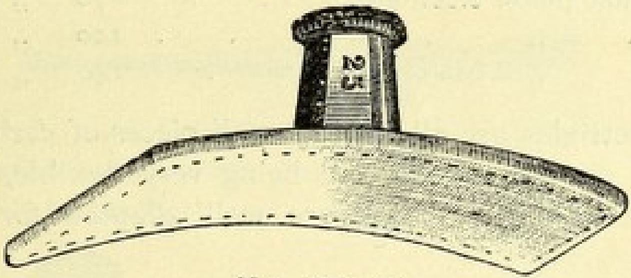
No. 442.	¾ inch diameter	1/4	No. 445.	2 inches diameter	2/-
No. 443.	1 " "	1/6	No. 447.	3 " "	2/9
No. 444.	1½ " "	1/9	No. 449.	4 " "	4/-



Nos. 452 - 58.

Round electrodes, of aluminium, with stout handles, and an arrangement allowing the flannel, leather, amadou or sponge cover to be easily exchanged.

No. 450.	¾ inch diameter	2/9	No. 454.	3 inches diameter	5/-
No. 451.	1¼ " "	3/6	No. 456.	4 " "	6/6
No. 452.	2 " "	4/-	No. 458.	5 " "	7/6



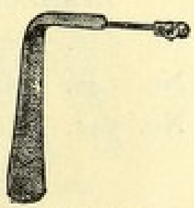
Nos. 460—70.

Square flexible electrodes, of tin, with leather covers.

No. 460.	1 square inch	1/6	No. 466.	6 square inches	3/-
No. 462.	2 " inches	1/9	No. 468.	8 " "	3/9
No. 463.	3 " "	2/-	No. 469.	10 " "	4/-
No. 464.	4 " "	2/3	No. 470.	12 " "	4/6

Nos. 441—449 and 460—470, with carbon plates and leather cover, 50 per cent. more.

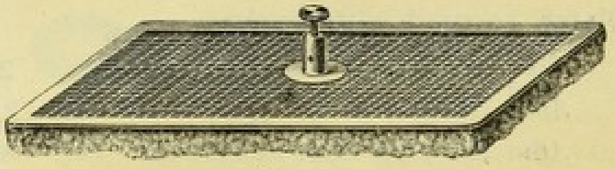
No. 475. Electrode for neck, covered with wash leather 4/6



No. 475.

Flexible tin electrodes, with white flannel covers and terminals, back of the electrode covered with wax cloth (see illustration No. 113, page 65).

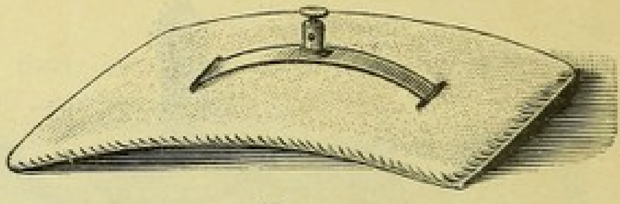
No. 480.	2½ × 4 inches	1/3	No. 491.	3¾ × 7 inches	2/3
No. 483.	2¾ × 5 "	1/6	No. 493.	4½ × 8½ "	2/6
No. 486.	3 × 5½ "	1/6	No. 495.	5 × 8½ "	2/9
No. 489.	3½ × 6 "	1/9	No. 497.	6 × 10 "	3/-



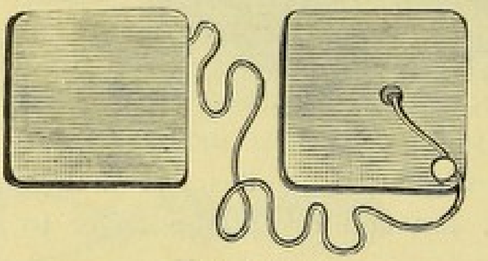
No. 500.

Flexible metal gauze electrodes, with sponge, according to sizes . 5/- to 12/-

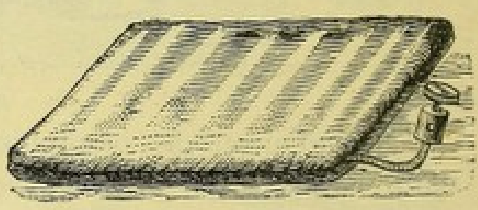
Large indifferent electrode . . . 5/-



No. 510.



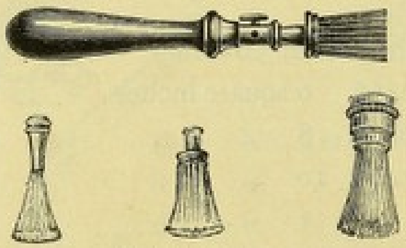
Nos. 520—21.



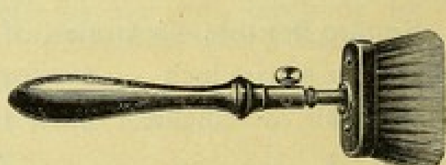
Nos. 525—28.

No. 520.	Foot plate electrode, with flannel cover and terminal,	100 square inches	7/6
No. 521.	Ditto ditto	130 " "	8/6
No. 525.	Flexible pillow electrodes . .	70 " "	10/-
No. 526.	" " "	100 " "	12/-
No. 528.	" " " . .	140 " "	14/-

These electrodes are filled with small pieces of carbon, they do not get blackened on the outside, and being very flexible, cling closely to any part of the body. They are well adapted for Dr. Apostoli's method.



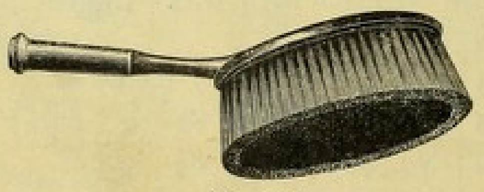
Nos. 540—42.



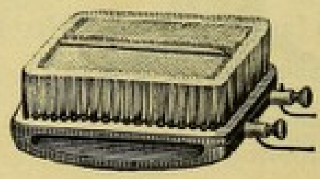
No. 545.

Brush electrodes with metal wire, without handles.

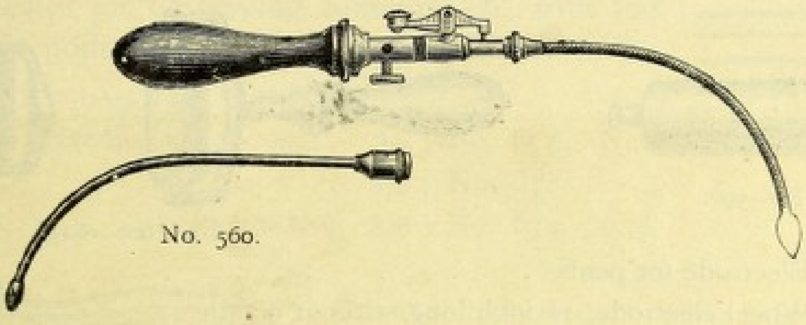
No. 540.	Small . . .	1/6	No. 545.	$2\frac{1}{2}$ square inches .	5/6
No. 541.	Medium . .	1/9	No. 550.	7 " " . .	8/6
No. 542.	Large . . .	2/6	No. 555.	Double brush, 9 square inches . .	10/-



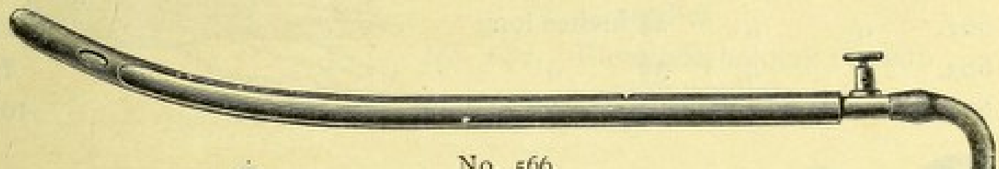
No. 550.



No. 555.



No. 560.



No. 566.

No. 572.

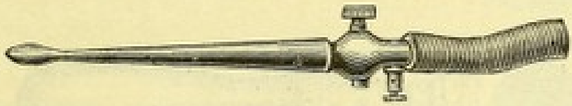
No. 560. Electrodes for larynx, with olive shaped button, shaft insulated with gutta-percha 2/6

No. 566. Electrode for stomach 9/6

No. 568. " for cervix, 3 sizes, each 6/6

No. 570. " for rectum " " 4/6

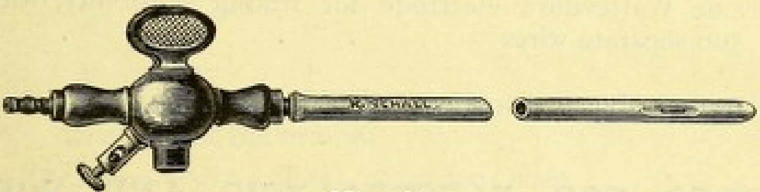
No. 572. Zinc Electrodes for rectum 3/-



No. 573.

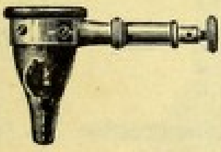
No. 573. Electrode for rectum, with douche 6/-

No. 575. Electrode for bladder 3/-



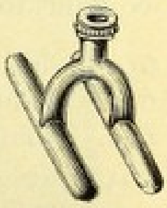
No. 580.

No. 580. Mr. Cardew's bladder electrode, with ebonite tap and soft catheter 8/-



No. 585.

No. 586.



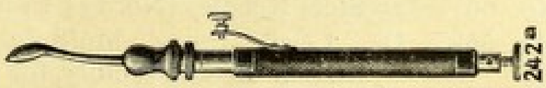
No. 589.

No. 585. Electrode for ear 6/-

No. 586. Dr. Weber Liel's electrode for ear . . 6/-

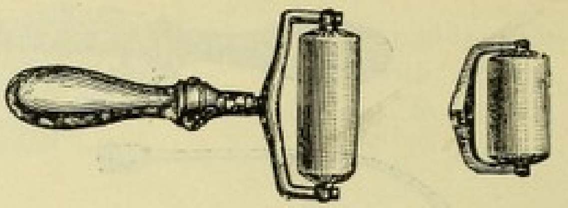
No. 588. Electrode for the eye 9/6

No. 589. Spinal electrode . 4/-



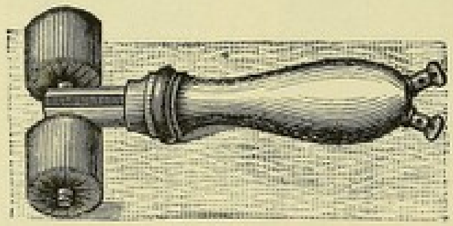
No. 588.

No. 590.

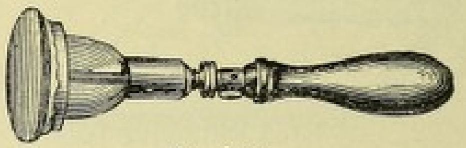


Nos. 600—603.

No. 590.	Electrode for penis	7/-
No. 600.	Wheel electrode, 1½ inch long, without handle . .	4/6
No. 602.	,, ,, 2½ inches long	5/6
No. 603.	,, ,, 3½ ,, ...	7/-
No. 604.	Double wheel electrode, with handle	16/-

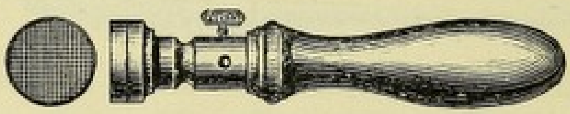


No. 604.



No. 610.

No. 610.	Glass vessel for holding various liquids (unpolarisable or diffusion electrode) . . . 1½ inch diameter	5/-
No. 612.	Ditto ditto ditto 2½ inches ,,	6/-



No. 620.

No. 620.	Dr. de Watteville's electrode for testing sensibility, with 500 separate wires	18/-

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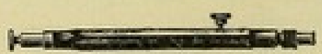
ELECTRODES FOR ELECTROLYSIS AND FOR THE TREATMENT OF STRICTURES.

Needles for removing hairs, nævi, and small tumours.

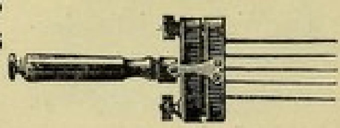
No. 650.	Steel Needle with terminal	1/6
No. 657.	Platinum Needle with terminal	2/6
No. 660.	Gold Needle	3/-
No. 664.	Needle Holder for the reception of different needles .	3/6
No. 665.	Needle Holder with interrupter	4/-
No. 666.	Forceps for epilation . .	2/6
No. 667.	25 Steel Needles (No. 12) .	-/6
No. 668.	Dr. Lewis Jones' Multiple Bipolar Needle Holder, for the treatment of nævi .	15/-

No. 650.

No. 664.

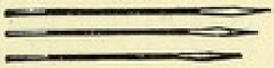


No. 665.



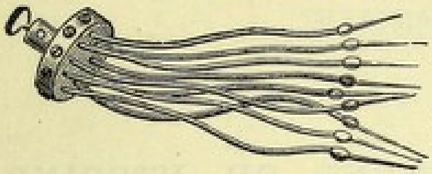
No. 668.

Needles for destroying tumours, etc., with flat platinum points, and shafts insulated with india-rubber.



Nos. 674—79.

No. 674.	Needle, 1 inch long		3/-
No. 675.	,, $1\frac{1}{2}$,,	.	3/3
No. 676.	,, 2 inches long		3/6
No. 677.	Needle, $2\frac{1}{2}$ inches long		3/9
No. 678.	,, 3 ,,		4/-
No. 679.	,, 4 ,,		4/6



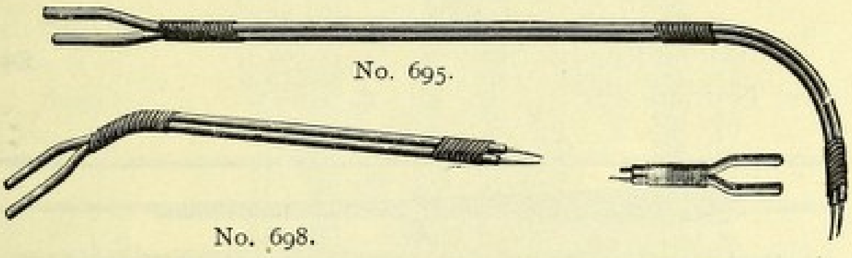
No. 680.

No. 680. Electrode, holding 12 steel needles . . . 8/-

No. 682. Electrode, holding 12 platinum needles . . 16/-

No. 690.

No. 690. Handle, holding Voltolini's needles 14/-

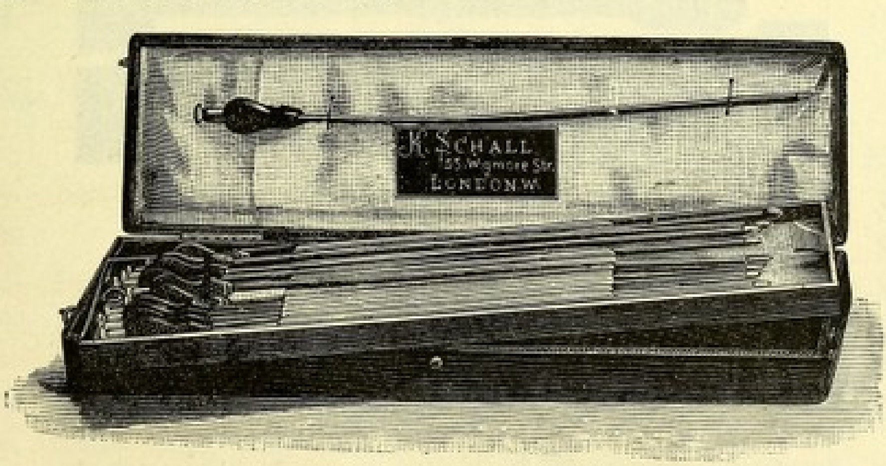


No. 695.

No. 698.

No. 700.

No. 695.	Voltolini's double needle	3/3
No. 698.	,, ,, ,, ...	3/3
No. 700.	,, ,, ,, ...	3/3
No. 710.	Bougie electrode, with Brodie's handle, for the treatment of strictures of the urethra	8/6
No. 712.	The same with 12 slides, of various sizes	18/-

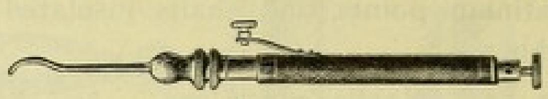


No. 715.

No. 715. Complete set of 12 urethral electrodes, in case . . £3 0 0

No. 730. Electrode for electrolysis of the Eustachian tube . . 12/6

No. 735. Electrode for electrolysis of the lachrymal duct, with blunt platinum top . . . 10/6



No. 735.

No. 738. Electrode for electrolysis of the cervix uteri 8/6

No. 740. Bougie electrode, with 12 heads of various sizes, for the treatment of strictures of the rectum 18/6

ELECTRODES FOR THE TREATMENT OF UTERINE FIBROIDS.

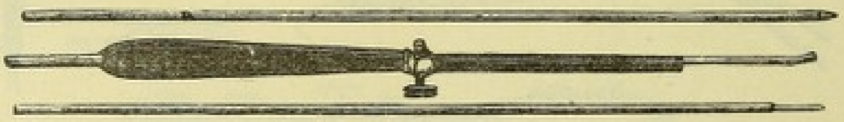
No. 745.

No. 745. Dr. Apostoli's carbon electrodes 8/6

No. 748. „ „ platinum sound, with handle and 3 insulators of different lengths £4 16 0

No. 750. Steel Trochars . . . . each 2/6

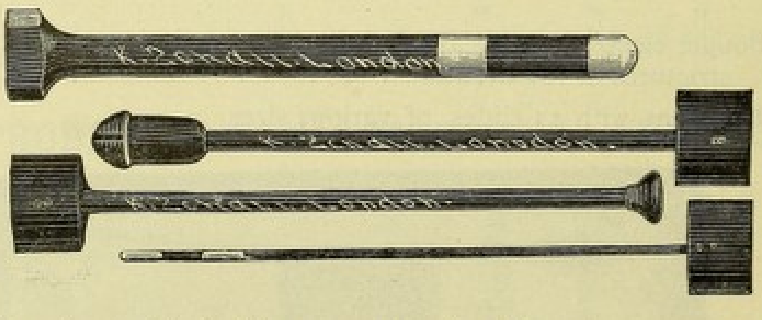
No. 750.
No. 748.
No. 750.



No. 755. Platinum sound, with handle and *flexible* insulator for electrolysis. The stem is of copper, and the tips 3 ins. long at each side, of solid platinum ; the whole is flexible . £3 10 0

No. 780. Dr. Milne Murray's electrode for uterine fibroids . . 2 15 0

No. 789.
No. 785.



No. 787.
No. 790.

No. 785. Dr. Apostoli's double concentric disc electrode . . . 12/6

No. 787. Ditto ditto ditto . . 13/6

No. 789. Dr. Apostoli's double vaginal electrode . . . 12/6

No. 790. „ „ electrode for the urethra and uterus 10/6

The electrodes Nos. 785 to 790 are intended for the localization of galvanic and faradic currents.

No. 795. Tin Plate, with connecting cord, to be used with potter's clay 6/-

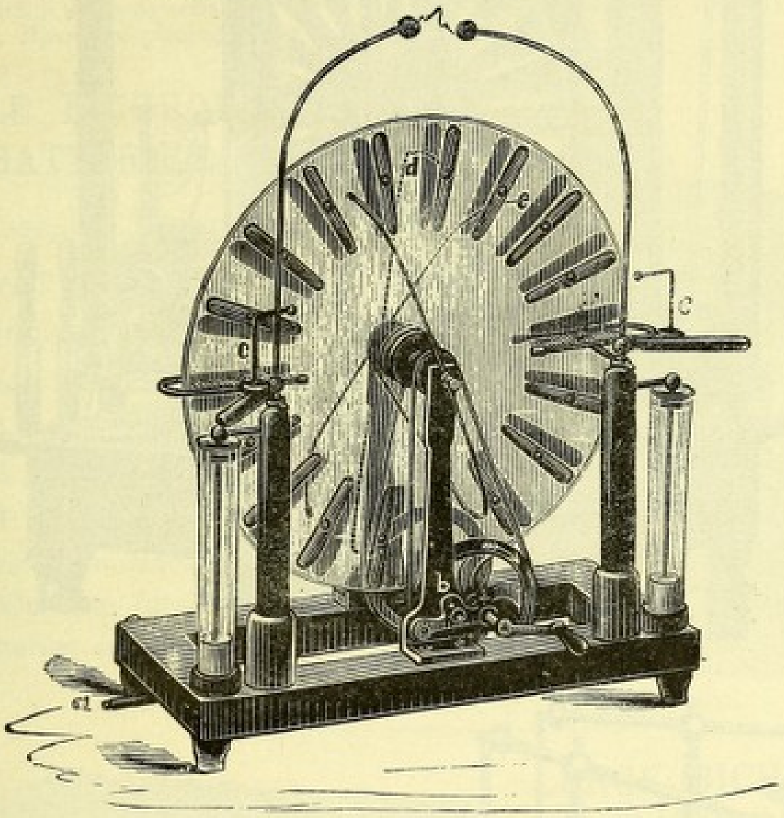
(See also Electrodes Nos. 514 and 525).

APPARATUS FOR FRANKLINISATION

(Static Electricity.) (See also pages 51 and 52.)

Of all the various constructions of statical machines the following type has been found to be the most reliable one. They can be started *immediately in any weather.*

WIMSHURST MACHINES.

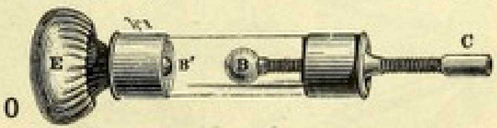


No. 950.

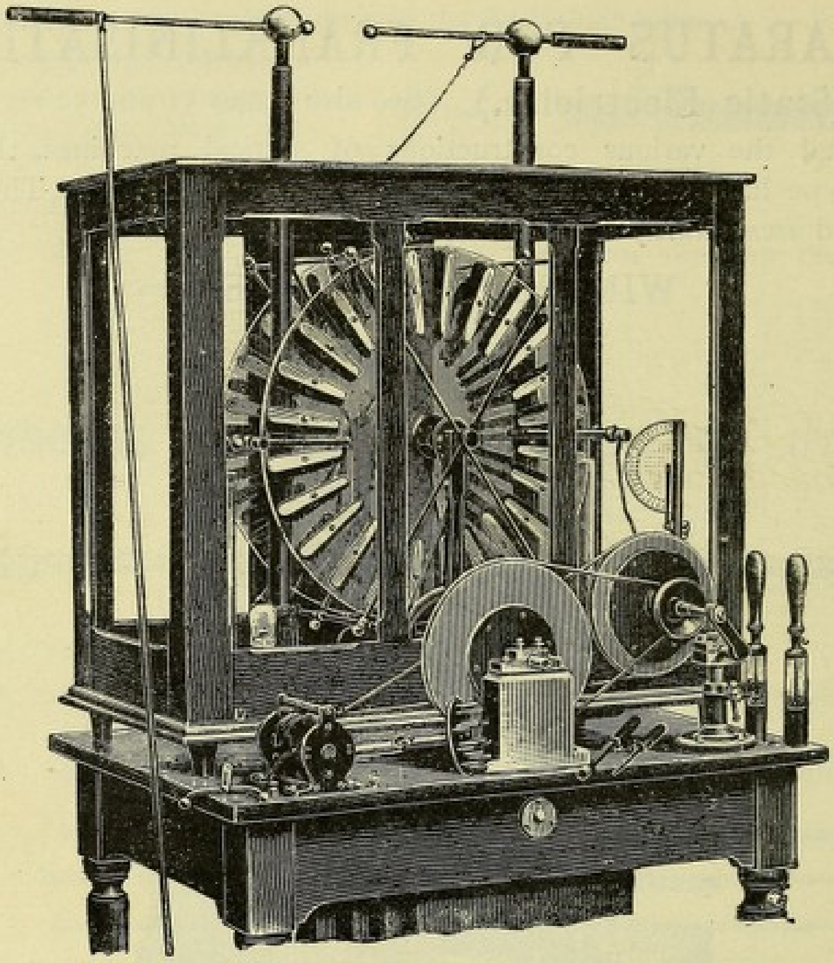
	Diam. of the discs in inches.	
No. 950.	16	£7 15 0
No. 951.	20½	10 0 0
No. 952.	24½	12 0 0

The prices include 2 Leyden jars.

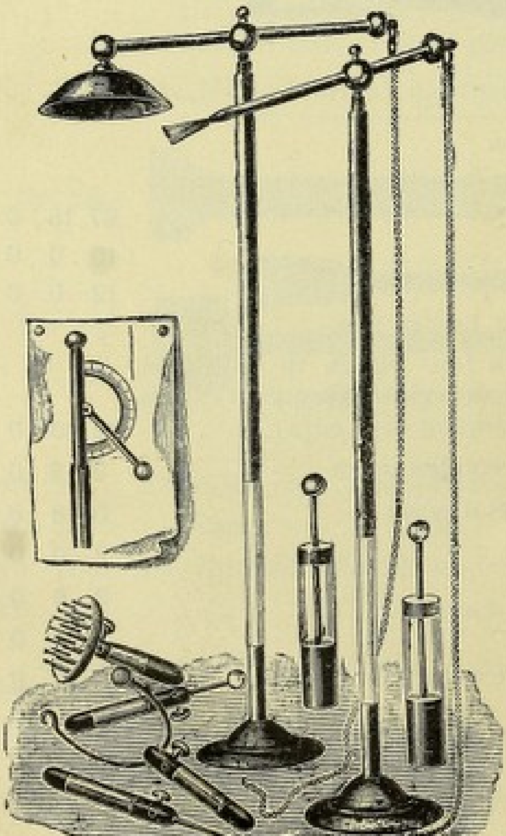
No. 955.	Large Wimshurst machine, with four plates, in glass case, large insulating chair, two hand electrodes, two cables, and bowl for the head *(Illustration next page)*	28 10 0
No. 960.	Electrode, with wooden ball or wooden point	0 8 6
No. 961.	„ „ metal ball or metal point	0 8 6
No. 965.	Large insulated stool	2 0 0
No. 970.	Bowl for the head	2 0 0
No. 972.	Ozone apparatus	2 0 0
No. 975.	Insulated cable, with balls at the ends, per yard	0 2 6
No. 985.	Glass tube, with two movable balls for regulating the length of the sparks	0 15 0



No. 985.



No. 955.



No. 986. Leyden jars, according to size . 6/- to 1 1 0

Glass cases for the static machines . . £3 to £15.

For small Dynamos for driving the machines, see pages 118—120.

BATTERIES FOR GALVANIC CAUTERY.

(For the most suitable Batteries for Cautery, the Connection of Cells, Regulation of the Current, Acid, Cleaning, &c., see pages 26—34.)

The batteries marked may also be used for lighting surgical lamps.*

Batteries with two cells suffice for eye operations with galvanic cautery: for all other operations where galvanic cautery may be applied, four cells are required. Batteries with six or more cells are supplied, partly to enable the operator to double the power of his cells by connecting them up parallel. Accumulators with 4 or more cells, and bichromate batteries with 6 or more cells, can be used for working motors and the large spark coils required for Roentgen photographs.

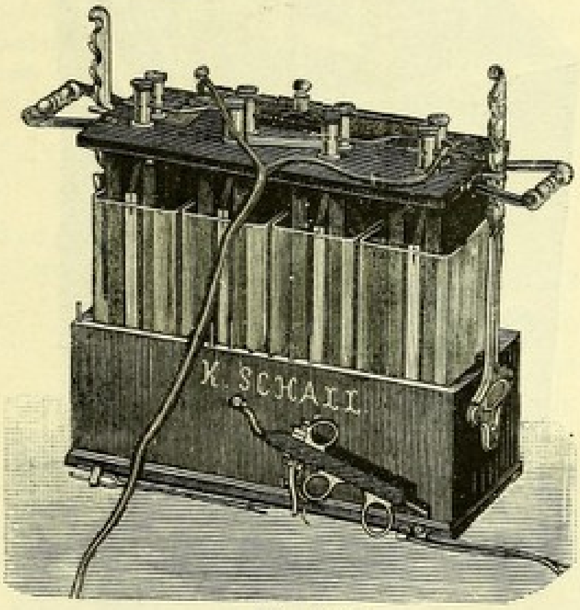
SIMPLE BICHROMATE BATTERIES.

IN OAK CASE, FOR HOSPITALS, &c.

Each cell gives a current of over 30 ampères.

No. 1000.	2 cells	£2 16 0
*No. 1001.	4 ,,	3 10 0
*No. 1003.	8 ,,	6 0 0
*No. 1004.	12 ,,	7 5 0

The prices include connecting cords. Rheostat for any of the above batteries, extra 15/-



No. 1001.

LARGE BICHROMATE BATTERIES,

FOR SPECIALISTS OF THROAT, NOSE, ETC., DISEASES, AND HOSPITALS.

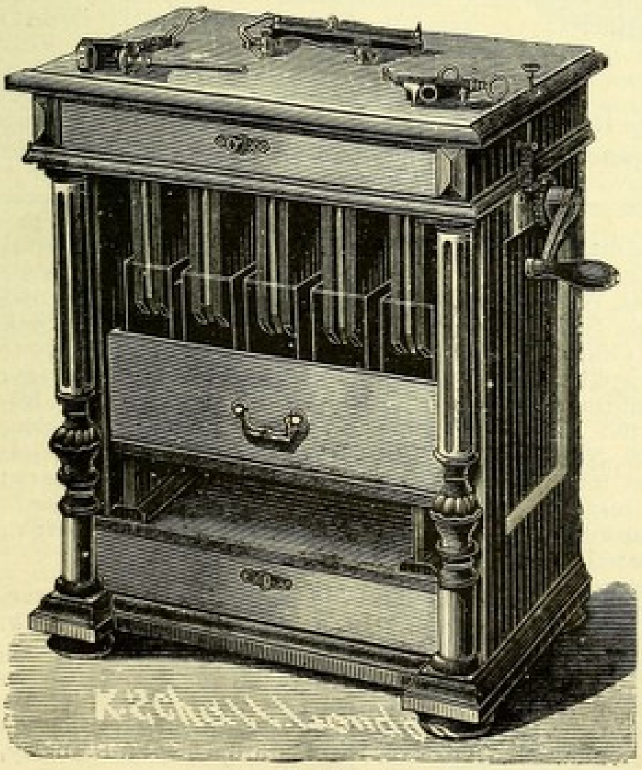
IN NEAT OAK CASE, with Rheostat and Connecting Cords.

*No. 1009.	8 cells	£14 10 0
*No. 1010.	10 ,,	16 0 0

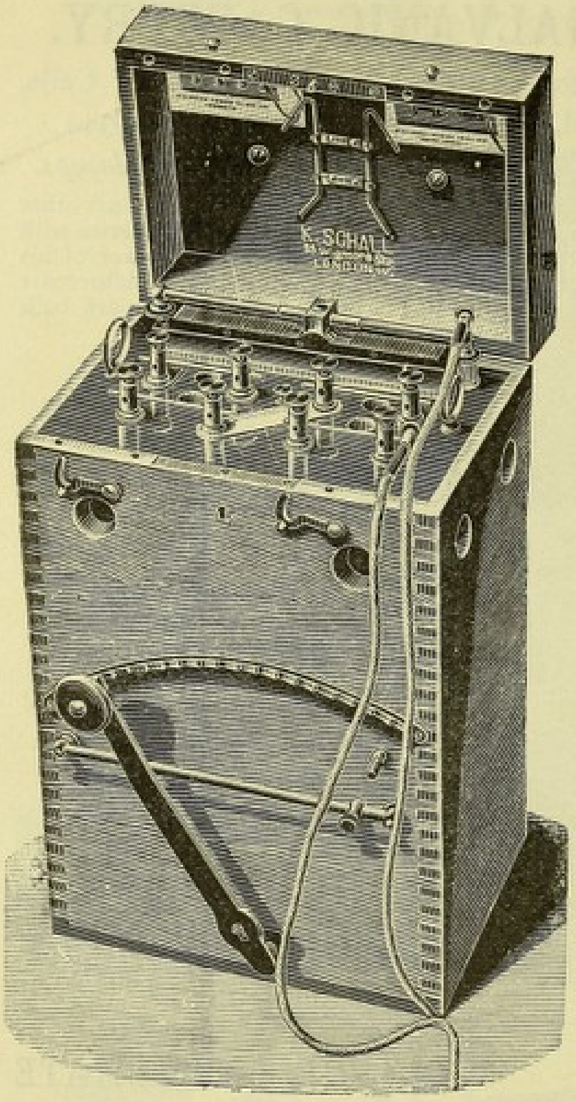
Spare zincs for batteries Nos. 1000—1010, consisting of 11 parts pure zinc, and 1 part of mercury, weight 2 lbs. 4-oz. . 2/6 each.

One pair of spare carbons, 6/- each.

Spare glasses . 2/- ,,



No. 1010



No. 1040.

SCHALL'S CAUTERY BATTERY,

IN OAK CASE, with rheostat and cords. Each cell gives a current of 25 ampères.

*No. 1040. 4 cells, $7 \times 9\frac{1}{2} \times 15$ inches. Weight, 24 lbs. **£5 10 0**

*No. 1042. 6 cells . **7 15 0**

Of the many *unsolicited* testimonials we have received about this battery, we will mention here one only. Mr. WALTER WHITEHEAD, of MANCHESTER, writes :—"*Four years ago I obtained a battery from you (No. 1042) which I have used ever since with complete satisfaction.*"

The 6-cell battery is provided with a current collector, in addition to the above-mentioned accessories.

There are now nearly 600 batteries No. 1040, and No. 1042, in use in Great Britain and the Colonies, the best proof of their practical construction and reliable working.† These

† We have supplied them amongst many others to the following hospitals and medical men :—St. Bartholomew's, Charing Cross, Guy's, St. Peter's, St. Thomas's, Westminster, Great Northern and London Hospital, Westminster Ophthalmic, Lock Hospital, Hospital for Diseases of the Heart and Paralysis, Soho, German Hospital, Victoria Hospital for Sick Children, Queen's Jubilee Hospital, Central London Ophthalmic Hospital, &c., London; Bristol Royal Infirmary; Queen's Hospital, and Ear and Throat Hospital, Birmingham; General Infirmary, Leeds; General Infirmary, Sheffield; Royal Infirmary, Glasgow; Children's Hospital, Pendlebury; Eye and Ear Infirmary, Southampton; Ear Institution, Manchester; Throat and Ear Hospital, Nottingham; Ripon Hospital, Simla; Medical College, Lahore; Royal Dispensary and Infirmary, Windsor; Eye Hospital, Shrewsbury; South Devon Hospital, Plymouth; Children's Hospital, Sheffield; Eye Hospital, Oxford; Eye and Ear Infirmary, Bath; Sanatorium, Weymouth; Royal Infirmary, Edinburgh; Hospital for Sick Children, Newcastle; Grimsby and District Hospital, &c.

Dr. E. Blake, Mr Buckstone Browne, Mr. Butlin, Mr. Critchett, Mr. Bruce Clarke, Mr. C. E. Coates, Mr. Coulson, Mr. Cardew, Dr. Dowse, Mr. S. Edwards, Mr. H. Fenwick, Dr. Griffith, Dr. de H. Hall, Mr. Reginald Harrison, Mr. Berkeley Hill, Mr. Victor Horsley, Dr. W. R. Holmes, Mr. Malcolm Morris, Mr. O'Connor, Mr. S. Paget, Dr. Pegler, Mr. B. Pollard, Dr. Richardson, Mr. W. Rose, Dr. A. Routh, Dr. Ryley, Mr. A. M. Shield, Dr. W. E. Steavenson, Dr. G Stoker, Dr. Swan, Dr. C. J. Symmonds, Mr. W. R. Stewart, Dr. de Voeux, Sir Henry Thompson, Dr. Tuchman, Dr. Herschell, Drs. Ezzard, Griffith, Prangley, batteries can be used equally well for cautery and for light, and they may be used to a certain extent for electrolysis, for removing hairs, destroying nævi, tumours, &c., as long as not more than about 10 milliampères are required, or when both poles (needles) are introduced through the skin.

The acid for the batteries Nos. 1040 and 1042 is contained in strong ebonite vessels, pressed out of one piece. The ebonite cell can easily be moved up and down by means of a handle on the outside of the battery, and can be fixed at any elevation. A 4-cell battery, if properly treated, keeps a platinum burner incandescent for about 30 minutes, and requires for its filling half a gallon of acid solution. If the battery is used several times every day, refilling is necessary about every four weeks, but if it is used only now and then, refilling is necessary every three months.

There is little danger of any acid being spilled in carrying the batteries, as perforated plates float on the acid, and prevent its splashing over. In plunging the battery in, the perforated plate is pressed down to the bottom of the ebonite vessel, and rises again to the surface as soon as the elements are removed from the acid.

Spare zincs for batteries Nos. 1040 and 1042, consisting of 10 parts of zinc and 1 part of mercury, weight 1 lb. 12 ozs.	each	2/3
One pair of carbons	,,	6/6
Ebonite vessel for 4-cell battery	,,	12/6
Ditto do. 6-cell do.	,,	18/6
Acid, ready mixed for charging the batteries Nos. 1000 to 1042	per gall.	3/-

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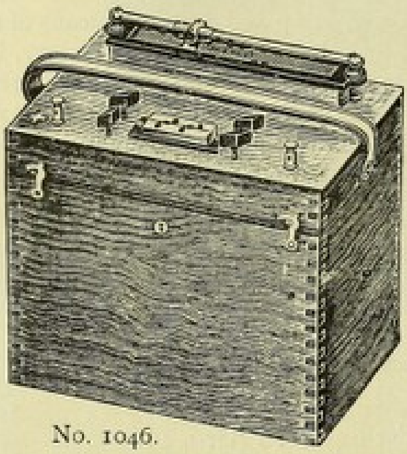
Clarke, Brown, Williams, Whitcombe, Fearnley, Beauchamp, Gage Brown, Addinsell, Caley, Kelson, Hudson, Waggett, Roberts, James, Lewis Jones, Hetley, Thomson, Wilkin, Lane, Hutchinson, Owen, Anderson, Cripps, Smith, Pollard, Lack, Shearer, Oppenheimer, Williams, Fallows, Stokes, Clemon, Wilbe, Macgregor, London.

Drs. Walton Browne, Nelson, Sinclair, Belfast; Drs. Brooke, Ransome, Walter Whitehead, Manchester; Drs. Reith, Garden, Macgregor, Riddell, Will, Aberdeen; Drs. Johnston, Murdoch, Duncanson, Macbride, Edinburgh; Drs. Renton, Newman, Napier, Maccintyre, White, Glasgow; Drs. Freeman, Ferry, Flemming, Bath; Drs. Wilson, Ranking, Neild and Crapper, Tunbridge Wells; Drs. Winden, Price, Abram, Rudge, Reading; Drs. Williams, Dunbar, Baron, Clifton; Drs. Prichard, Thomas, Cardiff; Drs. Cuff, Godfrey, Thompson, Scarborough; Drs. Taylor, Pryce, Nottingham; Dr. Dukes, Rugby; Dr. Collins, Wanstead; Dr. Smith, Northwich; Dr. Hardy, Huddersfield; Dr. Hewland, St. Leonard's; Dr. Stamp, Plymptom; Dr. Friel, Waterford; Dr. Bramwell, Cheltenham; Dr. Stamberg, Jersey; Dr. Myers-Ward, Birmingham; Dr. Davies, Bridgend; Dr. Hartigan, East Grinstead; Dr. Holderness, Windsor; Dr. Heard, Monkstown; Drs. Curry, Taylor, Liverpool; Dr. Tebb, Bournemouth; Dr. Gillibrand, Bolton; Dr. Stewart, Denton; Dr. Coleman, Hemsworth; Dr. Kingscote, Salisbury; Dr. Thorne, East Retford; Dr. Charnley, Shrewsbury; Dr. Barnes, Erith; Dr. Alexander, Southsea; Dr. Lowther, Grange-over-Sands; Dr. Morgan, Seaford; Dr. Atkins, Cork; Dr. Gwillim, Southampton; Dr. Hedley, Brighton; Dr. MacEvan, Dundee; Dr. Walker, Leeds; Dr. Balfour, Presteigne; Dr Ferguson, Malvern; Dr. Chapman, Hereford; Dr. Ruttle, Accrington; Dr. Dobie, Chester; Dr. Eccles, Plymouth; Dr. Griffith, Swansea; Dr. Pearson, Cork; Dr. Stewart, Nottingham; Dr. Smith, Halifax; Dr. D. L. Thomson, Newbury; Dr. Fogerty, Limerick; Dr. Craig, Londonderry; Mr. Wilders, Mr. Marsh, Birmingham; Mr. Sympson, Lincoln; Dr. Newman, Stamford; Dr. W. B. Thomson, Luton.

Dr. Rendall, Mentone; Dr. Lemander, Upsala; Dr. Holland, St. Moritz; Dr. St. Clair Thomson, Florence; Dr. E. Wilmot, Dr. Llewellyn, Melbourne; Dr. Muskett, Dr. Tarrant, Dr. Wilkinson, Dr. Clinton, Dr. Brady, Mr. Williams, Sydney; Dr. Sutcliffe, Indianopolis; Dr. Silver, Dr. Milbury, New York; Dr. Taylor, Canada; Dr. Scholtz, Dr. Stevenson, Cape Town; Dr. Considine, Port Elizabeth; Dr. Henderson, Jamaica; Dr. Cantlie, Hongkong; Dr. Frend, Rosario; Surgeon-Major Baker, Rangoon; Dr. W. Halt, Sydney; Dr. Rendell, St. John's; Dr. Thomson, Hankow; Dr. Stuart, Johannesburgh; Dr. Duston, Bombay; Dr. Rubidge, Cape Town; Dr. Duke, Cannes; Dr. MacKenn, Buenos Ayres; Dr. Lotz, Freemantle; Dr. Coulter, Calcutta; Dr. MacDougall, Cannes; Dr. Fuller, Cape Town; Dr. McCormick, Sydney; Dr. Daws, Johannesburgh.

DRY BATTERIES FOR SMALL CAUTERY BURNERS.

In Oak Case, with rheostat, commutator (to connect the elements parallel for cautery, or in series for light) and cords. (See also page 30.)



No. 1046.

*No. 1046. 6 cells, size, 9 × 12½ × 9 inches. Weight, 28 lbs. . . £4 4 0

These batteries are very clean and convenient on account of the absence of corrosive fluids. They will heat small as well as large cautery burners, but it must be borne in mind that the internal resistance of the cells rises gradually and that, on account of this, *even if the battery is not being used*, it ceases to heat the larger burner after about twelve months, and the smaller ones after eighteen to twenty-four months. The cells have then to be replaced by new ones. Price 4/- each.

SECONDARY BATTERIES. (Accumulators.)

(See also page 29.)

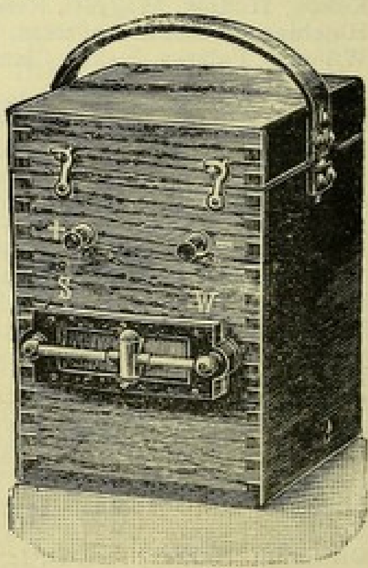
No. 1070. Two cells of 15 ampère hours capacity each, in oak box, with rheostat and cords £3 6 0

Size 6 × 7 × 10 inches; Weight 16½ lbs.

No. 1072. Four cells of 15 ampère hours capacity each, in oak box, with rheostat and cords. (This accumulator can be used for cautery or for surgical lamps) . . . £4 15 0

Size 6 × 14 × 10 inches; Weight 30 lbs.

No. 1073. Dr. Lewis Jones' accumulator of 4 cells, 8 ampère hours capacity each, with commutator to connect them parallel for cautery or in series for light, with rheostat . £4 15 0



No. 1073.

No. 1074. Large accumulator, of 6 cells, 15 ampère hours capacity each, with rheostat, in oak box, for cautery, surgical lamps, or for working large spark coils £6 0 0

No. 1076. Similar accumulator, but larger cells of 30 ampère hours capacity each 10 0 0

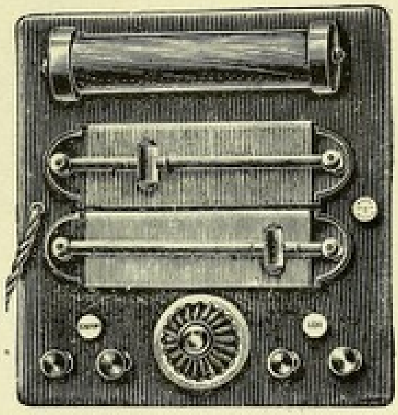
A Lamp Holder, for charging accumulators from the main, will be found on page 99.

TRANSFORMERS AND RHEOSTATS.

For utilising currents from dynamos for cautery and surgical lamps.

(See also pages 32—34, and *Lancet*, Aug. 8th, 1891.)

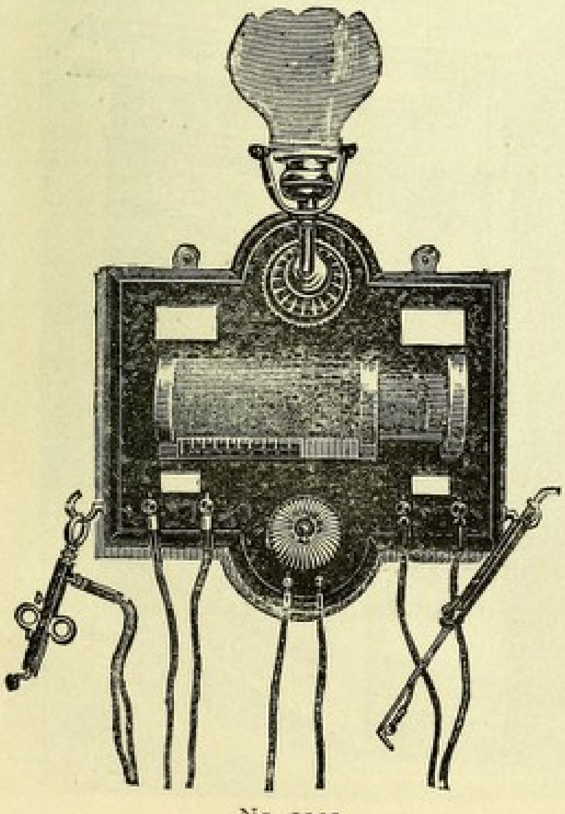
No 1049. Schall's Portable Transformer, for cautery and surgical lamps, on polished slate base. The current for cautery can be varied between 6 and 25 ampères, and the current for light between 3 and 15 volts, without any jumps. Cautery and light can be used at the same time . . £4 0 0



No. 1049.

Size: 9½ by 9½ inches, 2½ inches high.

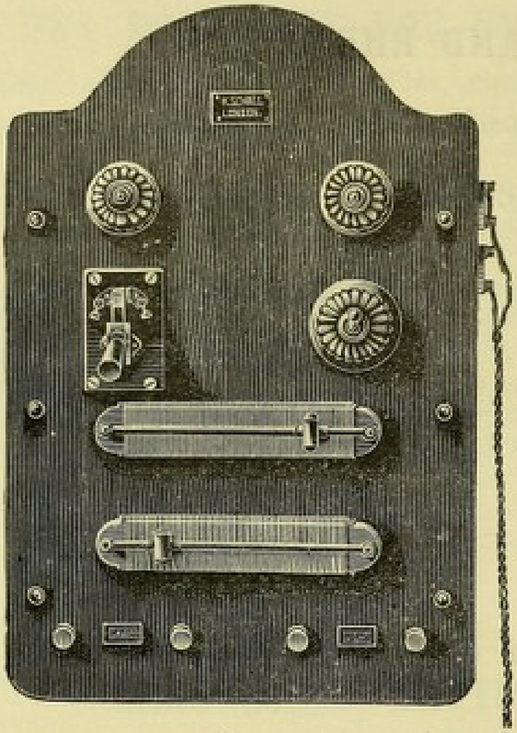
To keep a platinum burner alight for one hour, this apparatus consumes about half-a-unit of electricity (price about 3d.).



No. 1050.

No. 1050. A. B. Woakes' *patented* Transformer for 50, 100 or 110 volts alternating current . £6 0 0

* Transformers can be used on alternating currents only. In ordering please mention whether the transformer is intended for 50 or 100 volts installation.



No. 1052.

No. 1052. Rheostat, mounted on dark oak board, for utilizing the 100 to 250 volt *continuous* current for cautery and surgical lamps, with switches, fuses, lamps, variable rheostats and 24 spirals of stout platinoid wire. Price, up to 115 volts £9 9 0

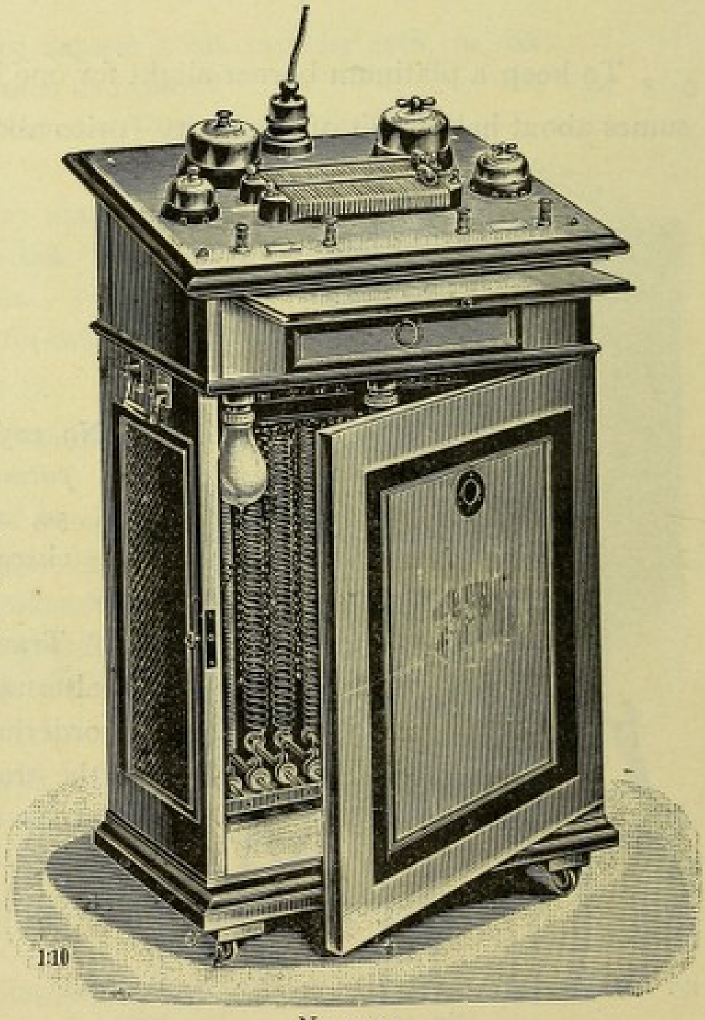
Size: 25 inches high, 15 inches wide, 7 inches projecting from wall.

Prices for higher voltages on application.

This apparatus consumes about $2\frac{1}{2}$ units of electricity for every hour in which it is connected with the main.

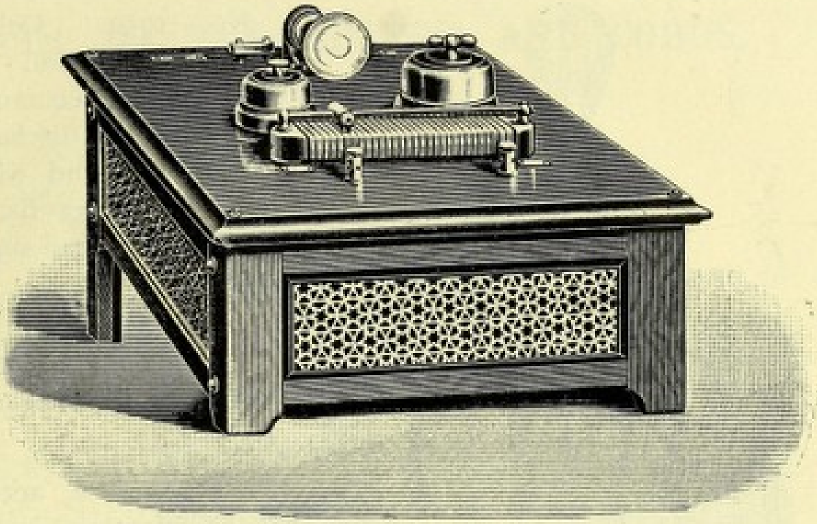
No. 1053. Similar rheostat, in cabinet of oak, mahogany or walnut £14 0 0

Rheostats Nos. 1052—1053 can also be used for working the large spark coils required for Roentgen photographs.

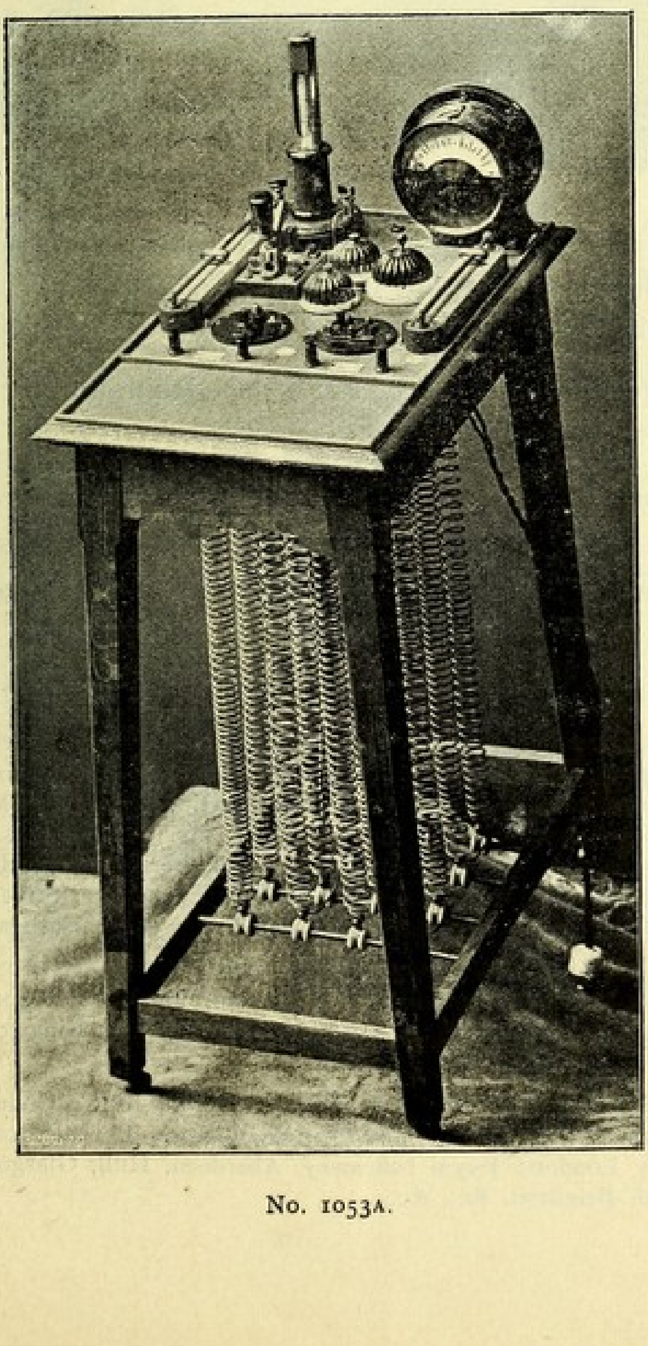


No. 1053.

No. 1052A. Rheostat for cautery only . £8 10 0



No. 1052A.



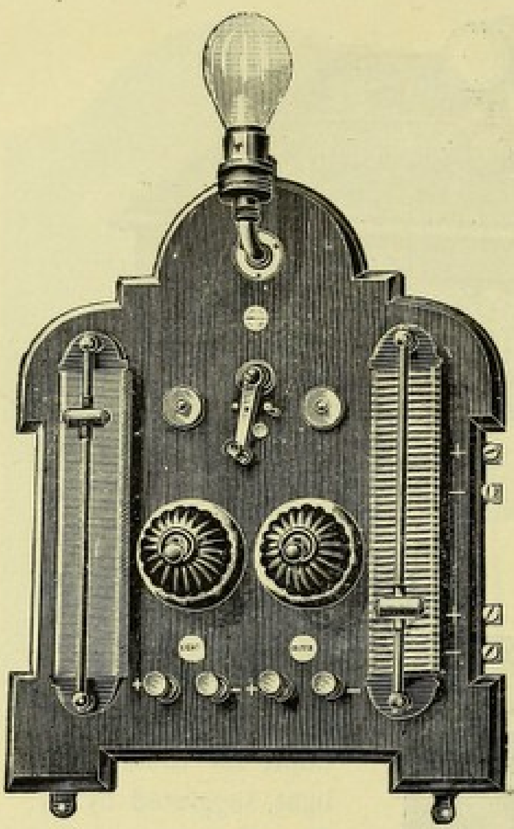
No. 1053A.

No. 1053A. Rheostat, on table, for cautery and light, suggested by Dr. Macintyre, and supplied to the Royal Infirmary, Glasgow; Cancer Hospital, London; and others . . £11 0 0

With Voltmeter and Ampèremeter . £16 0 0

If desired, the Rheostats Nos. 1052—1053A can be mounted on polished marble slabs instead of oak, difference in price £1.

Pole-finding paper and directions for using and fixing the above apparatus are sent with each instrument.



No. 1054.

No. 1054. Oak board, with switches and rheostats for charging accumulators from the main, and discharging them for cautery, and with a rheostat for utilizing the 100-volt current for small surgical lamps **£4 10 0**

Size: 15 inches high, 12 inches wide, 2½ inches projecting from wall.

No. 1070. 2 accumulator cells for cautery, in portable case, with rheostat and terminals, to be used in connection with No. 1054 . . . **£3 6 0**

No. 1075. 4 accumulator cells, for cautery or light, in portable case, with rheostat and terminals **£4 15 0**

No. 1077. 2 accumulator cells for cautery, in case, with terminals, to be used in connection with No. 1054 . . . **£2 0 0**

Nos. 1070 or 1075 are preferable to 1056 only, if it is intended to use the accumulators occasionally in patients' houses.

If unusually large cautery burners, taking more than 20 ampères, are used, please mention it, and send either the largest burner as a sample, or mention how many ampères the largest burner requires to get red hot.

Our transformers and rheostats are being used amongst others by—

Dr. Semon, Mr. V. Horsley, Dr. Routh, Dr. de Havilland Hall, Mr. Butlin, Mr. W. Rose, Dr. Woakes, Dr. Law, Dr. MacDonald, Dr. S. Mackenzie, Mr. F. M. Mackenzie, Mr. Lennox Browne, Mr. Walsham, Mr. Malcolm Morris, Mr. Startin, Mr. Smale, Mr. E. Cotterell, Mr. V. Cotterell, Mr. Percy Jakins, Mr. A. Cooper, Mr. Watson, Dr. T. Anderson, Mr. Herring, Mr. Howard, Mr. K. Shaw, Drs. Blake, Steele Perkins, Keightley, Schorstein, Waterhouse, Nauman, Maddock, Carpenter, Reg. Harrison, Stephens, Stivens, Bartlett, Palmer, Swan, Owen, Sansom, Powell, Gerard, Mackenzie, Des Vœux, Cathcart, and Edwards, London.

Drs. Coates, Gloucester; Murray, Johannesburg; Grossman, Bark, Liverpool; Maccintyre, Pearce, Glasgow; McBride, Edinburgh; Walker, Leeds; Goodman, Kingston; Rendell, Newfoundland; Taylor, Nottingham; Prof. Fraenkl.

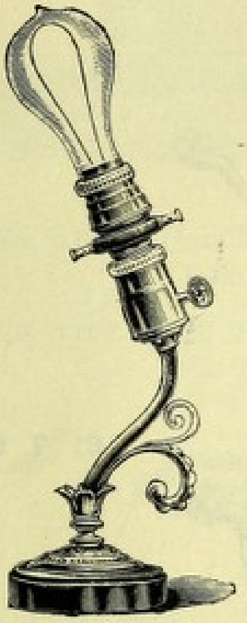
St. Thomas's Hospital, St. George's Hospital, Westminster Hospital, King's College Hospital, Victoria Hospital, Glasgow; Victoria Hospital, Chelsea, London Throat Hospital, Royal Hospital for Children, London; Royal Infirmary, Aberdeen, Hull, Glasgow, and Manchester; Sussex Hospital, Brighton, &c., &c.

RHEOSTATS, GALVANOMETERS, AND CORDS,

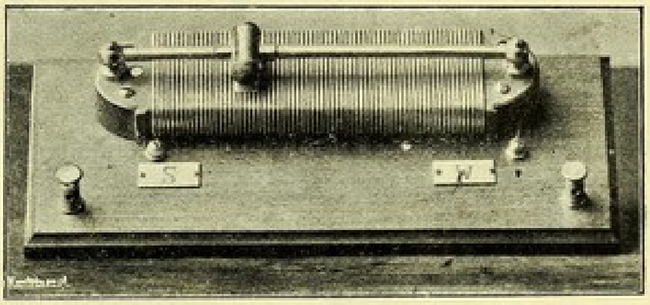
FOR CAUTERY.

No. 1080. Lamp holder with two terminals to connect a lamp in series, for charging accumulators . . £0 16 0

(*See page* 29).



No. 1080.



No. 1083.

No. 1083. Rheostat for galvanic cautery, with a total resistance of 0·8 to 1 ohm, in about 80 subdivisions, mounted on a board £1 0 0

No. 1084. Rheostat for electric light, with a total resistance of 50 ohms, in 240 sub-divisions, mounted on a board . £1 0 0

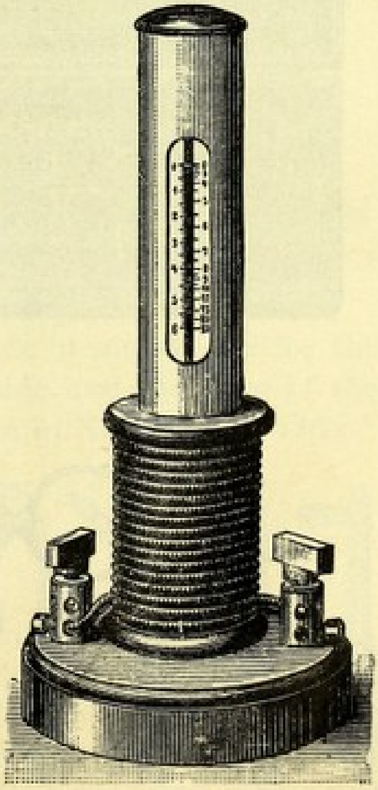
The Rheostats Nos. 1083 and 1084 may be screwed on to a table, or to a wall.

No. 1087. Galvanometer, showing from 1 to 25 ampères . . 1 5 0

No. 1090. Galvanometer, showing from 1 to 50 ampères . . 3 0 0

No. 1095. One pair of strong cords for cautery, five feet long, with terminals . . . 0 6 0

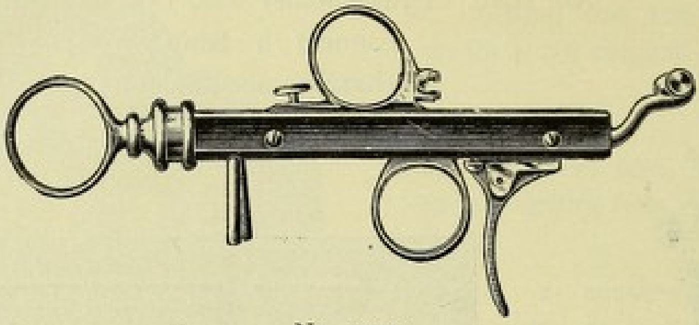
Longer cords can be made to order.



No. 1087.

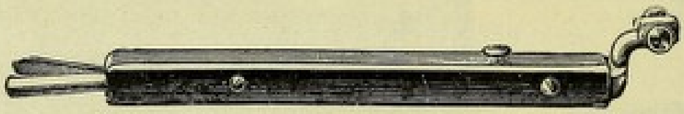
INSTRUMENTS FOR GALVANIC CAUTERY.

The "Universal" Handles can be used for burners *and* snares.
The "Simple" Handles can be used for the burners *only*.



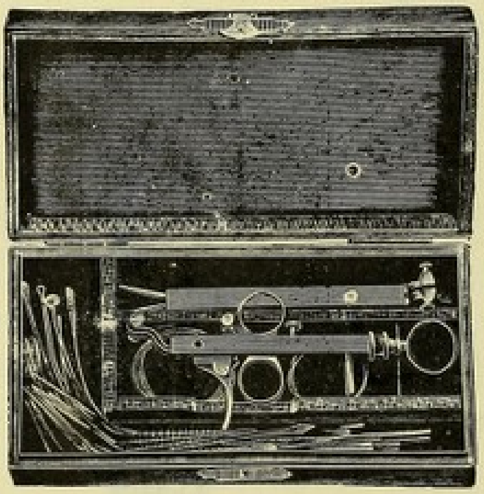
No. 1100.

No. 1100. Universal Handle, by Dr. Schech £1 7 0



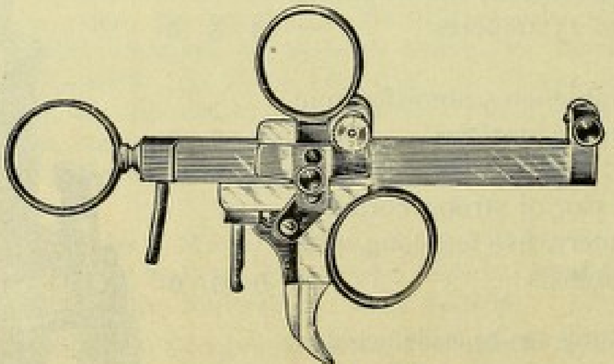
No. 1101.

No. 1101. Simple Handle, by Dr. Schech . . . 0 15 0



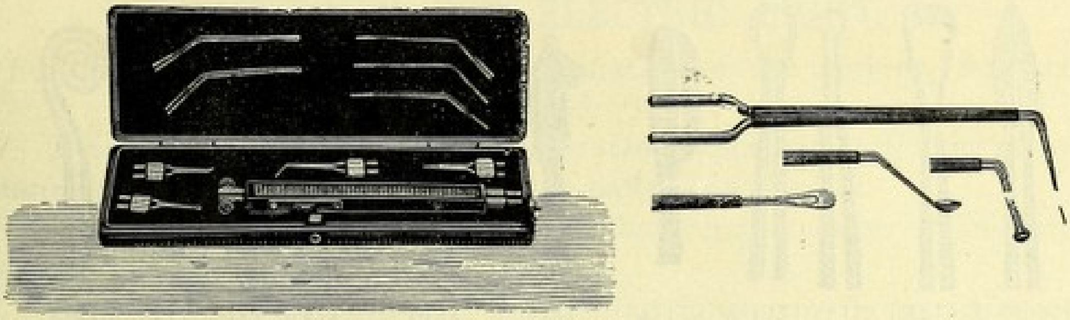
No. 1103. Schech's Handles are mostly used. The price of a case containing Universal Handle, six different burners, two ligature tubes and one porcelain burner, platinum wire for one loop, and steel wire for twelve loops is £3 0 0

No. 1104. Schech's Universal Handle and Simple Handle, with ten platinum burners, two ligature tubes, two porcelain burners, platinum and steel wire, in case . . £4 4 0



No 1112.

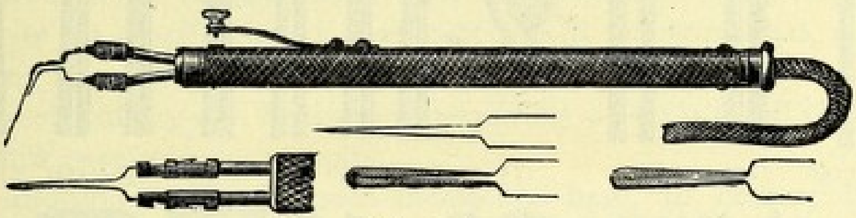
No. 1112. Universal handle, by Dr. Kuttner £1 14 0



No. 1117.

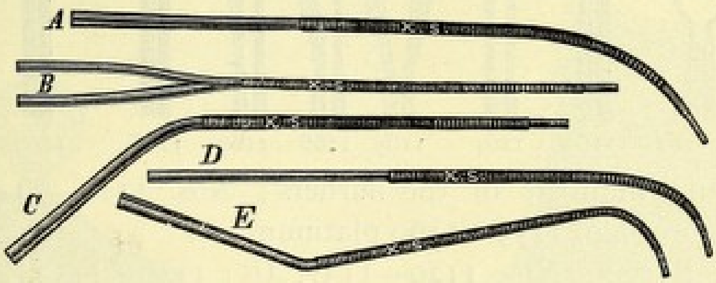
No. 1116. Handle, for eye operations, with five burners, in case, by Prof. Sattler-Nieden £1 5 0

No. 1117. The same instrument, with five additional burners for the ear 1 15 0



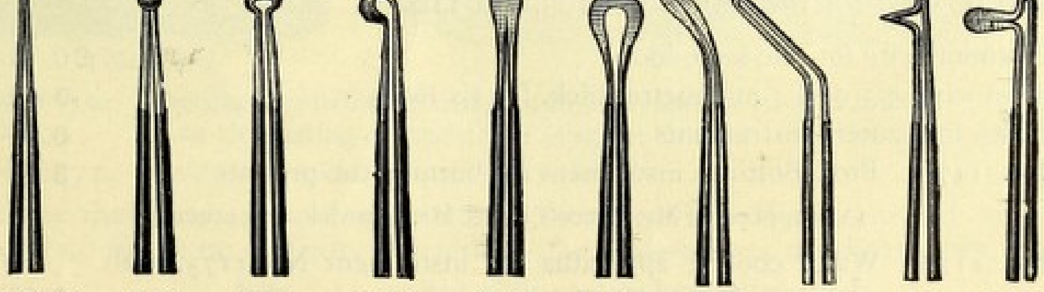
No. 1118.

No. 1118. Handle for dental, etc., purposes, with five burners, in case 1 10 0

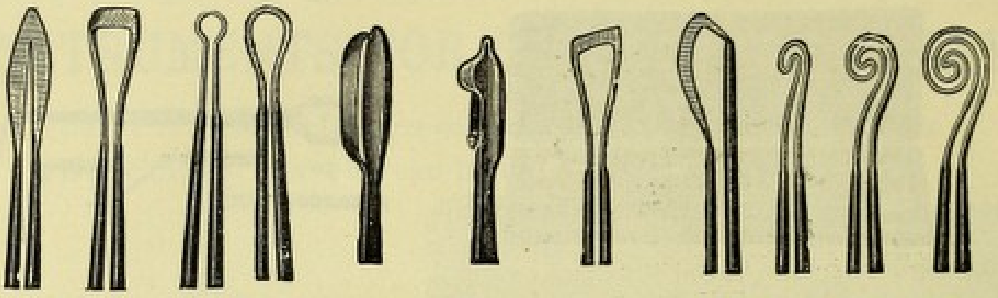


Shape and description of the ordinary curves of burners and ligature tubes. The length is 4, 6, or 8 inches, as desired. Other curves or burners can be made to order.

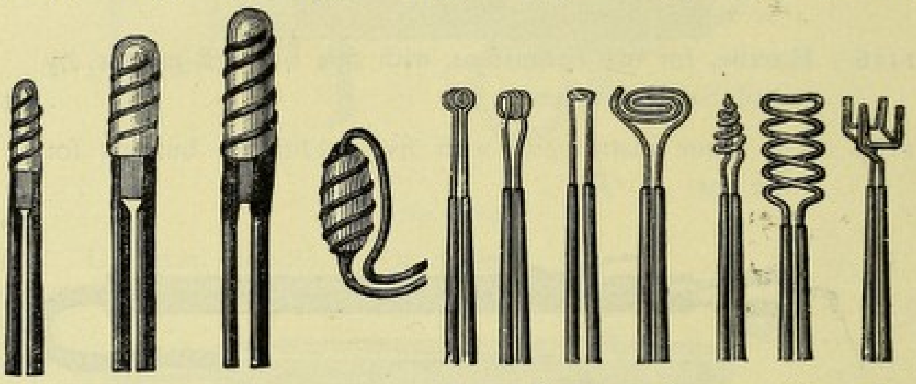
In ordering, please state the desired length in inches, and for the curve quote the capital letter printed by the side, and the form of the platinum, with its accompanying figure as shown in Nos. 1120 to 1169.



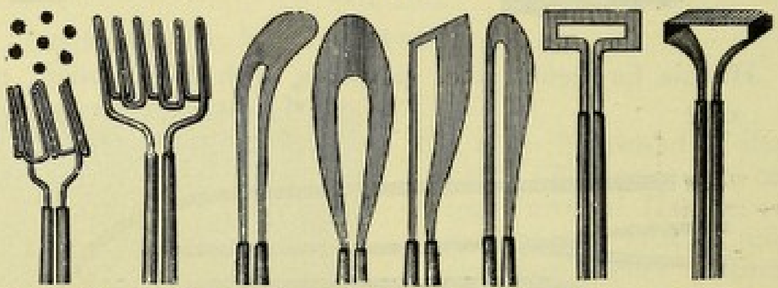
Nos. 1120 1121 1122 1123 1125 1126 1127 1128 1129 1130



Nos. 1131 1132 1133 1133a 1134 1135 1136 1137 1140 1141 1142



Nos. 1150 1151 1152 1153 1155 1156 1157 1158 1159 1160 1161



Nos. 1162 1163 1164 1165 1166 1167 1168 1169

Shape and numbers of the burners; Nos. 1120—1142 platinum, 1150—1153 porcelain, 1155—1169 platinum.

Prices:—Burners Nos. 1120—1137, 3/-; 1140—1152, 4/9; 1155—1169, 5/3; ligature tubes, 3/-.

If desired, an alloy of platinum and iridium can be used for the burners instead of pure platinum. The alloy remains stiff and hard, whereas pure platinum gets soft after it has been incandescent.

Nos. 1120, 1122, 1123, 1125, 1133 and 1150, are the most frequently used shapes of burners, and if not otherwise ordered, these shapes only—some straight for nose, pharynx, &c., and some bent for the larynx—will be used for the sets Nos. 1103 and 1104.

Platinum wire for one large loop	£0	3	0
Steel wire, 0·3 or 0·4 millimetre thick, for six loops	0	1	0
Cases for cautery instruments	0	4	0
No. 1175. Prof. Bottini's instrument for burning the prostate . .	3	10	0
(As supplied to Mr. Bruce Clarke, Mr. Fenwick, and others.)			
No. 1178. Water cooling apparatus for instrument No. 1175, with bellows, &c., complete	1	10	0

BATTERIES FOR ELECTRIC LIGHT.

(For the most suitable batteries, regulation of the current, &c., see also pages 35—39.)

For the following batteries we have stated approximately how many ampère hours the elements used in the batteries will yield.

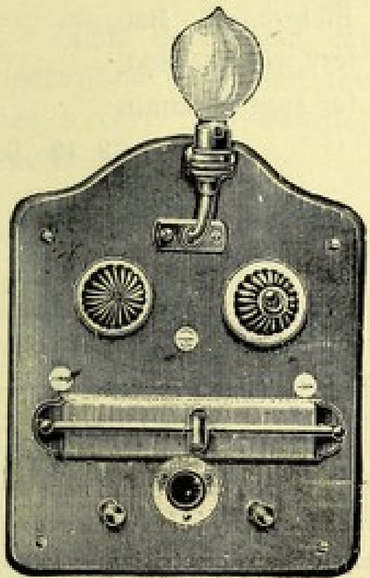
For the instruments we have stated the average number of ampères required by the lamps.

These two figures will help to find out how many hours a battery will keep a lamp incandescent before having to be re-charged. For instance, a battery fitted with cells of 10 ampère hours' capacity will keep a lamp requiring 0·5 ampère incandescent for 20 hours; a lamp requiring 1 ampère for 10 hours; a lamp requiring 1·5 ampère for 6·5 hours altogether; in other words, if a lamp requiring 0·5 ampère is kept incandescent for *5 minutes daily*, and the cells of the battery have a capacity of 10 ampère hours, the battery will be exhausted, and want recharging after about 8 months.

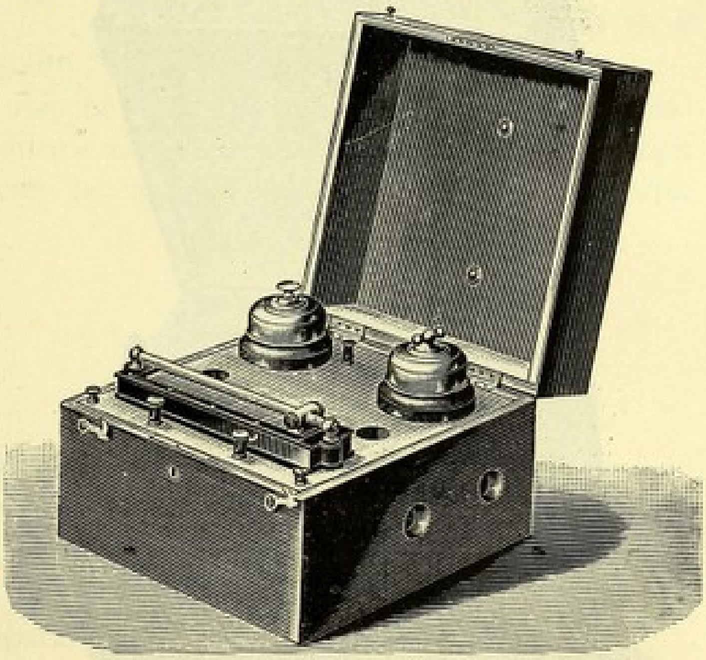
A 6-cell battery can light lamps requiring 5—8, an 8-cell battery can light lamps requiring 5—11 volts.

In addition to the batteries mentioned here, all cautery batteries marked * can be used for electric light.

The Transformers and Rheostats Nos. 1049—1054 can be used for utilizing the currents from dynamos for small surgical lamps.



No. 1170.



No 1.71

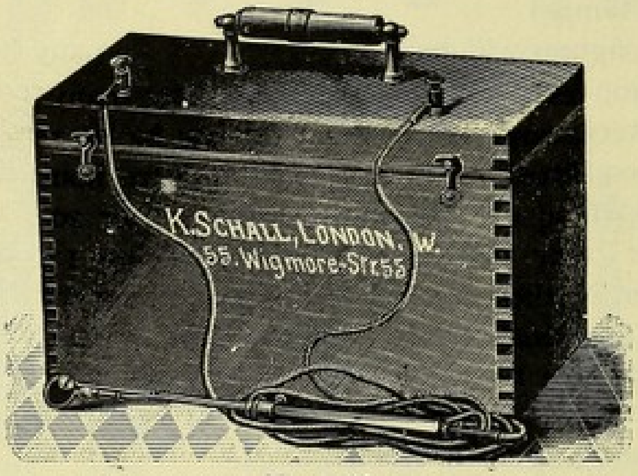
No. 1170.	Rheostat for utilizing currents from dynamos (continuous or alternating currents) for surgical lamps	£2 12 0
No. 1171.	Similar Rheostat, in portable case	2 15 0

The rheostats are so arranged that the breaking of the current occasions no spark on delicate instruments, as cystoscopes, urethroscopes, etc.

Size: 11 inches wide, 14 inches long.

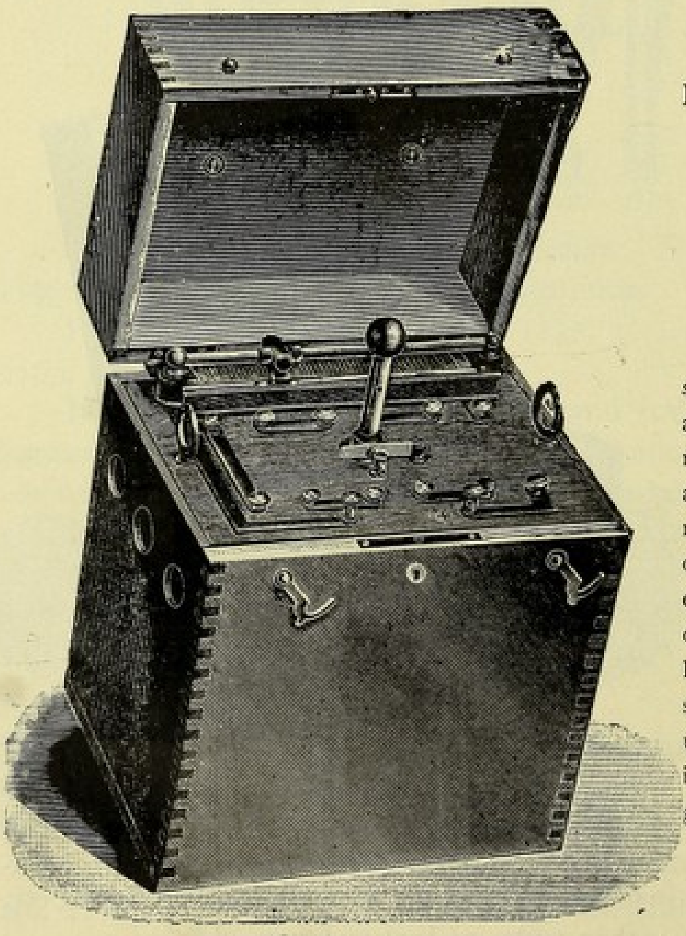
Leclanché Dry Batteries for electric light, with rheostat and cords.
(See also page 37.)

		Capacity in amp. hours.	Weight.	
No. 1185.	6 cells, 6 × $7\frac{1}{2}$ × 8 inches	12	12 lbs.	£2 2 0
„ 1186.	8 „ 6 × $9\frac{1}{2}$ × 8 „	12	15 „	2 7 0
„ 1187.	6 „ $6\frac{1}{2}$ × 10 × 9 „	20	20 „	2 7 0
„ 1188.	8 „ $6\frac{1}{2}$ × 13 × 9 „	20	24 „	2 14 0



No. 1086.

New cells for the batteries Nos. 1085 and 1086 . . each 0 2 6
„ „ „ 1087 „ 1088 . . . „ 0 3 0



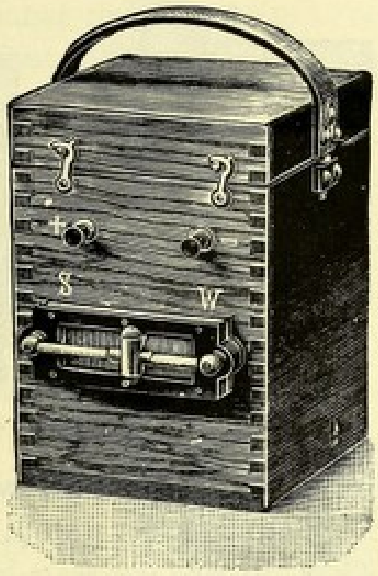
No. 1192.

No. 1192. 6-cell Bichromate Battery, with rheostat, for surgical lamps £3 12 0

This battery gives a *perfectly steady* light for $3\frac{3}{4}$ to 4 hours, and can be used for all lamps requiring between 4 and 11 volts and 0·4 to 1·5 ampères. India rubber floats prevent the spilling of the acid, and the battery can easily be re-charged and kept in order for many years without the help of an electrician. It is specially useful for Surgeons using incandescent lamps at irregular intervals, and for Surgeons living abroad.

No. 1193. 4-cell Accumulator, with rheostat for electric light; capacity of the cells, 5 ampère hours . . £2 0 0

No. 1194. 4-cell Accumulator, with rheostat for electric light; capacity of the cells, 12 ampère hours . . 3 12 0



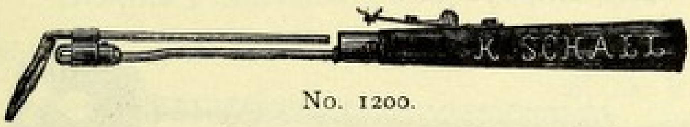
No. 1194.

No. 1193 will be damaged if used for heating a cautery burner.

About Accumulators, see also page 29.

INSTRUMENTS FOR ELECTRIC LIGHT.

Mounted spare lamps for the Instruments Nos. 1200—1370 *cost* 2/- *each.*

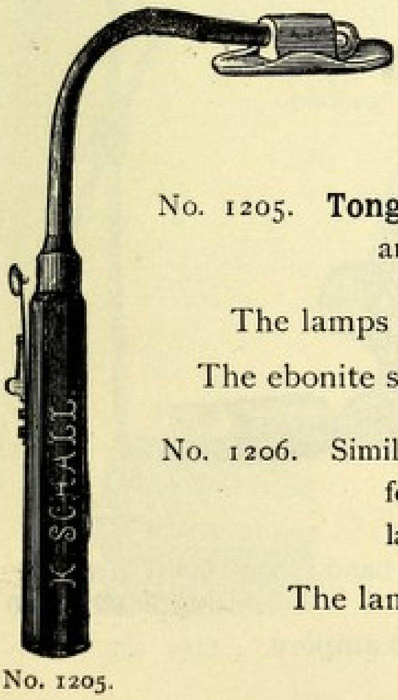


No. 1200.

No. 1200. **Laryngoscope,** by Dr. Semon, with case and one spare lamp £1 15 0

The lamps require 7 to 11 volts and 1 ampère.

This instrument can also be very advantageously used in dental operations. Further, the mirror can be removed, and the lamp, which has a very thin handle, can be used for the illumination of other cavities of the body.



No. 1205.

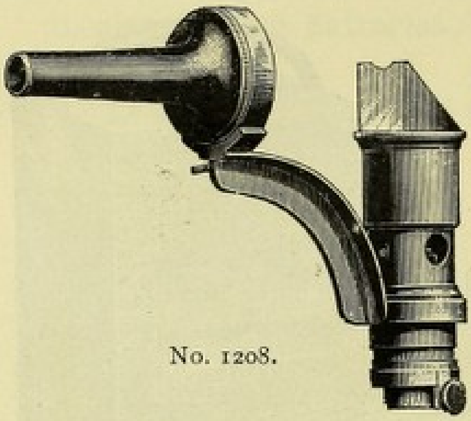
No. 1205. **Tongue-depressor,** by Schall, with case and one spare lamp £1 15 0

The lamps require 7 to 8 volts and 1·3 ampères.

The ebonite spatula can be removed to be cleaned.

No. 1206. Similar instrument, but with larger lamps, for making the antrum transparent; the lamps give a light of about 4 candles . £2 0 0

The lamps require 11 volts and 1·6 ampère.



No. 1208.

No. 1208. Schall's **Otoscope,** fitted with incandescent lamp, case, spare lamp and three ear funnels in case . . **£2 15 0**

(Patent No. 1725, 1896.)

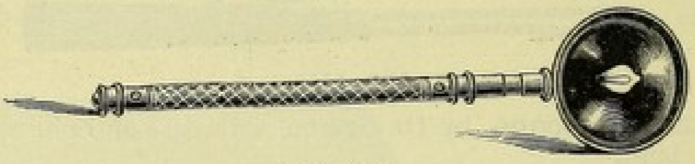
This instrument gives a very brilliant light, and allows perfectly free movement for the operating instruments.

No. 1210. **Speculum, with incandescent lamp,** by Schall, with one spare lamp **£1 5 0**

No. 1210.

The lamp is carried on a spring, which can be clamped to any speculum.

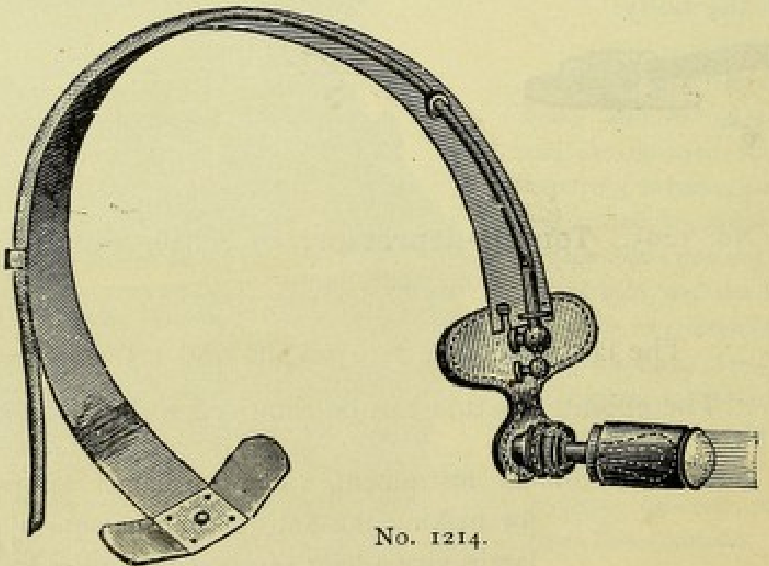
The lamps require 7 volts and 1 ampère.



No. 1211.

No. 1211. **Hand-lamp, with platinized reflector,** for abdominal and other operations, in case, with one spare lamp **£1 15 0**

The lamps require 8 to 10 volts and 0·75 ampère.

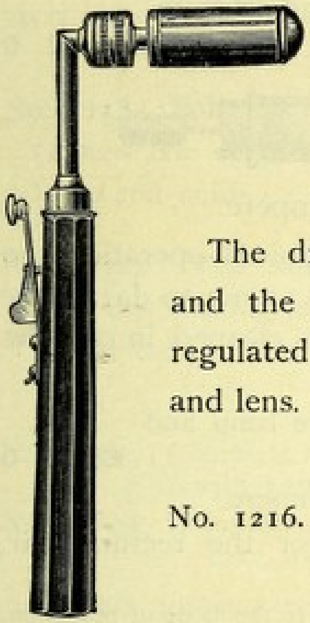


No. 1214.

No. 1214. **New forehead lamp,** with steel band, spare lamp and case **£2 2 0**

The lamps require 8 volts and 1·0 ampère.

In consequence of an important improvement the lamp No. 1214 no longer shows a picture of the carbon filament; the light is bright, and homogen. If the lens is pushed back as far as it will go, the illuminated area is large, and the light diffused; if it is drawn out the diameter gets smaller, but the light gets more concentrated and intense. A parallel beam of light can be obtained with the lamp if desired.

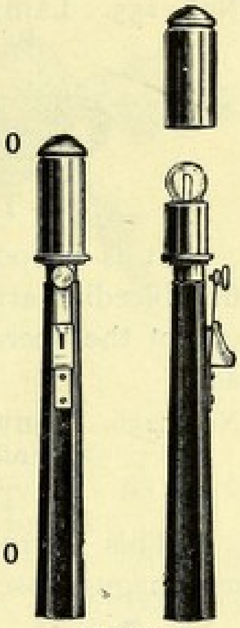


No. 1215.

No. 1215. Hand Lamp, with bull's eye, for surgical operations, with case and spare lamp £1 17 0

The diameter of the illuminated area and the intensity of the light, can be regulated by altering the distance of lamp and lens.

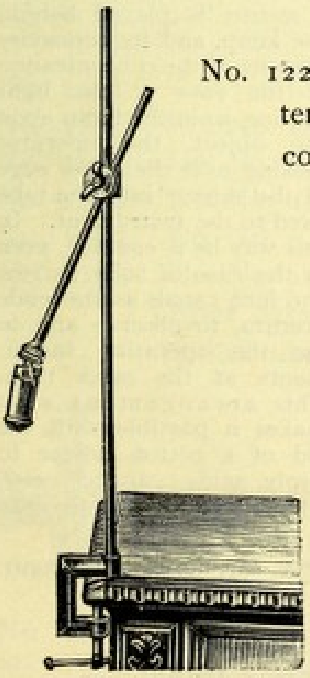
No. 1216. The same instrument, straight, £1 14 0



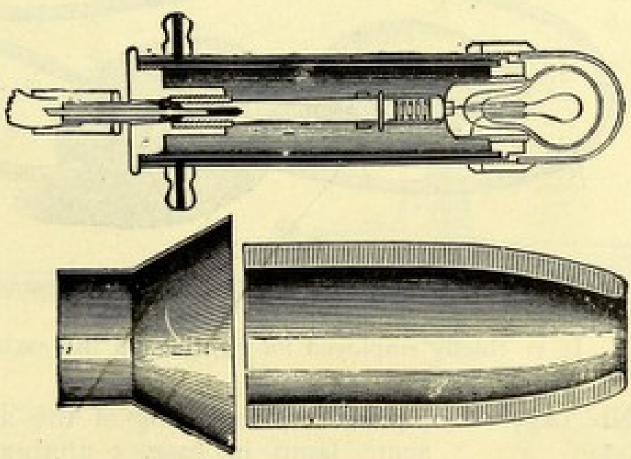
No. 1216

No. 1218. Lamp with bull's eye, and Stand with universal movement, for surgical and dental operations, microscopic work, etc. £2 10 0

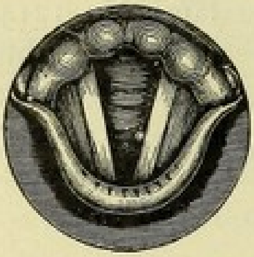
No. 1220. Lamp for transillumination of larynx, nose, temples, ear, etc., with indiarubber funnel and water cooling arrangement £1 18 0



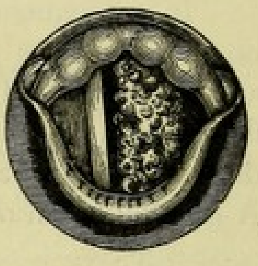
No 1218.



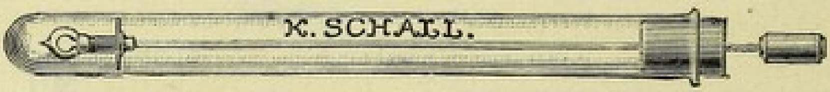
No. 1220.



No. 1250. **Phantom,** with imitation of mouth, larynx, post-nasal cavity and ear, with 30 coloured pictures of the principal diseases of the larynx by Dr. Schech, 8 coloured pictures of the post-nasal cavity, and 24 coloured pictures of the ear £1 1 0



No. 1255. **Lamp for abdominal operations,** made for St. Bartholomew's Hospital, price including 1 spare lamp £1 12 0



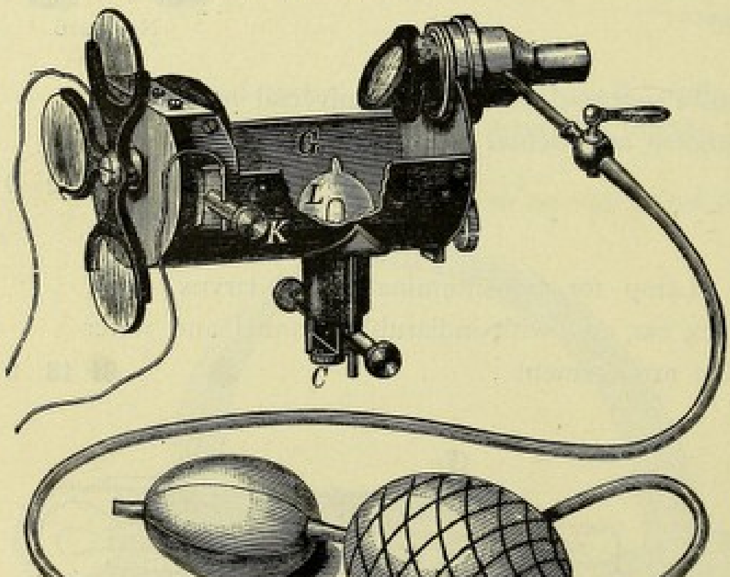
The lamps require 9 volts and 0·75 ampère.

It is introduced through wounds during abdominal operations, to find bleeding arteries, etc. The lamp is protected so as not to dazzle the eye of the operator. The instrument can easily be cleaned in carbolic acid.

No. 1256. **Fenwick's Urethroscope,** with one spare lamp and inflating arrangement £3 16 0

The lamps require 9 volts and 0·75 ampère.

This instrument can be used equally well for the rectum, ear, œsophagus, nose, vagina, etc.

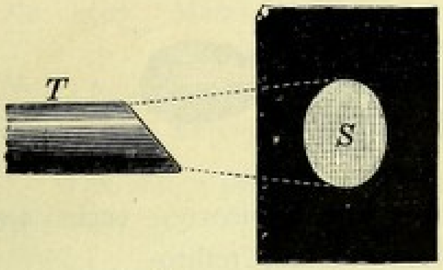


No. 1256.

In the mode of reflection, this instrument is a distinct innovation. In other endoscopic instruments the lamp was usually placed in front of a perforated mirror, and the operator looked at the object through a perforation; but in this instrument a mirror is placed behind the lamp, and its concavity permits of the concentration of the rays of the light coming from the lamp upon the object, the operator looking over the upper edge of the mirror into the tube fixed to the instrument. In this way he is enabled, even in the case of such narrow and long canals as the male urethra, to observe and to use the operating instruments at the same time. This arrangement also makes it possible with the aid of a cotton holder to apply acids, caustics, etc., exactly on the spot where their effect is most wanted, or with a pair of forceps to seize foreign bodies in the œsophagus, urethra, etc.

It is chiefly employed for lighting up the male urethra, the ear, nose, œsophagus, rectum and vagina.

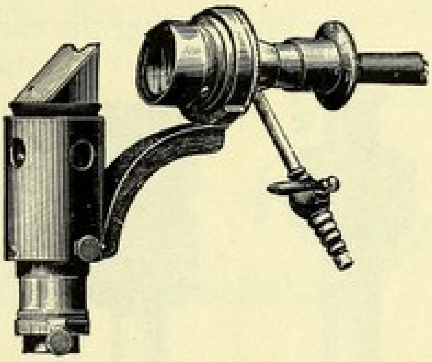
No. 1257. Complete set, consisting of the above instrument, with spare lamp in case, 5 urethral tubes and 2 cotton holders £5 10 0



With the Urethroscopes it is very essential that the lamp should be exactly in the focus of the mirror, as otherwise no light will be obtained at the end of the tube. This must be borne in mind in placing new lamps in their position. After exchanging the lamps, a piece of white paper is placed on a table, and the end of the tube directed upon this paper. Now, while the lamp burns, the handle is moved up and down, until an intense and circular light falls on the paper, and when in this position only, the handle must be fixed to the upper part of the apparatus by screwing down *S*.

No. 1258. **Schall's Urethroscope** (Patent No. 1725, '96), with spare lamp and cords £2 10 0

No. 1258A. The same instrument, with the inflating arrangement and double bellows in addition . . 3 6 0



No. 1258A.

No. 1259. Complete set, consisting of instrument No. 1258, in case, with 3 tubes and 2 cotton holders £3 7 0

No. 1259A. Complete set, consisting of instrument No. 1259A, in case, with 3 urethral tubes and 2 cotton holders . . 4 2 0

This instrument has the same advantages as No. 1256, but the light is utilised in a more economic manner, and the illumination at the end of the tube is therefore more intense.

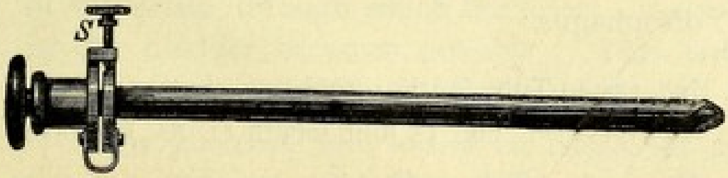
In order to use the instrument for an examination of the urinary organs, the following accessories are wanted:

No. 1261.

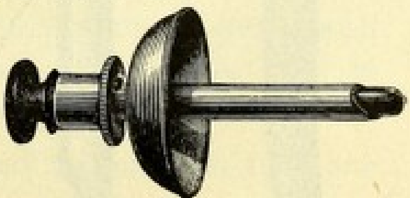
No. 1261.	Tube with conductor, No. 16 French gauge, 3½ inches long	4/-
No. 1262.	Do. No. 18 French gauge, 4 ins. long	4/-
No. 1263.	Do. No. 20 " " 4½ " "	4/-
No. 1264.	Do. No. 22 " " 5 " "	4/-
No. 1265.	Do. No. 24 " " 5 " "	4/-
No. 1266.	Do. No. 26 " " 5 " "	4/-

Other sizes and lengths of tubes are made to order.

Similar tubes, with cups, as shewn in *Fig.* 1269, 5/- each.

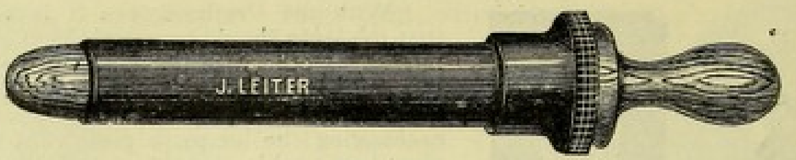


No. 1270.



No. 1269.

No. 1270.	Urethral Tubes, lengthwise, open	each	8/-
No. 1272.	Tubes for the prostate, with conductor . . .	"	6/-
No. 1280.	Cotton holders for the urethra	"	2/-

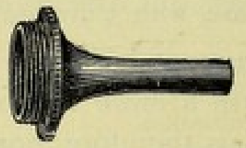


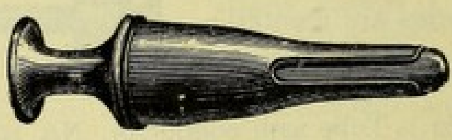
No. 1290.

No. 1290. Rectal Tube, with conductor, in three different sizes . each **4/6**
No. 1294. Metal Ring, to connect these tubes with the Urethroscope . . . . „ **3/-**

For illuminating the ear and nose, funnels of different diameter can be directly screwed on to the instrument, and they can also be closed by means of Siegle's apparatus, to evacuate or compress the air in the ear.

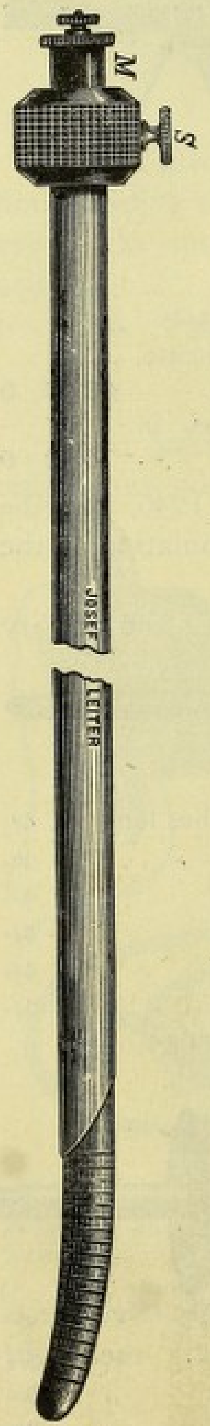
No. 1296. Ear Funnel, in three different sizes . . . . . each **2/-**
No. 1299. Siegle's Locking Arrangement **5/-**
No. 1300. Tube for examining the nose **3/6**


No. 1296.

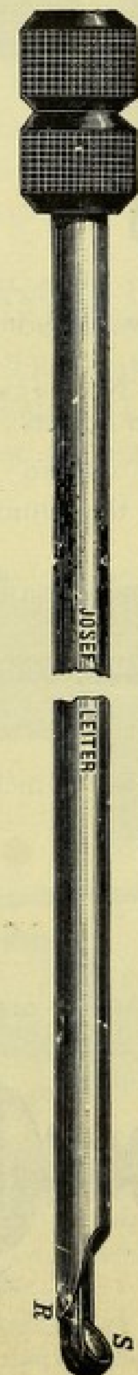

No. 1300.

In order to examine the œsophagus, the tubes shown (Nos. 1304 and 1305) are to be used. No. 1304 shows the tube and the flexible conductor. No. 1305 shows the same, with a mirror, for examining the walls of the œsophagus.

No. 1304. Tube for the œsophagus, diameter 15 mm. length 11 ins. each **11/-**
No. 1305. Tube, diameter 17 mm., length 15 inches . . **12/6**
No. 1306. Tube, diameter 17 mm., length 18 inches . . **14/-**



No. 1304.

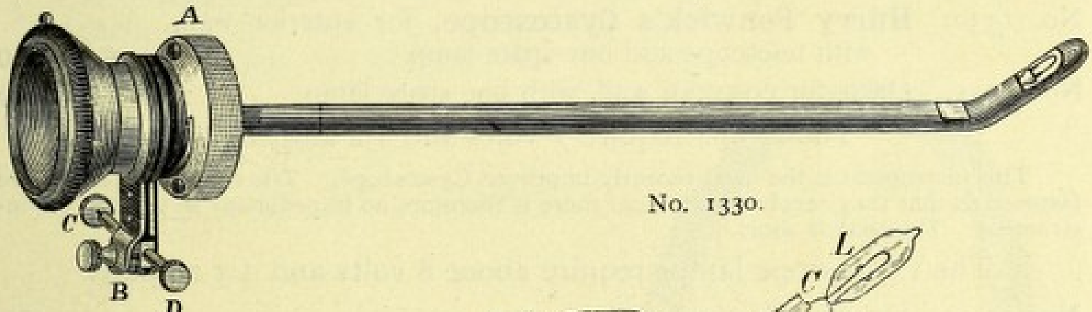


No. 1305.

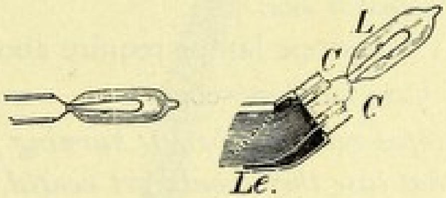
No. 1307.	Metal Ring, to connect the œsophagus tubes with the urethroscope . . . . each	4/-
No. 1309.	Forceps, for the urethra, by Schroeter	18/6
No. 1310.	Forceps, for the œsophagus, by Boecker	35/-

With such a pair of forceps an artificial set of teeth has been removed from the œsophagus, in Prof. v. Billroth's clinique.

Cystoscopes.—The Cystoscopes made by Leiter are now universally recognized as the best make. In Great Britain there are nearly 400 of them in use ; this is, no doubt, the best proof of their usefulness and reliability. They are being used by all the well-known specialists for diseases of the bladder, and in all the larger hospitals.



No. 1330.



They consist of a tube bent at the end like a calculus sound. In this part of the instrument the lamp is placed, specially protected by a thick window of rock crystal. To exchange a lamp the bent part of the instrument is unscrewed, the lamp taken out and a new one put in its place by the aid of a pair of forceps. Screw *B* opens and closes the circuit, and a knob indicates the part of the bladder towards which the prism is directed. By aid of the telescope, a surface of 3 to 4 inches diameter can be seen at once, very distinctly. The apparatus is provided, at the concavity of the elbow, with a prism. This form is most frequently used, as with its aid more than three-quarters of the bladder can be brought under examination. With it, however, the posterior wall of the bladder cannot be discerned, and a second instrument is required for this purpose, the opening of which is on the convexity of the elbow. A simple glass window here takes the place of the prism, through which the direct observation of the posterior wall of the bladder becomes possible. This latter apparatus is only to be used for examinations of the posterior wall and base of the bladder.

The telescope can easily be taken out and replaced, so that one telescope serves for two instruments.*

* For uses, *vide* "Electric Illumination of the Bladder and Urethra" (E. Hurry Fenwick), second edition, 1889; "British Medical Journal," No. 1424, and "Lancet," No. 3378.

The usual diameter of the Cystoscope is No. 22 French gauge. They can, however, be supplied as thin as No. 18 French gauge, or as thick as No. 40—in the latter case more light can be got and a larger surface be examined at a time.

Cystoscopes with irrigator, or with an arrangement for introducing a sound into the urethers, straight cystoscopes and cystoscopes provided with a camera for taking photographs of the living bladder can be supplied to order. Prices on application.

The usual length of that part of the instrument which can be introduced through the penis is 7½ inches, but any length can be supplied to order. It is, however, well to remember that the longer and thinner the instrument, the smaller and darker must be the picture, and *vice versâ.*

No. 1330.	**Hurry Fenwick's Cystoscope,** for anterior wall, with telescope and one spare lamp	**£4 16 0**
No. 1331.	Ditto, for posterior wall, with one spare lamp . .	**2 16 0**

The lamps require 7 volts and 1·2 ampére.

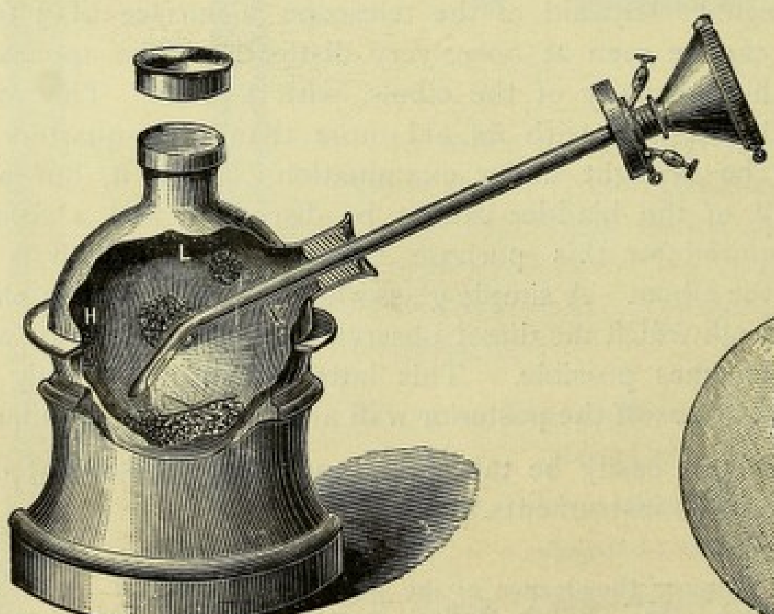
This instrument is the most recently improved Cystoscope. The connecting cords are fastened so that they revolve easily, and there is therefore no impediment in turning the instrument. The beak is short.

The Cystoscope lamps require about 8 volts and 1·3 ampère.

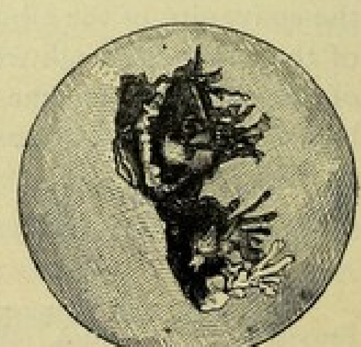
No. 1341.	Case for Cystoscopes	**10/-**

Cystoscopes must not be left burning for any length of time in the open air, as in that case they would get heated, and the insulation of the electric conductor might be destroyed. If, however, that part of the apparatus containing the lamp is surrounded by water, the Cystoscope may be kept burning for hours before it becomes perceptibly heated.

To be examined with a Cystoscope the bladder always ought to contain 5—8 ounces clear water. If the water in the bladder is not clear, it ought to be rinsed out previous to the operation.



No 1342.



No. 1343.

No. 1342. For practising with Cystoscopes and for demonstrations, a Phantom as shown (No. 1342) exhibiting artificial tumours, stones, and foreign bodies, &c., is very convenient. £0 18 0

No. 1343 shows two blood-red villous papillomata, of the exact size seen by a Leiter Cystoscope in a lady aged 50, who had suffered many years from painless hæmaturia. It was modelled according to the plan recommended by Mr. Hurry Fenwick ("Brit. Med. Journ." Jan., 1889).

No. 1350. **Gastroscope,** with telescope . . . £9 10 0

This apparatus is essentially of the same construction as the Cystoscope.

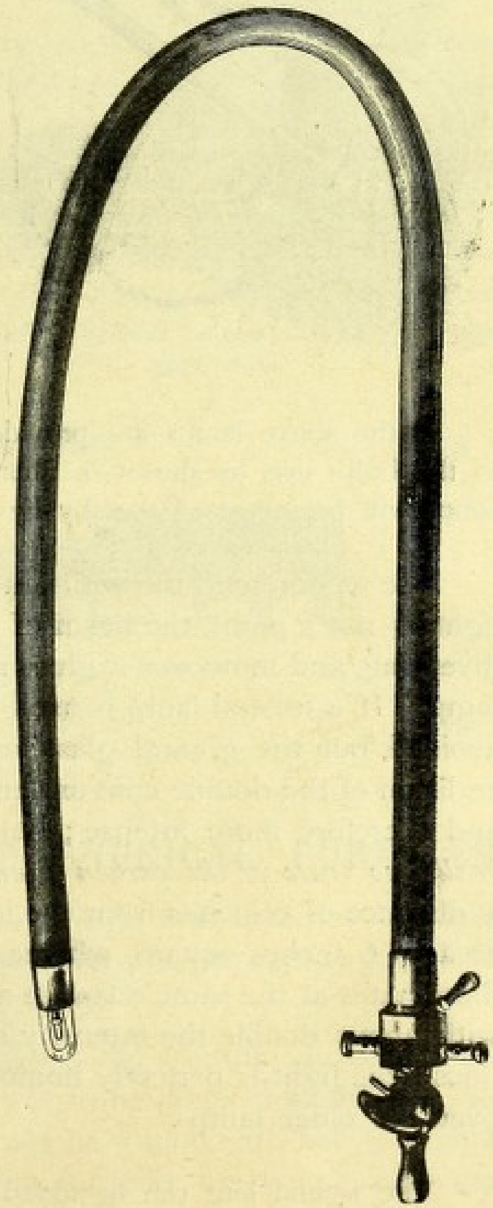
No. 1353. Instrument for making the stomach transparent, with spare lamp £4 0 0

To utilize this apparatus, the stomach is emptied, and filled with water; the instrument which is as flexible as an india-rubber tube, is then swallowed, and shows in a dark room the exact position, size and shape of the stomach.

No. 1356. **Ophthalmo-Diaphanoscope,** in case, with one spare lamp £1 18 0

The lamps require 6 volts and 1 ampère.

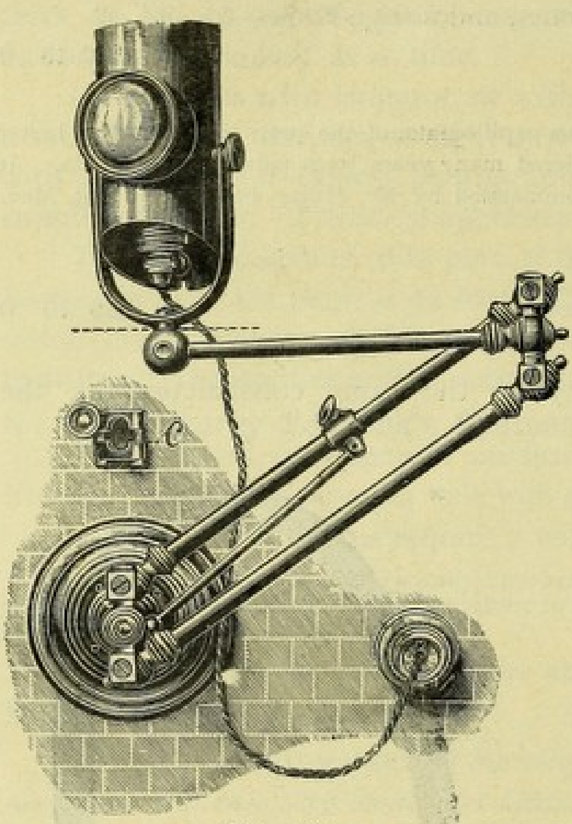
No. 1358. Water Cooling Apparatus, with bellows and tubes, shown in No. 1358. . . . . £1 10 0



No. 1353.

ILLUMINATING INSTRUMENTS.

To be used with the current supplied from dynamos.



No. 1395.

No. 1395. Dr. MACDONALD'S Lamp with bull's eye, for throat, nose, ear and eye examinations, and for surgical and dental operations. The lamps are movable in all directions: they can be taken off the bracket to be used as hand lamps or in other rooms. Price, with parallel bracket, as shown in illustration, and with a 32-candle power *focus* lamp . **£4 0 0**

With an ordinary frosted lamp, the price would be 6/- less.

Focus lamps of other candle power can be supplied if desired.

No. 1397. The same lamp, without the bracket, but with a clamp (*C*,) by means of which it can be easily fixed to any existing gas bracket . . . **£2 6 0**

If the above lamps are provided with a double convex lens in addition to the bull's eye, as shown in illustration No. 1399, the price of the above lamps will be increased thereby by 9/-.

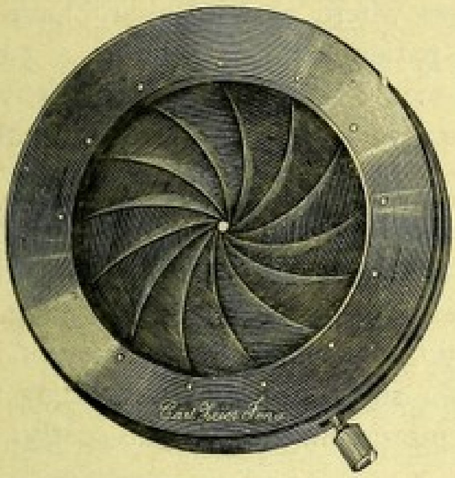
We recommend the addition of this second lens. As the source of light is not a point, the beam of light obtained with a bull's eye only is diverging, and moreover it gives an image of the carbon filaments of the lamp. If a frosted lamp is used instead of the clear lamp, the image is avoided, but the ground glass reduces the light very materially. The addition of the double convex lens makes the beam of light converging, and therefore more intense; but what is more important still, *there is really no trace of the carbon filament visible with this arrangement.* At a distance of 6 inches from the lens, the bull's eye alone illuminates an area of 6 inches square, whereas the combination of the two lenses illuminates at the same distance a circle of 3½ inches diameter only, but with about double the intensity and without showing any light or dark lines; the light is perfectly homogeneous, which is a great improvement over the older lamps.

The second lens can be added to all lamps sold previously; price of the alteration, approximately, 17/-.

No. 1399. Dr. MACDONALD's Lamp on stand, with lens and focus lamp of 32 candle power **£4 0 0**

No. 1400. EDISON SWAN's Focus Lamps, of 32 or 50 candles . **0 10 6**

In ordering, please state the number of volts and candle power required.



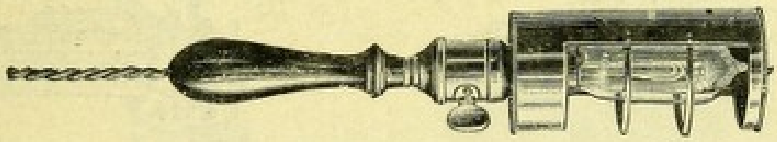
No. 1403.

No. 1403. **Iris Diaphragm,** for utilizing any of the above lamps for **ophthalmoscopic** purposes (*Fig.* 1403) **£1 1 0**

As supplied to Dr. Nettleship, Mr. Hutchinson, and Dr. Morrison, London; Dr. Bickerton, Liverpool; Dr. Claremont, Southsea; Royal Infirmary, Manchester; General Infirmary, Birmingham; Royal Infirmary, Aberdeen, and many others.

This can be added to any existing lamp. The lens is removed (they are held with a bayonet catch), and instead a frosted glass plate, bearing a Zeiss Iris diaphragma, is inserted. By means of this diaphragma the *intensity* of the light can be varied between ¼ and 20 candles, *without varying in any way the colour of the light*, which is all important for ophthalmoscopic purposes, and the frosted glass destroys any trace of the carbon filament.

No. 1405. Hand Lamp, with reflector and switch **£1 15 0**



No. 1405.

No. 1407. Similar lamp, with bull's-eye **£3 15 0**

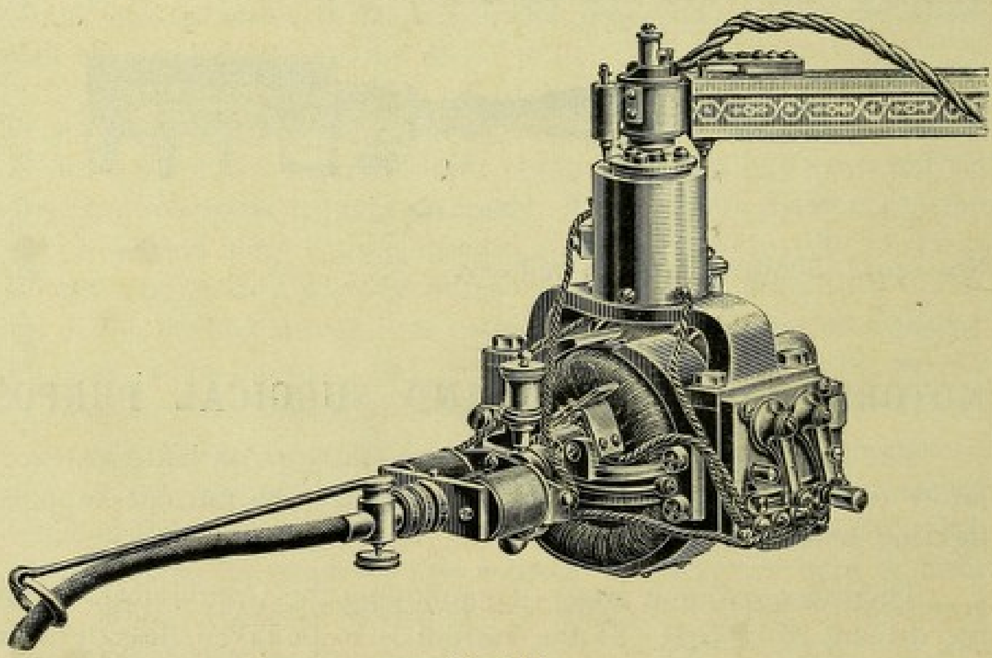
MOTORS FOR DENTAL AND SURGICAL PURPOSES.

The following motors can be worked either with batteries (accumulators or bichromate batteries) or else with the current supplied for lighting houses.

There are different ways of employing the Continuous current for the driving of motors. If the current is to be taken directly from the main, without a resistance, the motor must be wound with fine wire, so as to have a high resistance. Many motors, however, are wound with comparatively thick wire, so that they can be worked by batteries of about 10 volts (5 accumulators or 6 bichromate cells). These latter motors would get burnt at once if they were directly connected with the 100-volt current, but if a suitable resistance is inserted, they may be connected with the main, or else 5 accumulators may be charged from the main, and the motor may be connected with them. For dentists, in hospitals, and for driving static and other machines, the first mentioned motors are without doubt the best; they are also the most economical. The 10-volt motors, however, are preferable in cases where a motor may have to be portable, in order to be taken to a patient's house, because a 5-cell battery can be carried too, whereas you would be helpless with a 100-volt motor, unless by chance the same current is obtainable in the other house.

The Alternating current motors had better be mentioned here as well, so that we need not refer to them again later on. They differ from the Continuous current motors, especially through the electro-magnets not consisting of solid iron (as this would not change the polarity of the magnetism quickly enough), but of thin sheet iron, which renders the construction of the Alternating current more complicated and costly.

No. 1410. Dental motor, wound for 10, 100 or 200-volt continuous current, with automatic clutch to stop the tools immediately the current is broken, and current reverser, for altering the direction of rotation (*Fig.* 1410) £6 6 0



No. 1410.

No. 1412. Dental motor, wound for alternating current, with current reverser £7 0 0

No. 1414. Foot contact for these motors . . £0 15 0

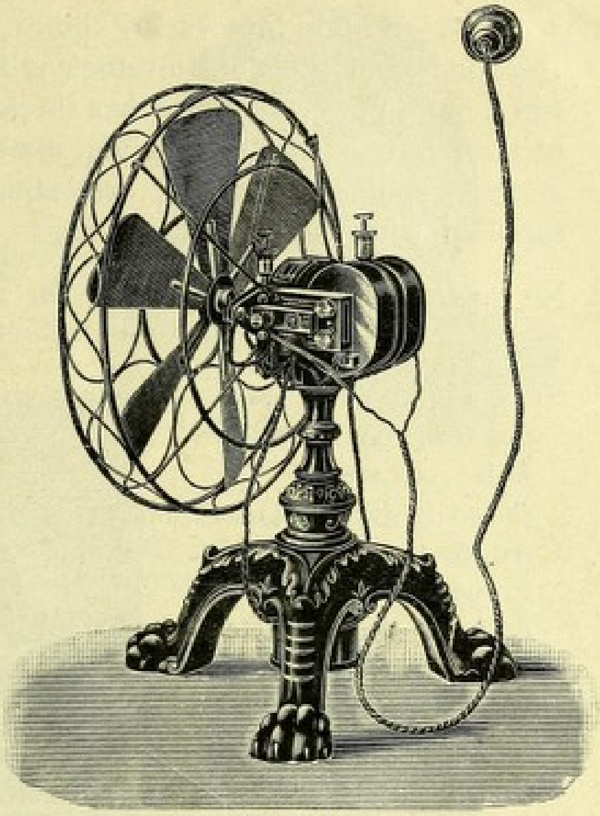
No. 1417. Flexible cable and universal hand piece for dental motors . £1 18 0

No. 1420. Movable brackets, to be fixed on wall, from £1 12 0 to £5 0 0

Illustrations will be sent on application.

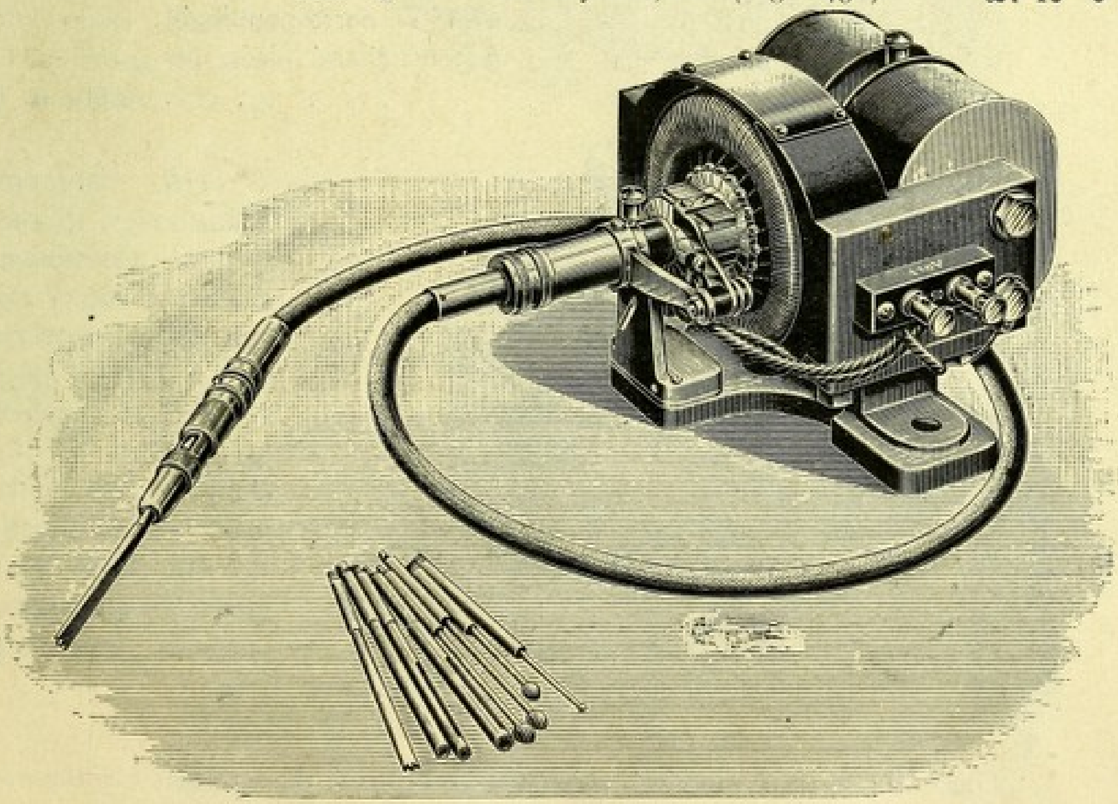
No. 1422. Motor, with fan, for ventilating consulting rooms, sick rooms, cabins, etc. (*Fig.* 1422) . £6 4 0

In ordering, please state the voltage, and whether it has to be used on continuous or alternating current circuits.



No. 1422.

No. 1430. **Surgical Motor,** wound for 10 or 100-volt continuous current, with strong flexible shaft and universal hand piece, for working trephines, circular saws, straight saws; for applying massage in nose, ear, etc., and for applying vibrations to joints, etc. (*Fig.* 1430) . £7 10 0

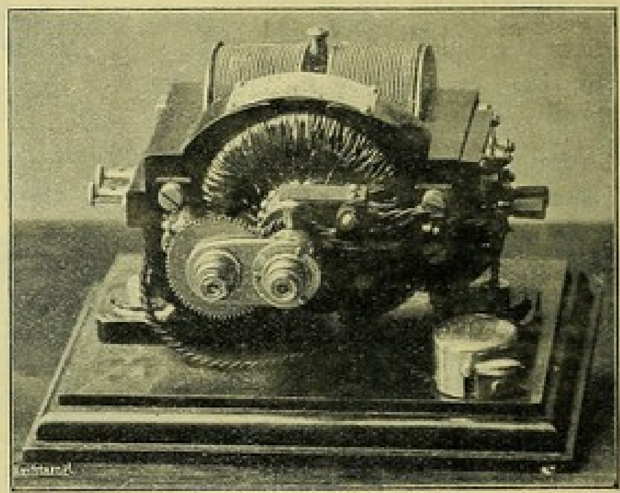


No. 1430.

The Dental Motors are quite powerful enough for all dental operations, but they are insufficient for the larger trephines, saws, etc., and a more powerful motor has therefore been constructed specially for such operations. The flexible shaft and hand piece, and the shafts of the trephines, drills, etc., are about three times as strong as those supplied with the dental motors.

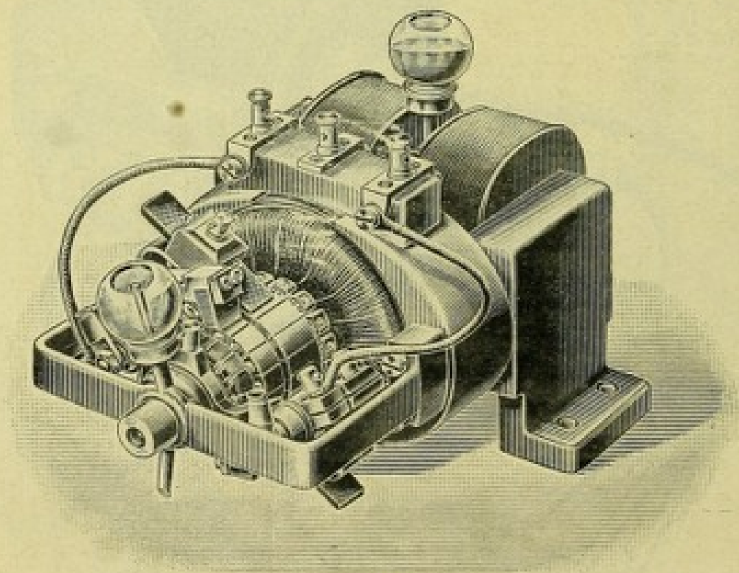
No. 1432. Similar Motor, wound for alternating current, with strong flexible shaft and universal hand piece . **£10 0 0**

No. 1434. These Motors can be provided with cog-wheels (as shown in *Fig.* 1434) to reduce the speed, and to increase thereby the power of the saws, etc. The addition of the cog-wheels and a current reverser for altering the direction of rotation, increases the price of the motors by **£2 15 0**



No. 1434.

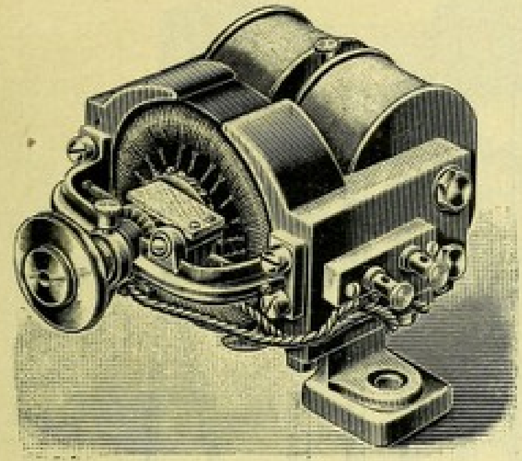
No. 1436. Large Motor, of ¼-horse power, for the largest surgical operations in hospital, with a correspondingly strong flexible shaft and universal hand piece, for 10, 100 or 200-volt **£30 0 0**



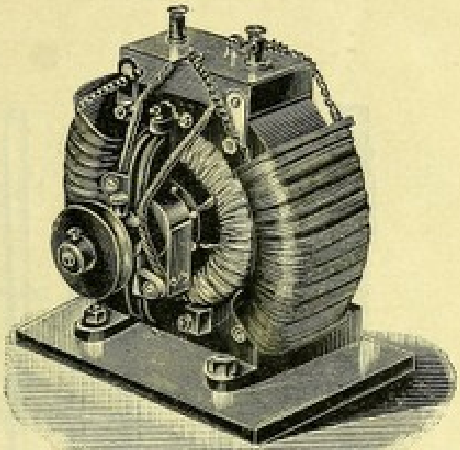
No. 1438.

No. 1438. Motor Transformer, to convert a Continuous current of 100 or 200 volt and 2½ ampères into a current of 8 volt and 20 ampères, for cautery, or for charging accumulators. It can equally well be used as a motor for all surgical purposes **£18 0 0**

This is the most economical apparatus for utilizing the 230-volt Continuous current, which is supplied now in many towns, for cautery, etc.



No. 1440.

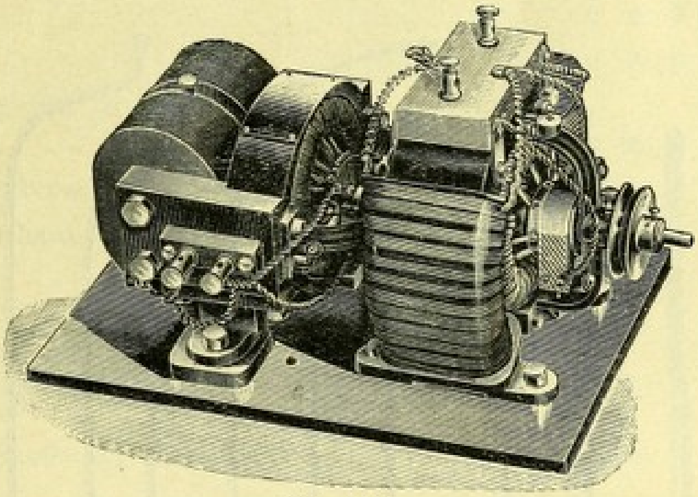


No. 1442.

No. 1440. Powerful Motor, 10 or 100-volt Continuous current, for driving static machines, etc. (*Fig.* 1440) . . £6 0 0

No. 1442. Similar Motor, wound for Alternating current (*Fig.* 1442) 7 5 0

No. 1444. Alternating Current Motor with small dynamo attached, for converting an Alternating current into a Continuous current, for charging accumulators, etc. (*Fig.* 1444) £18 0



No. 1444.

No. 1448. Rheostat, for regulating the speed of 10-volt motors £1 1 0

No. 1449. Rheostat, for regulating the speed of 100 or 200-volt motors £1 12 0

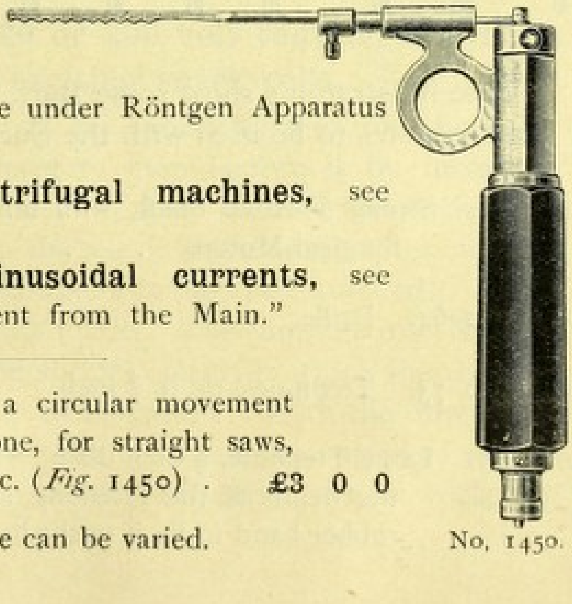
For Motor Interrupters, see under Röntgen Apparatus (page 124).

For Motors driving centrifugal machines, see Centrifugal Machines (page 131).

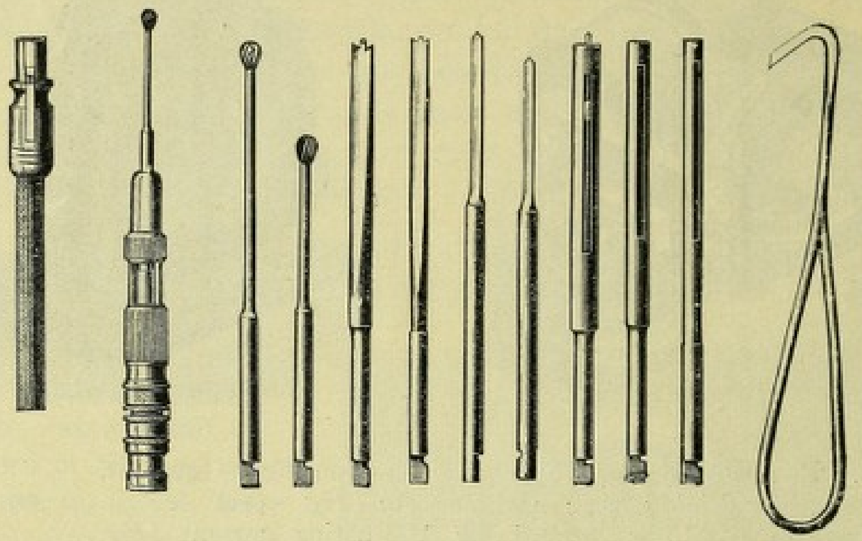
For Motors producing sinusoidal currents, see "Apparatus for Utilizing the Current from the Main."

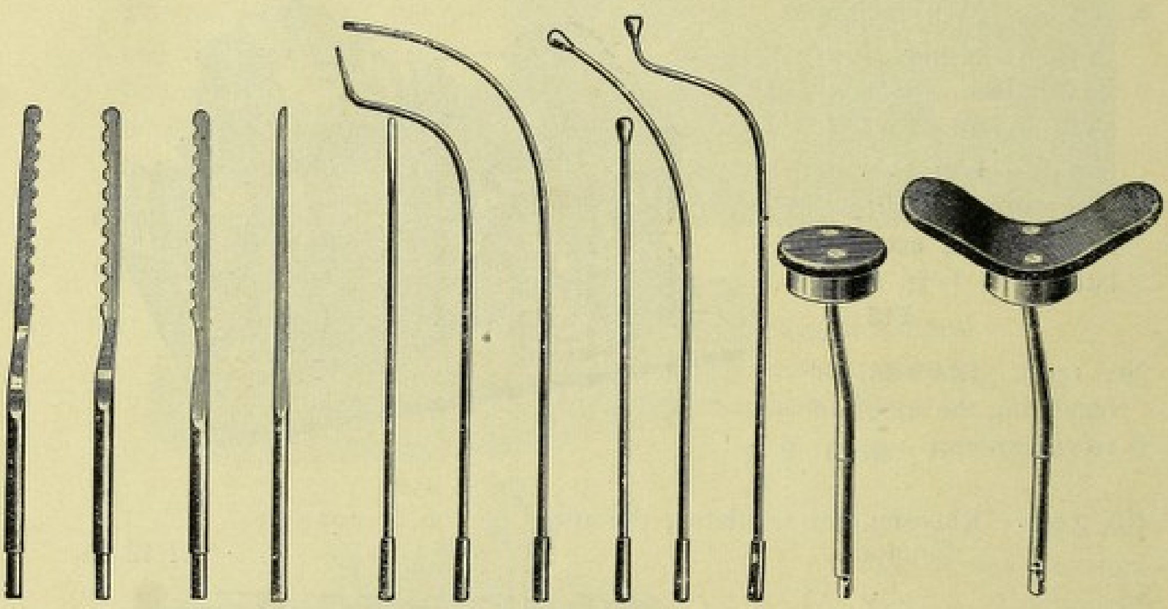
No. 1450. Handle, for converting a circular movement into a longitudinal one, for straight saws, massage, percuteur, etc. (*Fig.* 1450) . £3 0 0

The length of the stroke can be varied.



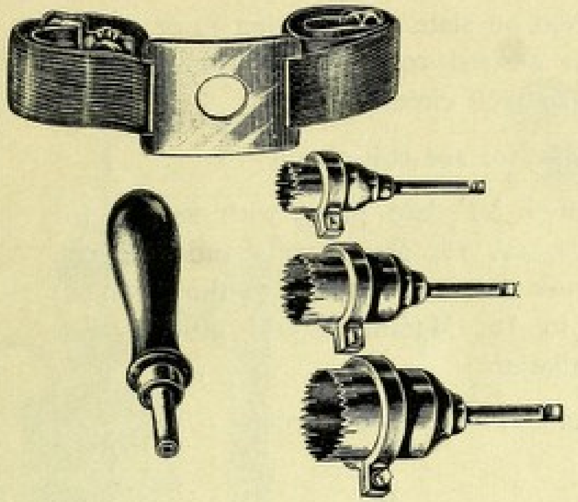
No. 1450.





These illustrations show some Burs, Drills, Trephines, Saws, Sounds for massage, etc., to be used with the Surgical Motors.

No. 1452.	Strong Flexible Shaft, with universal hand piece, for Surgical Motors	£3 0 0
Nos. 1460–64.	Drills . . . . each	0 2 6
Nos. 1470–73.	Trephines, up to $\frac{3}{8}$ inch . . . . . ,,	0 5 6
No. 1475.	Large Trephine, $\frac{1}{2}$ inch diam., with ring for controlling the depth of the incisions, and plate with India rubber band to fix it to the head of the patient .	1 1 0



No. 1475.

No. 1476.

No. 1477.

No. 1476.	Similar Trephine to No. 1475, ¾ inch.	£1 5 0
No. 1477.	„ „ „ 1 „	1 10 0
No. 1480.	Circular Saw, ¾ inch diam.	0 5 0
No. 1480*a*.	„ „ 1 „ „	0 6 0
No. 1480*b*.	„ „ 1½ „ „	0 8 0
No. 1481.	Handle, enabling you to hold the circular saw with both hands	0 15 0
No. 1485.	Straight Saws, for bones	0 4 6
No. 1486.	„ „ for hard tissues, etc.	0 3 6

APPARATUS FOR PRODUCING RONTGEN X RAYS.

About Apparatus for producing Röntgen X Rays, see pages 39—42.

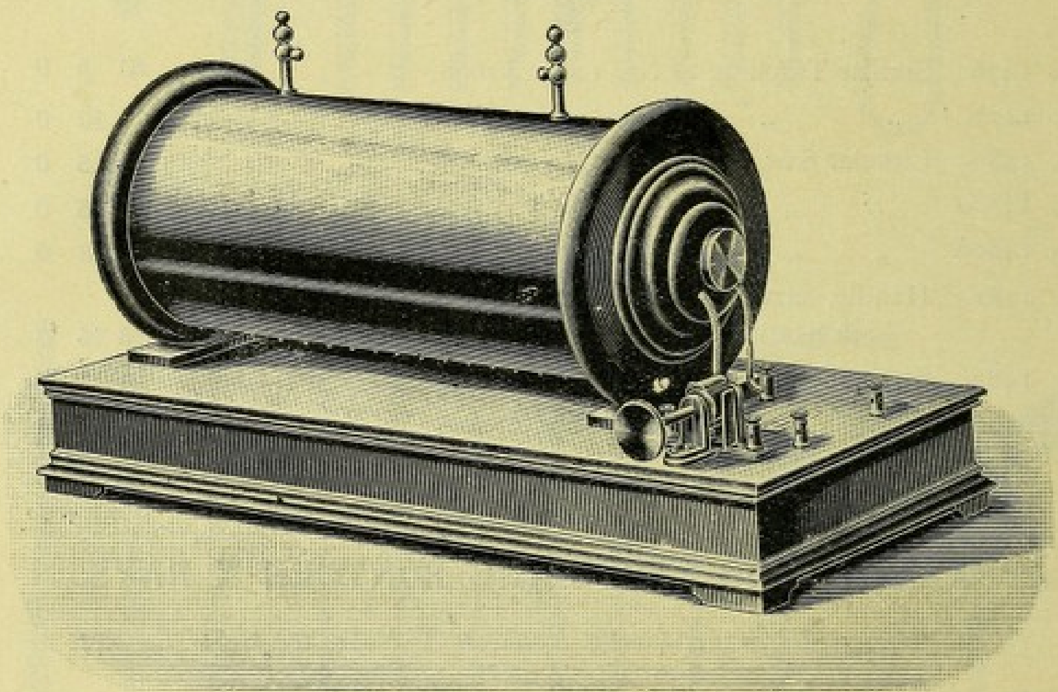
Batteries and Accumulators *to work the spark coils will be found on pages* 91—97.

RHEOSTATS, for utilizing the 100 or 200 volt continuous current from dynamos for exciting spark coils.

It is evidently more convenient to get electricity sent into the house all ready made for use, than to have to manufacture it by means of primary or secondary batteries. Moreover, these rheostats have the very great advantage of doing away with the spark at the interrupter, and the renewal of the expensive platinum contacts is therefore avoided.

There are two kinds of rheostats made. The simpler one has got the number of volts fixed to suit the special coil with which the rheostat is to be used, and the ampères only can be varied. With the other kind (made to the orders of Dr. Macintyre) the volts may be varied as well as the ampères, and these rheostats can be used for experimental work, and with any size of coil.

No. 1496.	Rheostat, mounted on slate plate, giving 12 or 16 volt (or any other desired voltage), and from 6 to 25 ampères, for 100-volt circuit	£9 0
No. 1496A.	The same Rheostat for 200-volt circuit . .	14 0 0
No. 1499.	Rheostat, mounted on slate plate, with switch, for taking 10, 12, 14, 16, or 20 volts and ampères, variable between 6 and 25 ampères (without jumps) as supplied to Dr. Macintyre, and others. For 100-volt installation	11 15 0
No. 1499A.	The same Instrument for 200-volt circuit . .	16 16 0

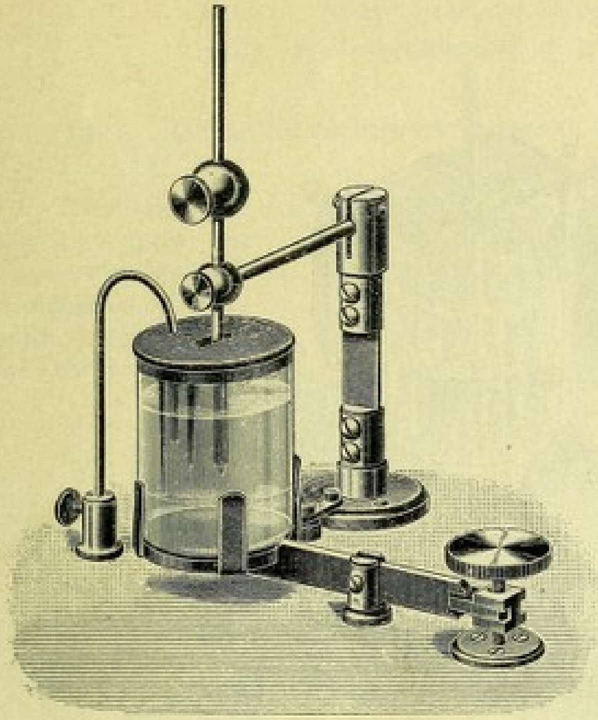


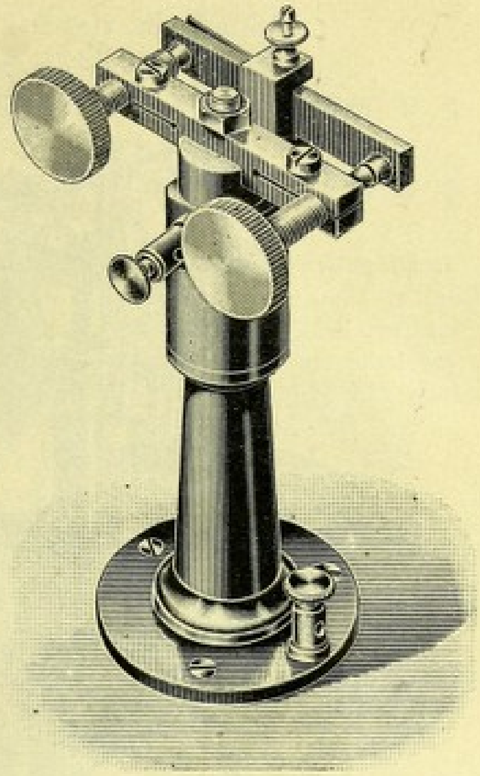
Spark Coils, with commutator and large condenser, in polished mahogany case.

These Coils are of the best quality obtainable. We guarantee that the length of the spark stated below may be exceeded by about 15 to 20 per cent. without risk of damaging the coil.

No. 1502.	4 inch spark Coil, with platinum interrupter . .	£12 16 0
No. 1504.	6 " " " " mercury " . .	16 10 0
No. 1505.	8 " " " " " " . .	20 10 0
No. 1506.	10 " " " " " " . .	26 10 0
No. 5107.	14 " " " " " " . .	39 0 0
No. 1508.	18 " " " " " " . .	60 0 0

Estimates for larger Coils on application.





These illustrations show the Mercury Interrupter and the Deprez Platinum Interrupter, which can be fitted to our coils if desired.

MOTOR INTERRUPTERS.

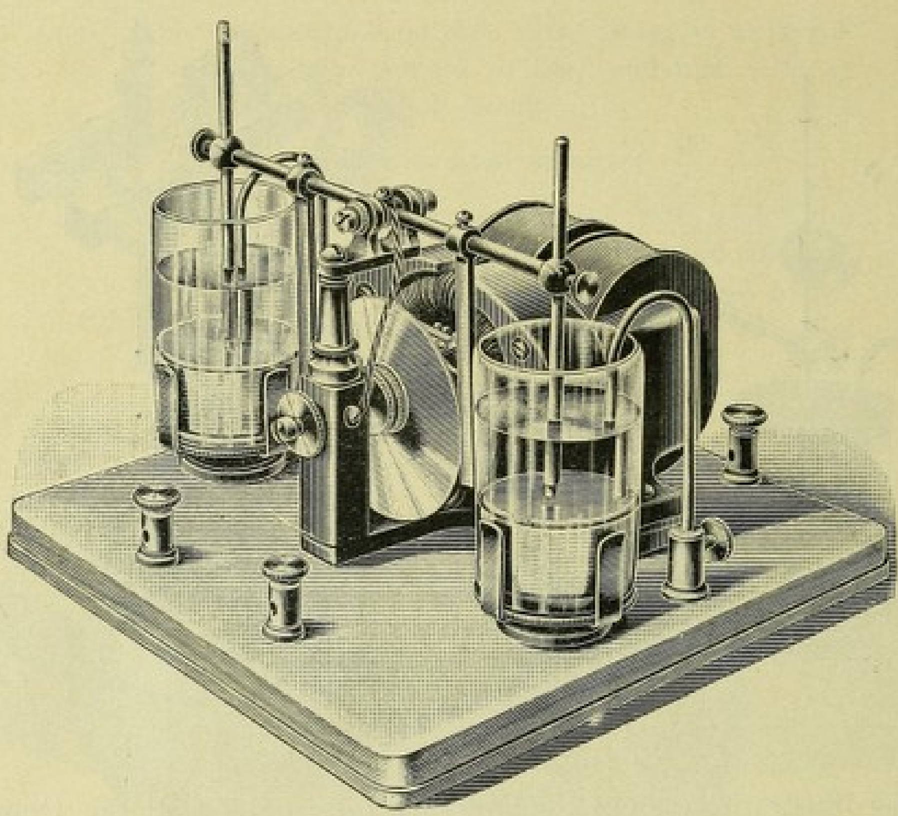
Experience has shown that good photographs depend more on the intensity of the discharge than on the mere rapidity of the interruptions. A mercury interrupter is a little better in this respect than a platinum interrupter, and for this reason many authorities prefer the mercury interrupter. The best results, however, are obtained by the motor or rotary interrupters. With these alone the primary current can reach its full strength, and the sparks discharged by coils fitted with these interrupters are 25 to 50 per cent. longer than the sparks obtained with interrupters dependent on the magnetism of the iron core. The rapidity of the interruptions is controlled by means of a rheostat. The motors are perfectly silent.

No. 1511.	10 or 100-volt Motor Interrupter, with rheostat for regulating speed, switch, and mercury cup (*Fig.* 1511)	**£8 15 0**
No. 1512.	The same Motor, with platinum points instead of the mercury contact	**11 0 0**

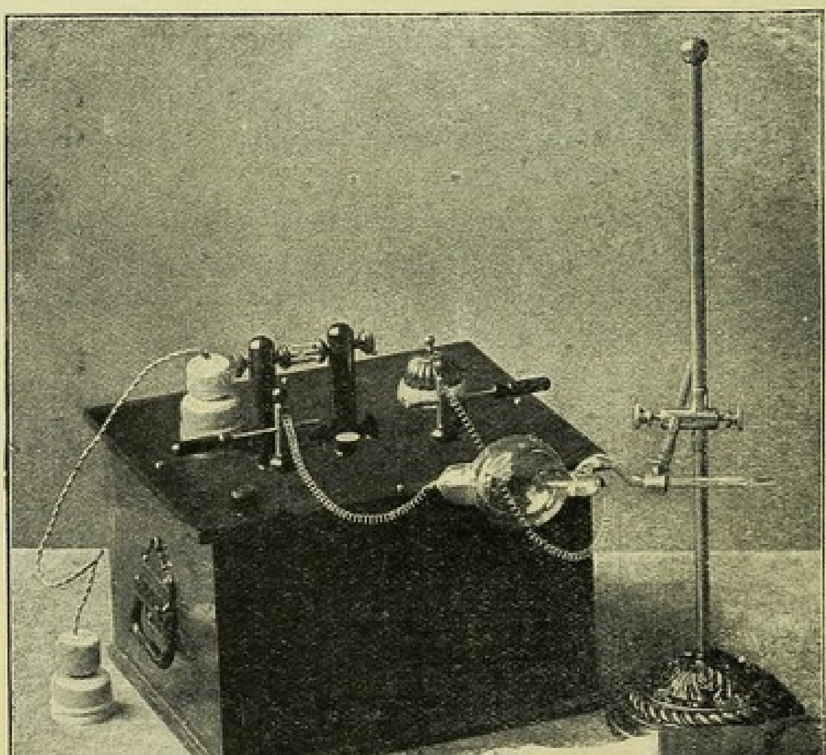
If desired, the motors can be so arranged that the current is twice made and broken with every revolution of the motor (*as shown on Illustration*).

The price is increased thereby by **£2** for the motors with mercury cups, and by **£3 10s.** for the motors with platinum points.

The motors may be worked with the same battery which supplies the current for exciting the spark coil.



No. 1511.

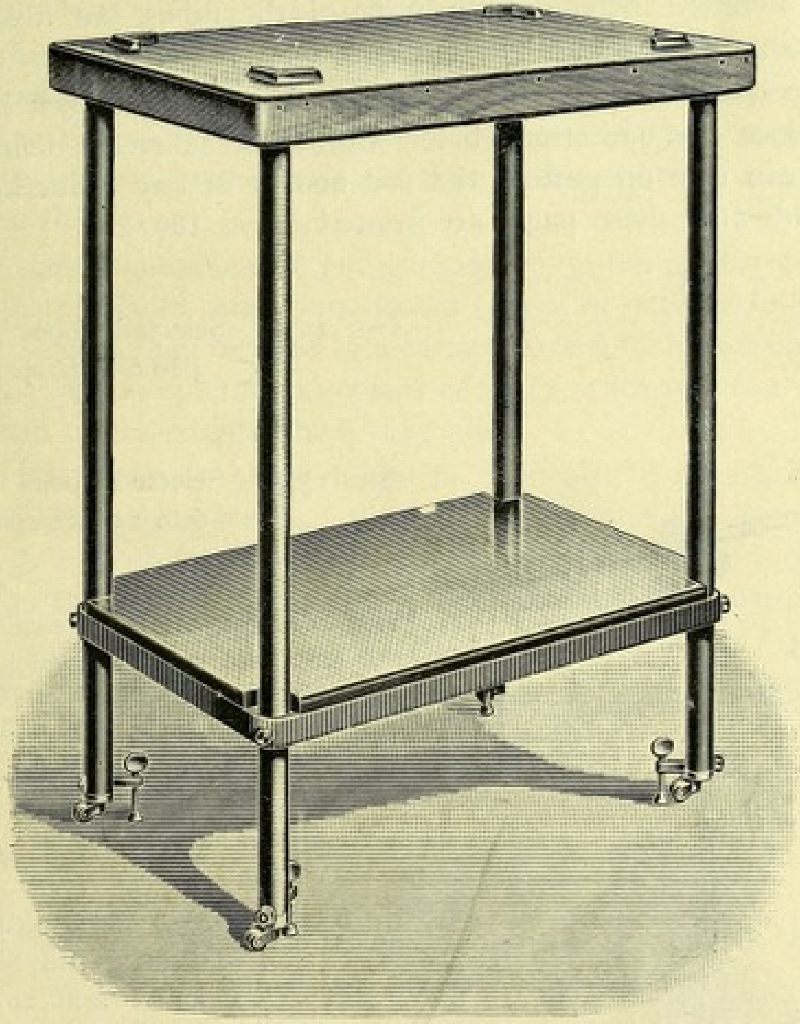


No. 1520.

No. 1520. Transformer for utilizing the 100-volt alternating current from dynamos directly (without a spark coil), for the production of X rays (*Fig.* 1520) . £18 0 0

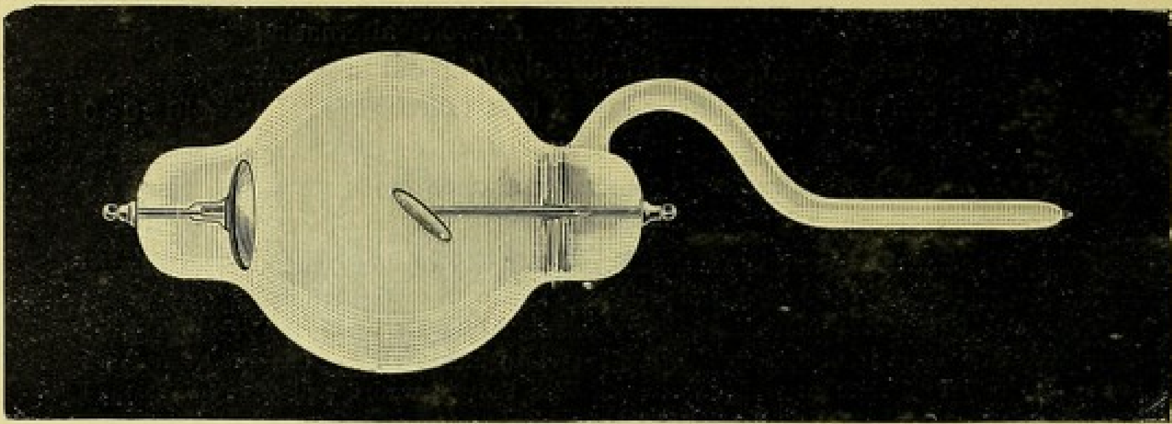
No. 1522. Ditto, but plainer arrangement, in 2 open tanks . 15 15 0

These apparatus are more convenient than a coil and a battery, and an extraordinary supply of sparks can be obtained from them. In No. 1520 the terminals, etc., of the 6000-volt transformer are nowhere accessible, and the sparks from the Tesla coil are harmless. Our Tesla transformers give sparks 3 to 9 inches long. The only drawback is the difficulty to find tubes which will work with the apparatus, and which will stand the enormous pressure for any length of time.



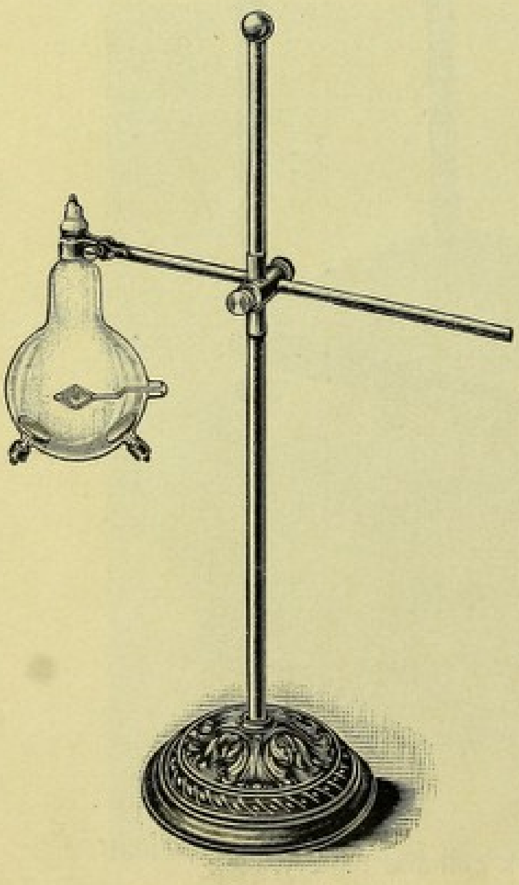
No. 1529.

No. 1529. Strong Table, for placing spark coil and battery, etc., on ; very convenient for Hospital use, etc. . £3 6 0



Focus Tubes.—As mentioned on page 41, the success or failure depends more on the quality of the tubes than on anything else. We do not sell a single tube which we have not carefully tested and found satisfactory. The testing requires much time, and the rejection of many tubes; it therefore increases the price of the tubes, but it saves our customers time, disappointment, and worry.

It is possible that the price of the tubes will go down in course of time, hence the quotations below cannot be taken as definite; our customers can rely on getting the full benefit of any reduction which may be made after these pages are printed (Dec., 1897).



No. 1536.

No. 1530. Selected Focus Tube, for 4 to 6-inch spark **£0 18 6**

No. 1532. Selected Focus Tube, for 6 to 15-inch spark **£1 10 0**

In ordering tubes, please mention the length of spark for which they are intended.

No. 1535. Plain Stand for holding the Tubes **£0 6 0**

No. 1536. **Stand for holding the Tubes,** 2 feet high, with ebonite arm and clamp to prevent leakage **£1 5 0**

No. 1537. Large Stand, 6 feet high **£3 15 0**

No. 1538. **Actinometer,** for testing and comparing accurately the quality of focus tubes and fluorescent screens £1 5 0

This useful instrument consists of a polished mahogany case, the interior of which contains 12 squares of tin-foil of various thickness, and each square is provided with a leaden figure. The thinnest square bears the figure 8, the next thicker one the figure 10, and so on.

The case is to be held between the tube and the platinum screen; the higher the value of the figure yet visible on the screen, the better is the penetrating power of the tube, and *vice versâ*. The quality of different screens can also be compared; if various screens are placed in front of the actinometer, the one which makes the highest figure discernible with a given tube is the most sensitive, and *vice versâ*.

FLUORESCENT SCREENS FOR REDUCING EXPOSURE.

These screens are no doubt the most important improvement which has been made in X Ray apparatus during these last eighteen months.

By their aid the exposure required is only ¼th or ⅕th of the time required without such a screen, thus increasing the life of the tubes four or five times. This fact alone would pay for the screen in a short time, quite apart from the saving in time and convenience both for the doctor and the patient.

The screens produce no grain whatever on the photographic plate, whereas the platinum screens produce a coarse, objectionable grain. The tungstate screens may be used to a certain extent for direct observations, but for this purpose platinum screens are very much superior on account of the much brighter light which they give.

The photographic plate should be laid with the sensitive side on the coated side of the screen. Screen and plate have to be so arranged that the X rays fall first on the object, then on the fluorescent screen, and last on the plate. To obtain sharp outlines there must be no space between screen and plate.

Fluorescent Screens for reducing the exposure, mounted on stout wooden frames:—

No. 1560.	7 × 9 ins.	£0 16 0
No. 1561.	9 × 12 ins.	1 5 0
No. 1562.	12 × 16 ins.	2 2 0
No. 1563.	16 × 20 ins.	3 10 0

Fluorescent Screens for reducing the exposure, with dark slide for the protection of the plate during exposure. (This is the most complete and convenient arrangement.)

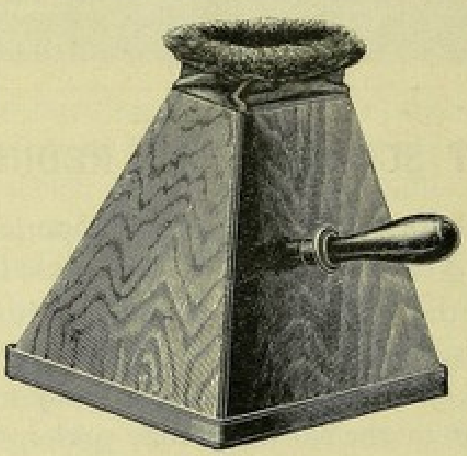
No. 1565.	For Plates up to 6½ × 8½ ins.	£1 12 6
No. 1567.	For Plates up to 10 to 12 ins.	2 6 0

Other sizes can be made to order.

(As supplied to Drs. Macintyre, Davidson, Wolffenden, Hedley, Lewis Jones, Mackenzie; Prof. Oliver Lodge, Charing Cross Hospital, London Hospital, etc., etc.)

Fluorescent Screens for direct observation, coated with two thick layers of large crystals of barium platino-cyanide :—

No. 1550.	5 × 7 ins.	£1 5 0
No. 1554.	7 × 9½ ins.	2 0 0
No. 1556.	9½ × 12 ins.	3 3 0
No. 1558.	12 × 15½ ins.	5 0 0
No. 1561.	**Cryptoscope,** with Screen No. 1554 (*Fig.* 1561)	3 0 0



No. 1561.

PHOTOGRAPHIC MATERIALS.

Dry Plates and Films, per dozen—

	Cadett, Ilford, or Thomas plates.	Edwards' Isochromatic plates.	Eastman X-Ray Paper.	Ruby silk bags to protect plates against daylight.	Printing out paper.
6½ × 4¾ ins....	2/3	3/8	...	1/6	16 sheets, 1/-
8½ × 6½ ins. ..	4/3	6/6	4/3	2/3	10 sheets, 1/-
10 × 8 ins....	7/3	10/-	7/3	3/-	6 sheets, 24 × 17 ins. 4/3
12 × 10 ins....	10/6	16/-	10/6	4/-	

Developing trays, porcelain dishes, printing frames, boxes for storing negatives, etc., supplied to order.

In ordering plates please state whether you desire medium, rapid or instantaneous plates (see page 42).

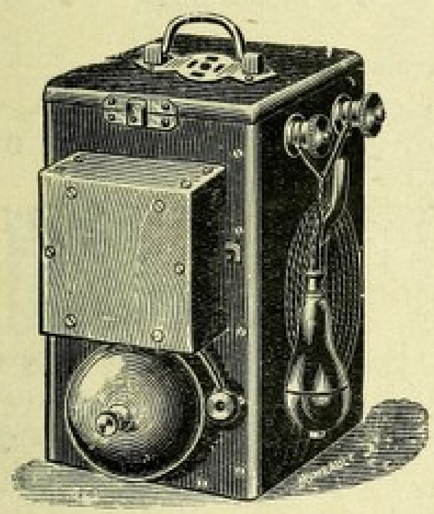
Oil Lamp, with dark ruby chimney	5/-
Graduated Glass Measure, 6 ozs.	1/-
Concentrated Developer, 40 ozs., in 2 glass-stoppered bottles	3/3
Fixing Solution (40 ozs.), in stoppered bottle	1/3

No. 1570.	Complete set of photographic materials, for plates up to $8\frac{1}{2}$ by $6\frac{1}{2}$ inches, consisting of 1 xylonite and 1 porcelain dish, 1 measure, 1 ruby lamp, 1 silk bag, 40 ozs. developer and 40 ozs. fixing solution .	£0 16 0
No. 1572.	The same set, for plates up to 12 by 10 inches . .	1 3 0
No. 1586.	**Complete outfit for Roentgen X rays, consisting of a 4-cell battery, 4-inch spark coil,** and selected focus tube with stand . . .	17 0 0
No. 1588.	The same set, with photographic set No. 1570 in addition	17 16 0
No. 1589.	**Complete outfit, consisting of 6-cell battery with rheostat, 6-inch spark coil, 2 selected focus tubes and stand**	26 0 0
No 1590.	The same set, but with the photographic set No. 1572 and a fluorescent screen, No. 1554, in addition .	29 10 0

Excellent photographs of the head, larynx, chest, legs, arms, etc., from 2/6 to 9/-, according to size.

Charges for taking X-Ray photographs of patients from 10/6 to 30/-, according to size of plate, number of prints, etc. required), if taken in our office ; from 30/- to 50/- if taken at the residence of patient or doctor.

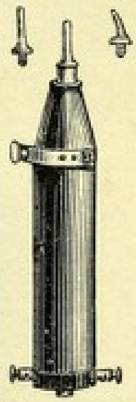
VARIOUS INSTRUMENTS.



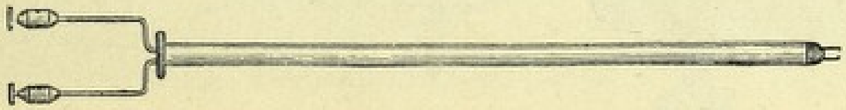
No. 1700.

No. 1700. **Invalid's Bell,** complete with large dry cell, 3-inch bell, 12 yards of flexible cord, and push . £0 18 0

No. 1710. **Electro-magnet,** with 5 different points, for removing pieces of iron or steel from the eye . . . 1 6 0



No. 1710.

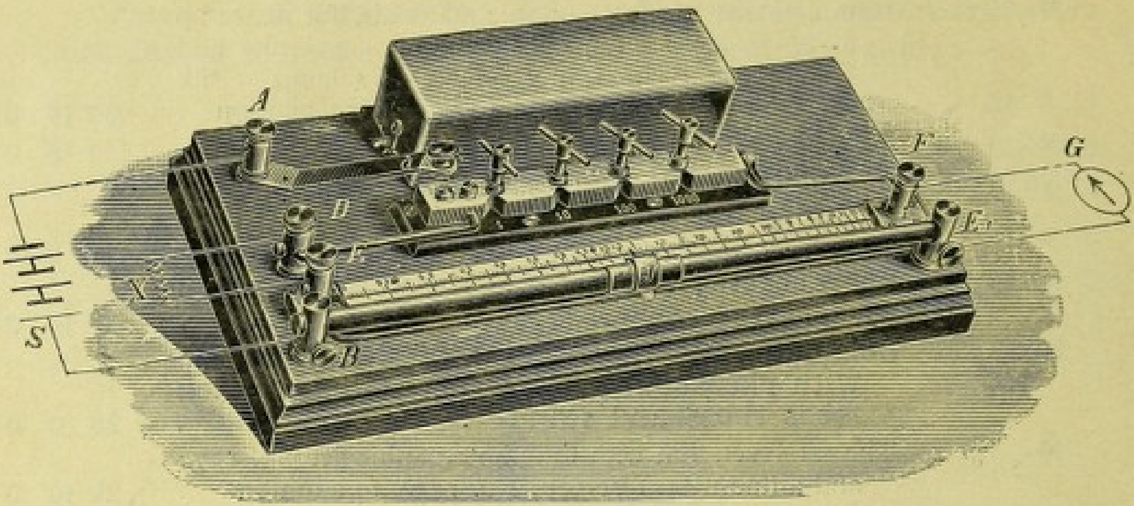


No. 1720.

No. 1720. **Bullet Finder** £0 8 6

In a narrow metal tube two needles are fixed, insulated from each other, their points reaching beyond the end of the tube. The apparatus, when connected up with one cell and a galvanometer or electric bell, will deflect the galvanometer or ring the bell immediately both points are brought into contact with a metallic body.

No. 1750. **Wheatstone's** Universal Measuring Bridge, after Prof. Kohlrausch, with resistances of 1, 10, 100 and 1000 ohms, and bridge wire £6 10 0

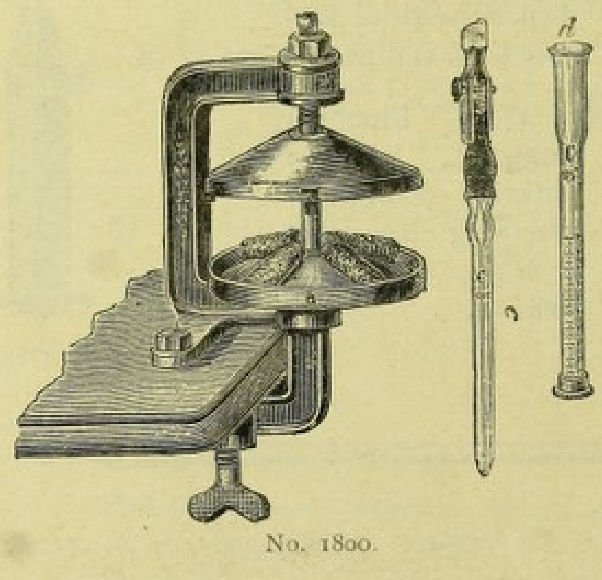


No. 1750.

This bridge is especially arranged for quick measurements with direct reading of the resistances of the human body, etc., and is accurate for resistances between about 2 ohms and 10,000 ohms. For measuring the resistance of fluids it is best to use the alternating current and a telephone (price 17/-); for measuring the resistance of solid bodies, the continuous current, with galvanometer, Nos. 277 or 278, had better be used.

The bridge is used by Drs. Althaus, Gamgee, Milne, Murray, Stone, Turner, Mr. Cardew, Guy's Hospital, etc.

No. 1800. **Centrifugal Machine** for examining blood, urine, milk, etc., with 12 testing tubes, and case containing pipette, burette, etc., suggested by Prof. Gaertner **£30 0 0**



As supplied to Charing Cross Hospital, Westminster Hospital, North Eastern Hospital for Children, Dr. Keser, St. George's Hospital, Owen's College (Manchester), Dr. M. Murray, Dr. Keightley, Mr. Fenwick, Royal Infirmary, Liverpool, etc., etc.

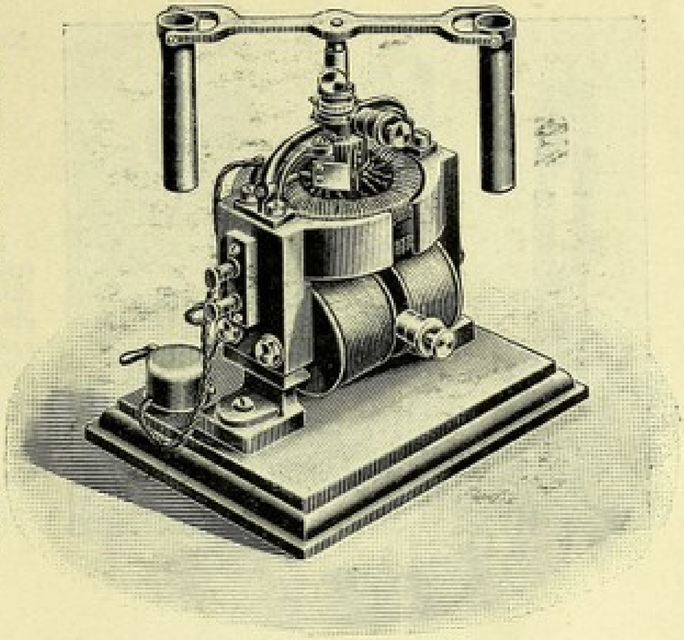
No. 1800.

By means of this apparatus, the red parts of a drop of blood can easily be separated from the serum within a few minutes, and the exact proportion can be read on a scale in %. The sediments of urine, etc., are also obtained within a few minutes, and the chemical analysis can be begun at once; this is of great importance in some cases of disease, and in hot climates. Printed instructions for examining blood, etc., are sent with the apparatus.

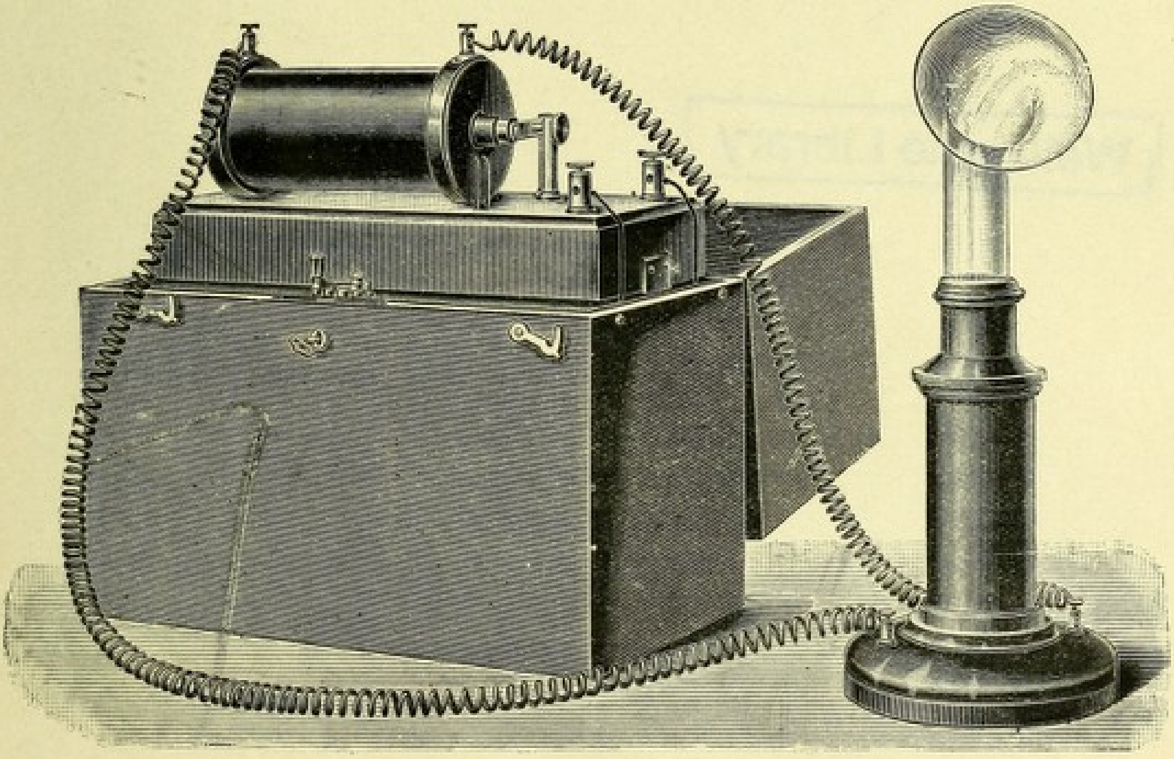
The instrument is simpler than any other centrifugal machine. There is no need to drive it by hand all the time. It is started like a spinning top, by the pulling of a cord, and the machines are so well made that they keep rotating for some ten minutes.

No. 1810. **Centrifugal machine,** connected with an electric motor. The motor can be arranged either for a 10-volt current from a battery, or the 100 or 200-volt currents from dynamos (continuous or alternating currents).
£6 10 0

In ordering, please state the source of electricity with which it is to be used.



No. 1810.

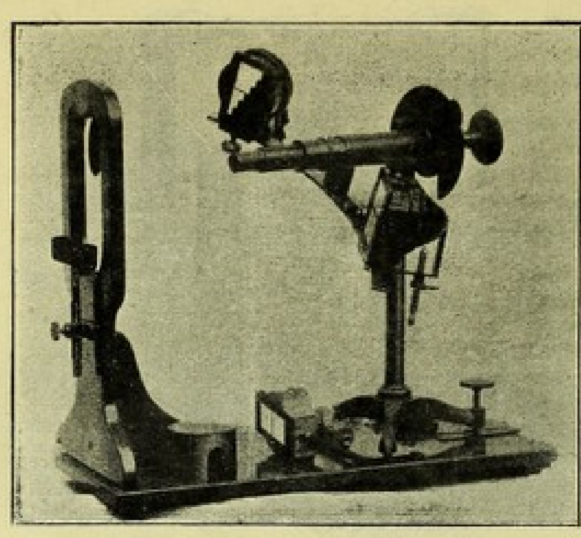


No. 1860.

No. 1860. **Apparatus for Generating Ozone,** complete . . £5 10 0

(To work the coil a 2 to 6-cell battery is required ; accumulators, large bichromate cells, or very large dry cells will do.)

No. 1862. **Tube for Generating Ozone** (to be connected with any spark coil used for Röntgen Photography) £1 5 0



No. 1890.

No. 1890. **Javal Schiotz Ophthalmometer,** with improved transparent figure plates (as supplied to Moorefields Hospital) . . **£18 0 0**

In the old instruments, the light is *reflected* from *enamelled* plates, but in this new instrument, candles or electric lamps are placed *behind transparent* plates. This is a great improvement, the images on the patient's eye are more distinct and clear.

No. 1892. Iron Table for the above apparatus . **£1 12 0**

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