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However, at Vancouver, Southport and Doubtless Bay, where clock exchange signals were made over land lines and the conversation was done over the wires from the observatory, all parts of the switchboard were brought into requisition.

The accompanying diagram (Fig. 3) will illustrate the various parts and connections of the switchboard.

When observing, the switch is to the left, and plug 1 is in. The chronograph circuit is broken by the chronometer at the points of the clock relay, as well as by the observing key.

For simply talking over the line the switch is to the left, plug 2 in, plug 3 out, and also plug 8 out if the sounder is to be used. Experienced operators do not need the sounder but read off the relay.

For clock exchange, both clocks (of the two stations) beating simultaneously over the wire, the switch is put to the right, plugs 1 and 2 out; 3 may be out or in. When 3 is in, the talking relay is cut out. In clock exchange the main line current passes over the points of the clock relay and is there broken; similarly the distant clock breaks the local chronograph circuit at the points of the signal relay.

For arbitrary signals, sent with the break-circuit signal key, the switch is to left and plugs 1 and 2 out, so as to throw the chronograph circuit over the points of the signal relay. Under all conditions the chronometer always records on its own chronograph.

When the switch is to one side, the opposite points are in contact. The switch separates them, and changes thereby route of current. One dry cell (Meseo) is sufficient for the clock circuit. This is always independent of any other current, and to protect the points of clock contact only one cell is used.

For the circuit of the observing key and chronograph two or sometimes three cells are used.

Cable Attachment.—From former experience it was found undesirable to have a direct connection between the clock and the cable siphon, *i.e.*, to have the clock recording directly by means of the cable siphon. It is better to have an independent clock siphon tracing a line parallel to the one of the cable siphon.

To obtain the local clock record or two-second beats on the cable fillet, an ordinary sounder (Fig. 4) was provided with a $4\frac{1}{2}$ -inch long threaded rod attached vertically to one end of the sounder arm. Over the rod fitted loosely an oval ring held in position by two opposing screws and also by two nuts, one above and the other below the ring. The heads of the screws were perforated to admit of centering and fastening the silk fibre, to be spoken of presently. The sounder was screwed on a small board and the latter securely attached to the pillar on which the cable instruments are set, as it was found that by placing the sounder on the table the vibrations to which it was subjected by walking or other causes, made the siphon record unsatisfactory. On the brass frame (of the cable instrument) carrying the ordinary cable siphon was stretched another thin wire to which was attached a siphon which was connected by a raw silk fibre with the rod of the sounder arm, so that the siphon responded to the pulsations of the sounder and hence when filed with ink would leave a record on the cable fillet.

The recording of this siphon differed from that of the ordinary cable siphon, in as much as it dragged a continuous line on the fillet, while the other makes necessarily a dotted line, produced by the small vibrations of the frame. The magnetic effect, produced by the weak current used on cables, and which actuates laterally the cable siphon, is too weak to permit the siphon to rest permanently on the fillet, it could not draw it aside, so the siphon is kept just above the paper and by means of the vibrator is made to deposit drops of ink—about 60 per second—and thereby leave a record.

Before attaching the silk fibre to the sounder rod and siphon it was subjected to a constant pull by means of a small weight for a day in order to remove its elasticity sufficiently to permit of instantly responding on the siphon to the movements or pulsations of the rod. The tension of the fibre was adjustable by means of the two small opposing screws in the oval rings of the rod.