HINTS REGARDING THE MANAGEMENT AND USE OF X-RAY APPARATUS.

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In presenting to the readers of the Journal the first of a series of papers dealing with this subject, I desire to point out that it will be treated entirely from a practical standpoint. The published works dealing with the practice of skiagraphy, although excellent in their way, are too much burdened with theoretical matter to be of any real assistance to the average aspirant. It is not altogether necessary to understand the technicalities affecting the manufacture of the instruments. Makers having a reputation to maintain are not likely to supply apparatus which will not stand the test for efficiency. The X-ray worker should simply endeavour to understand the functions of each component part and thus be able, not only to manipulate the instrument as a whole in an intelligent and methodical manner, but at the same time to locate a fault wherever situated. It is advisable, although not indispensable, to have an elementary knowledge of electricity before commencing the study of skiagraphy. The X-ray worker only needs to know the meaning and application of a few of the principal electrical terms, and these will be explained in the text where necessary. With these few remarks as a preface, I will now endeavour to explain the different parts of the apparatus, avoiding technicalities as much as possible, and lastly, how a skiagraph may be taken.

Electrical Supply.—The electrical supply may be either direct or indirect. Direct, when the instrument is connected with a dynamo or public main; indirect, when accumulators are charged from either of these, and afterwards used to supply the necessary current to the apparatus. In the direct method the voltage is too high and must be brought down. Before deciding, however, on this means of supply, it must first be ascertained whether the current is continuous or alternating, as the latter requires a rectifier or transformer. Being satisfied in this particular, the services of an electrician should be obtained to arrange for the necessary current and connections. When a continuous current is available the strength and volume is modified by means of ordinary incandescent lamps placed in circuit. The electrician should be informed
regarding the amount of volts and ampères required, and he will arrange the necessary number of lamps. If the current is required for a ten-inch coil having a platinum interrupter, eighteen volts with five ampères will usually be ample. For the same size of coil, but fitted with a mercury interrupter, at least thirty-two volts with five ampères will be necessary. In either case the lamp resistance should be adjustable, that is to say, it should be possible to increase or diminish at will the number of lamps; the reason being that, as each lamp allows a certain quantity of current to pass, the supply will be under control.

Accumulator Cells.—The indirect supply falls under this heading, and as it is the most generally used, a full description of these cells will appeal to the needs of the average operator. An accumulator cell differs from a primary cell in that its action is the result of current obtained from a dynamo, whereas the action in the latter is originated in the cell by electrolysis. The enumeration of the parts comprising an accumulator cell will, it is hoped, be of some little assistance to the uninitiated.

Case.—Made of teakwood and varnished.

Cells.—Usually made of vulcanite, on account of its non-conducting properties, which provide against leakage of electricity from the cell.

Plates.—These are made of lead, as free from impurities as possible. On their surfaces are cast numerous small holes in which to contain a paste containing red lead for the positive and yellow lead for the negative plates. There is always an odd number of plates in a cell, the positives being in the minority. These being placed side by side in the cell both sides of the positives will be faced by negatives.

Separators.—These are made from strips of vulcanite, and are placed between the plates to prevent contact, and also between plates and sides of cells to give firmness to the section.

Connections.—These are strips of lead and serve the purpose of joining all the positive plates of one cell to all the negative plates in adjoining cell, when the cells are coupled in series.

Electrolyte.—This is the medium by which the current passes from plate to plate, and is composed of sulphuric acid and water. The specific gravity of this solution is 1.2 when the cell is fully charged.

Terminals.—Two brass terminals are fitted to each cell to connect it with an apparatus. The positives are marked + and the negatives —. The former are painted red and the latter black.
Arrangement of Cells.—In batteries containing two or more cells the positive plates in one cell are coupled to the negative plates in an adjoining cell. This arrangement is termed coupling up in series. For example, if the voltage of one cell is two volts, then that of a six-cell battery would be twelve volts. In cases where much current (amperage) is required at a low pressure or voltage, all the positive plates in the cells of a battery are coupled together to form one pole or terminal, and all the negative plates coupled in like manner to form the other pole or terminal. It converts the six cells into one large cell. The voltage, however, is that of one cell, hence the amperage is increased at the expense of the voltage.

To briefly illustrate the above examples of batteries coupled in series and in parallel, the following will show by comparison how the volts and amperes are affected by the different arrangements.

<table>
<thead>
<tr>
<th>Arrangement</th>
<th>Volts</th>
<th>Ampères</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six-cell battery in series</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>in parallel</td>
<td>2</td>
<td>210</td>
</tr>
</tbody>
</table>

Capacity of a Cell.—By this is meant the number of hours a given cell will supply an instrument absorbing one ampère of current; in other words, the number of ampère-hours a cell contains. Approximately a square foot of positive plate (not surface) should give 100 ampère-hours.

Voltage (Electro-motive Force).—The voltage of a cell should be 2.5 volts when fully charged, but this pressure quickly falls to 2 volts and remains at this until exhausted, when it rapidly sinks.

Action in the Cell during Process of Charging.—Before the current from the dynamo is switched on, the condition of the plates and electrolyte is as follows:—

--- | --- | ---
PbSO₄ | H₂SO₄ + H₂O | PbO

When the current from the dynamo is passed through the cell a series of changes takes place in the plates and electrolyte, molecules of water are removed from the latter and an equal number of molecules of H₂SO₄ added, thus increasing the strength of the solution. The following will convey a general idea of what takes place:—

--- | --- | ---
PbO | H₂SO₄ + H₂O | PbO

When the cells are fully charged the condition of the plates and electrolyte will be:—
Management and Use of X-ray Apparatus

Positive Plates.  
\[ \text{PbO}_2 \]

Electrolyte.  
\[ \text{H}_2\text{SO}_4 + \text{H}_2\text{O} \]

Negative Plates.  
\[ \text{Pb} \]

Indications showing that a Cell is Fully Charged.—(1) By means of a voltmeter each cell should give at least 2 volts. (2) The specific gravity of the electrolyte should be 1.2.

Care of Cells.—As the care of cells is by no means the least important item, a few essential points are given in detail regarding their management.

(1) Rate of Discharge.—The number of amperes taken from a cell at one time must never exceed the amount as stated by the makers. If exceeded, a strain is put on the plates which they are not made to withstand.

(2) The practice of trying the strength of a cell by connecting the terminals by a piece of wire cannot too strongly be condemned. It short-circuits the plates, and will cause irreparable damage.

(3) Accumulator cells should be kept in as even a temperature as possible, as they are very sensitive to atmospheric variations. This is often the cause of otherwise unaccountable leakage.

(4) Batteries should preferably be placed on glass blocks to prevent any possibility of leakage occurring through the medium of moisture either from a damp floor or solution percolating through the casing from the cell.

(5) The level of the electrolyte should be kept at least a quarter of an inch above the tops of the plates.

(6) When cells are being moved from place to place they must be kept as level as possible to avoid spilling the electrolyte. They must also be carefully carried, as knocking and jarring might possibly damage the plates.

(7) The terminals must be kept clean, as dirty contacts act as a resistance, and therefore a needless loss of energy.

(8) The interiors of the cells require to be frequently examined for the purpose of ascertaining if the junctions are in good condition, and the solution is at the proper level. The colour of the solution should also be noted, because if dirty something is wrong with the plates. Sulphating should be looked for in order that this evil may be checked in its earliest stages.

(9) The efficiency and life of a cell depends in a great measure on the manner the charging and recharging have been carried out. Unfortunately we are in the hands of the people owning the charging plant, and damage to plates might be originated through carelessness in charging, which may not become manifest for some time afterwards, hence the instructions given in No. 8 should be carefully carried out.
(10) Cells must on no account be worked when the voltage has fallen below 2 per cell. To keep them in good order they should be sent to the charging station at least once a fortnight, whether they have been worked or not. This system will assist in keeping down sulphating to a considerable extent.

If the foregoing instructions are carefully carried out the evils inherent to accumulator cells will be greatly minimised, if not entirely obviated.

**Buckling.**—The buckling of a plate infer that it has become bent from some cause, and whilst in this condition there is danger from the paste falling down and not only causing a loss of active surface but by pieces sticking between the plates and short-circuiting the cell. These should be carefully removed, and the cell sent to an electrician for repair, as only skilled workmen are capable of putting matters right. Buckling may be caused by exceeding the discharge as laid down by the makers. It may also be caused by knocking or jarring the cell.

**Sulphating.**—This is generally the result of overworking the cell, and is known by a white sulphate forming all over the plates; when it appears the addition of a solution of caustic soda to the electrolyte, together with a prolonged recharging, will assist in checking its further progress.

**Wires from Battery to Coil.**—These should be at least B.W.G. No. 14, in order that the current may not suffer any resistance in passing. They should be well insulated to avoid leakage.

**Switch.**—An appliance placed in circuit for turning on and off the current.

**Rheostat.**—A variable resistance placed in circuit for controlling the current.

**Cut Out.**—An appliance made of stoneware, and is placed in the main circuit. In it is fixed a piece of lead wire calculated to carry any desired amount of current; when this current is by any chance exceeded, the wire offering a resistance to its passage melts and breaks the circuit.

**Ammeter.**—An instrument for recording the number of ampères passing in a main circuit.

**Voltmeter.**—Used for measuring the voltage of a cell. It is never placed in the main circuit on account of the resistance it offers to the passage of a current.

The next paper will deal with the induction coil, and the various types of interrupters.

*(To be continued.)*
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