material, like clouds of water on the earth, but in view of the high solar temperature it seems improbable that any body, except, perhaps, carbon, could exist in any condition other than the gaseous state in the solar atmosphere; so that it seems more probable that sun-spots are due, at least partly, to reflection by convection streams of gas, rather than by clouds of transparent solid or liquid particles.

"Influence of Alterations of Temperature upon the Electrotonic Currents of Medullated Nerve."* By AUGUSTUS D. WALLER, M.D., F.R.S. Received December 14,—Read December 17, 1896.

(Abstract.)

The effects of a rise of temperature upon electrotonic currents may be briefly stated as follows:—

1. The ordinary electrotonic currents, A and K, are temporarily diminished or abolished at about 40°.

2. At about 30° of a rising temperature the K current is increased without notable alteration or with actual diminution of the A current.

3. On returning from 40° towards the normal (15° $\pm$ 2°) temperature, the A and K currents reappear. K is increased and A is diminished, so that the previous normal inequality $A > K$ is diminished, or actually reversed to $A < K$. In all cases the quotient A/K is diminished; in some cases it actually falls below unity.

[The negative variation is temporarily abolished at about 40°; a positive gives place to a negative variation in consequence of a raised temperature to 40°.]

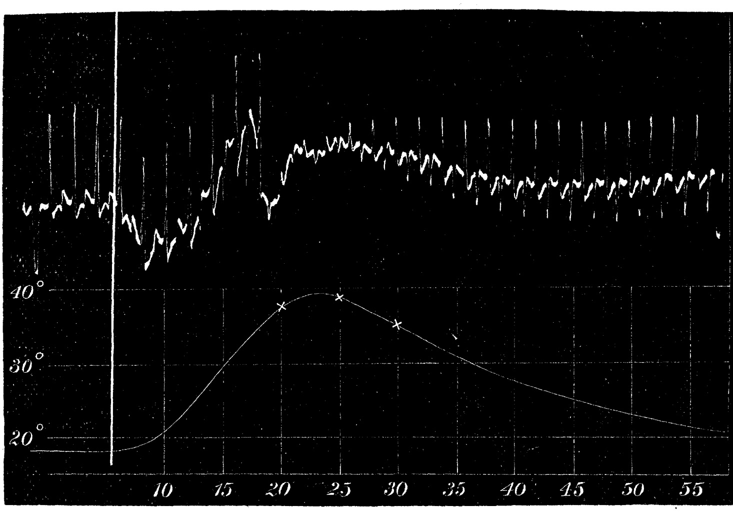
The above three statements are illustrated by Experiments 2366, 2322, and, from the examination of their records, it will be clear that there is here no question of the effects being due to alterations of resistance. A and K are tested for alternately, and the deflection by 0·001 volt is taken at intervals of about ten minutes. [Other examples of a similar character are given in the 'Proceedings of the Physiological Society' for November, 1896, and a record of temporary diminution of the negative variation is given in fig. 12 (Experiment 777), 'Phil. Trans.,' 1897.]

* In all the experiments referred to in this communication, the polarising current is by one Leclanché cell (the resistance in its circuit being about 100,000 ohms). The nerve lies upon four unpolarisable electrodes fixed at intervals of 12 mm., serving as leading-in electrodes to the polarising current and leading-out electrodes to the electrotonic current. On the galvanometer records, the anelectrotonic deflection A reads upwards, the katelectrotonic deflection K reads downwards; after-anelectrotonic and after-katelectrotonic deflections A′ and K′ read respectively downwards and upwards (there being under the conditions of experiment no marked homodromous after-katelectrotonic deflection).

Exp. 2322.—Influence of raised Temperature upon Anelectrotonic and Katelectrotonic Currents.

Time.	Temperature.	A.	A′.	K.	K′.	$\frac{1}{1000}$ volt.
0 min.	17°	—	—	—	—	9
1	”	+12	−2	—	—	
2	”	—	—	−trace	+2	
5	”	+12	−2	—	—	
6	”	—	—	−trace	+2	
Heat. 10	21	+12·5	−2·5	—	—	
11	—	—	—	−trace	+3	
15	30	—	—	−5	+3·5	
16	—	+11·5	−5	—	—	
20	38	+3	—	—	—	
21	39	—	—	−1	—	
25	39	—	—	−2	—	
26	38·5	+3	—	—	—	
30	35·5	+5	−1·5	—	—	
31	35	—	—	−3·5	+0·5	
40	28	+8·5	−2·5	—	—	
41	—	—	—	−4·5	+1	
50	24	+8·5	−2	—	—	
51	—	—	—	−4·5	+1	
52	—	—	—	—	—	9

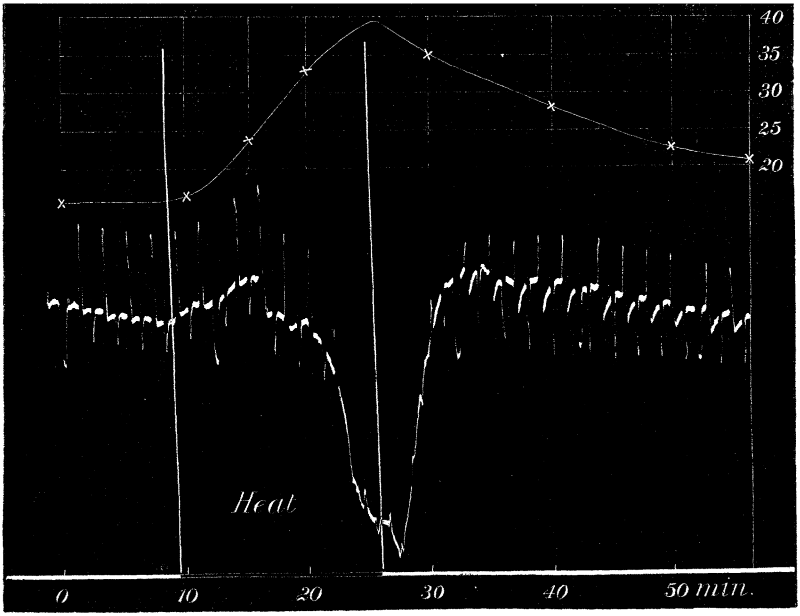
The K current is very small, the K′ after-current is comparatively large. In consequence of heating to 39·5°, K is increased, A and K′ are diminished. The quotient A/K is diminished.



Exp. 2366.—Influence of raised Temperature upon Anelectrotonic and Katelectrotonic Currents.

Time.	Temperature.	A.	K.	$\frac{1}{1000}$ volt.
0 min.	16°	—	—	8
1	,,	+11·5	—	
2	,,	—	−4·5	
7	,,	+11·5	—	
8	,,	—	−4	
Heat. 12	19	—	—	8
14	22·5	+12	—	
15	24	—	−4·5	
16	26	+12	—	
17	28	—	−5	
18	29·5	+11	—	
19	31·5	—	–	
20	33	+10	—	
21	35	—	−5	
25	40	+ 2	—	
26	40	—	1·5	
30	36	+4	—	
31	35	—	−4	
32	34	—	—	10
33	33	+4	—	
34	32	—	−7	
42	26·5	—	—	7
43	26	—	−8·5	
44	25·5	+6·5	—	
52	22·5	—	—	6·5
53	22	+6	—	
54	22	—	−6	

After heating to 40° the A current is diminished, the K current is increased, and a well-marked A′ after-current has developed. The quotient A.K is diminished.



Electrotonic after-currents, A′ and K′, when present to any marked degree, are opposed to the previous electrotonic currents A and K. Designating A and K respectively as positive and negative, the after-currents A′ and K′ are respectively negative and positive. Such after-currents are in general modified by previous rise of temperature, which gives rise to an evident A′ (negative) in a nerve which previously gave no marked A′, and abolishes a K′ (positive) that may previously have been present. Experiment 2366 exhibits the development of an evident negative A′ subsequent to heating of the nerve. Experiment 2322 exhibits the abolition of a positive K′, evident previous to heating of the nerve.

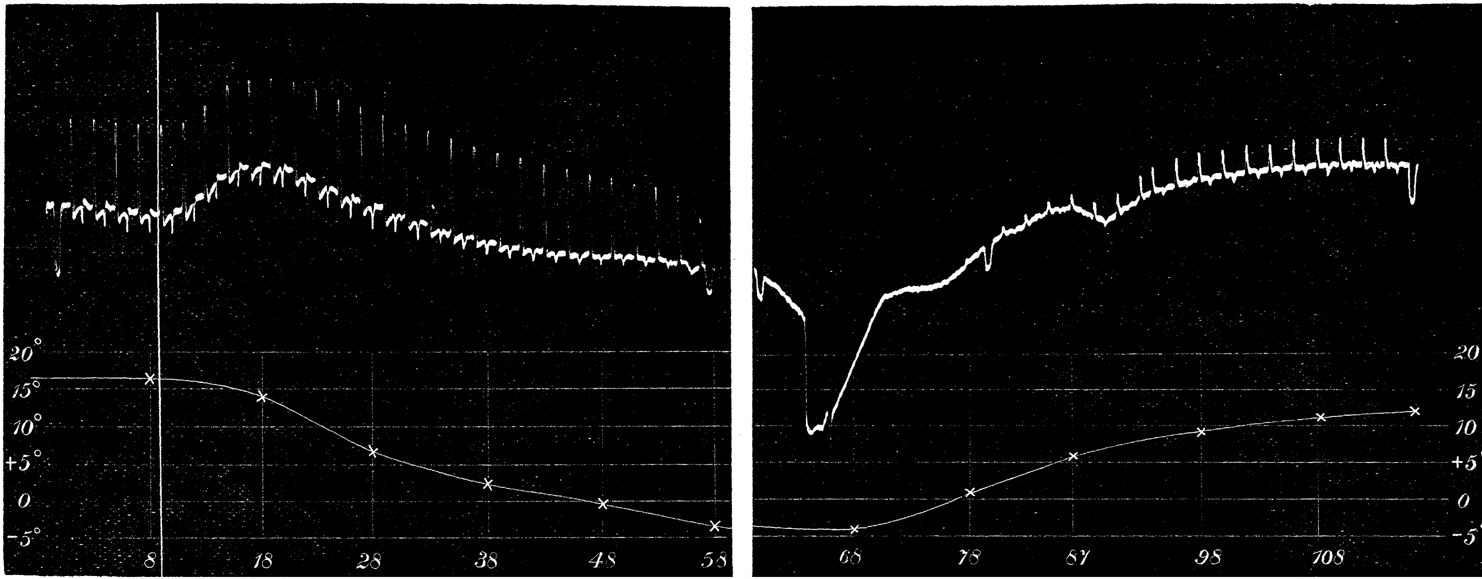
A fall of temperature causes an increase of the A current and, in less degree, of the K current; by reason of the diminution of resistance that takes place with lowered temperature, the increase of A is more marked than is apparent upon the record, and the smaller increase of K is quite masked by the diminution of resistance. The quotient A/K is augmented. At a temperature of $-4°$ to $-6°$ both currents are somewhat suddenly abolished; this abolition may be complete and final, no recovery taking place, or it may be temporary, being succeeded by imperfect recovery as the nerve temperature returns towards normal. It is noteworthy that the A and K currents are not abolished at 0° suddenly, and all but finally abolished at $-4°$

to $-6°$, probably by reason of the nerve having been frozen at this temperature and thus cut to pieces.

It is evident that little stress is to be laid upon an apparent decrease of K with falling temperature (2417) and increase of K with rising temperature (2366). On the other hand, a diminished A with rising temperature (2366) and an increased A with falling temperature (2417) are not open to doubt.

Exp. 2334–5.—Influence of lowered Temperature upon Anelectrotonic and Katelectrotonic Currents.

Time.	Temp.	A.	K.	$\frac{1}{1000}$ volt.
0 min.	17°	—	—	9·0
1	"	+11·5	—	
2	"	—	−2·5	
7	"	+11·5	—	
8	"	—	−2·5	
Cold. 9	"	+11·5	—	
10	16·5	—	−2·5	
17	15	+11·5	—	
18	14·5	—	−2·5	
27	8	+12	—	
28	7·5	—	−2·5	
37	3	+12	—	
38	2·5	—	−1·5	
47	−0·5	+10·5	—	
48	−0·5	—	−1	
56	−3	—	−0·5	
57	−3	+ 6·5	—	
58	−3·5	—	—	3·5
67	−4	0	—	
68	−4	—	0	
77	+1·5	0	—	
78	+2	—	0	
80	4	—	—	3·5
87	6	+ 2	—	
88	6	—	− trace	
98	9	+ 3·5	—	
99	9·5	—	−0·75	
108	11	+ 3·5	—	
109	11·5	—	−1	
116	12	—	—	4·5
180	14	+ 4	−2	6·0


20°
15°
10°
+5°
0
-5°
8
18
28
38
48
58
68
78
87
98
108

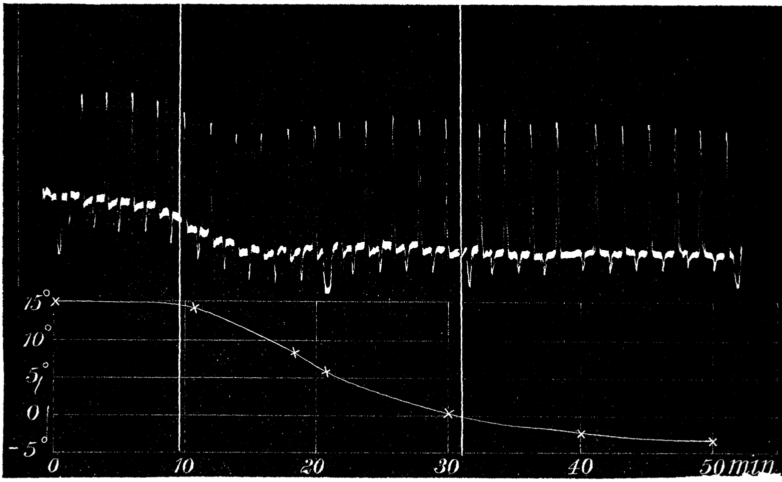
Expt. 2417.—Effect of Cold on A and K.

Time.	Temperature.	A.	K.	A/K.	$\frac{1}{1000}$ volt.
0	15°	—	—	—	7·5
1	,,	—	−4	—	
2	,,	+13	—	3·25	
7	,,	—	−4	—	
8	,,	+13·5	—	3·37	
11	14	—	−4	—	
12	—	+14·5	—	3·62	
13	—	—	−4	—	
14	12·5	+14·5	—	3 62	
15	—	—	−3·5	—	
16	11	+15	—	4·28	
17	—	—	−4	—	
18	9	+15·5	—	3·87	
21	6	—	—	—	5·5
23	4	—	−3·5		
24	3	+16 5	—	4·71	
27	2	—	−3·5	—	
28	1·5	+16·5	—	4·71	
29	—	—	−3	—	
30	0·5	+17	—	5·66	
32	—	—	—	—	4·5
33	−0·5	+16·5	—	—	
34	—	—	−3	—	
35	1	+17	—	5·66	
36	—	—	−2·5	—	
37	−1·5	+17	—	6·8	
38	—	—	−2·5	—	
39	−2	+17·5	—	7	
40	—	—	−2·5	—	
41	−2·5	+17	—	6·8	
42	—	—	−2·5	—	
43	−3	+17	—	6·8	
44	—	—	−2	—	
45	−3	+16·5	—	8·25	
48	—	—	−2	—	
49	−3·5	+16·5	—	8·25	
52	—	—	—	—	4

The A effect obviously increases with fall of temperature (increasing resistance); the K effect apparently diminishes, but actually increases a little, the increase being masked by increased resistance. The A/K quotient is obviously increased.

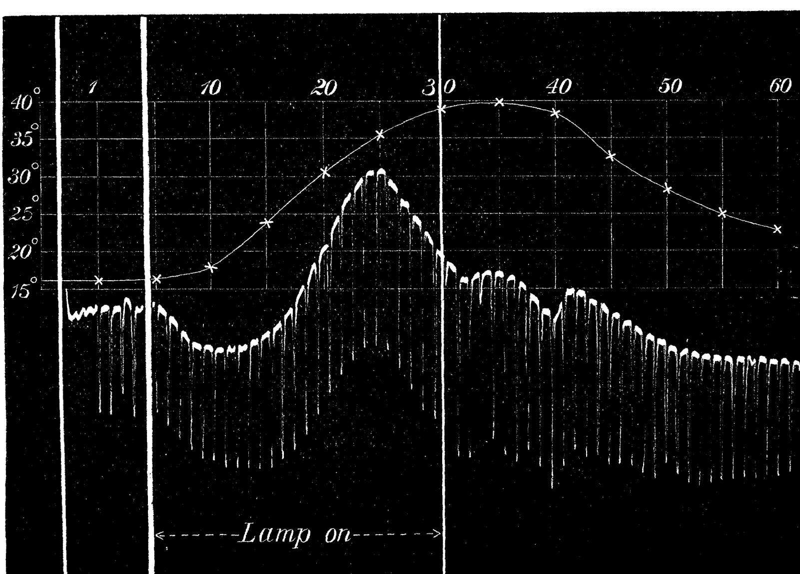
The voltage calculated from the data of this experiment is:—

At 15°	A = 0·00173 volt.	K = 0·00053 volt.
,, 10	A = 0·00244 ,,	K = 0·00059 ,,
,, 5	A = 0·00285 ,,	K = 0·00064 ,,
,, 0	A = 0·00360 ,,	K = 0·00070 ,,



Exp. 2344.—*Influence of Alterations of Temperature upon the Electrical Resistance of Nerve.*

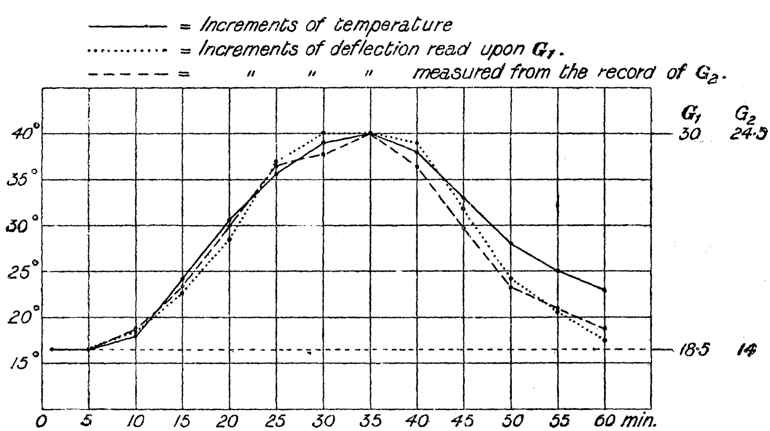
The following experiment (2344) made to test the effect of rising and falling temperature upon the electrical resistance of nerve, and the value attaching to observations of a standard deflection by constant E.M.F. as an indication of altered resistance, shows very



clearly that such standard deflection gives measure not only of the electrical resistance, but also—due reservation being made of the effect of drying in the course of a prolonged observation at raised temperature—is itself available in measure of the alteration of temperature of the nerve.

Exp. 2344.—Deflections by a small constant E.M.F. (0·002 volt) through a Nerve at rising and falling Temperature and through two Galvanometers.

Time.	Thermometer.	Demonstrating galvanometer, G_1.	Recording galvanometer, G_2.
1 min.	16·5°	18·5 c.m.	14·0 mm.
5	16·5	18·5 „	14·0 „
10	18·0	19·5 „	15·0 „
15	24·0	21·5 „	17·0 „
20	30·5	25·5 „	20·0 „
25	35·5	28·5 „	23·0 „
30	39·0	30·0 „	23·5 „
35	40·0	30·0 „	24·5 „
40	38·0	29·0 „	23·0 „
45	33·0	26·0 „	20·0 „
50	28·0	22·0 „	17·0 „
55	25·0	20·5 „	16·0 „
60	23·0	19·0 „	15·0 „



[Experiments on the comparative effects of acids and bases upon the A and K currents, have shown that within a certain moderate range of concentration (soakage of the nerve in $n/15$ to $n/20$ solution for one minute) acid favours the K current and disfavours the A

	Plate No.	Before.			Reagent.	After.			Remarks.
		A.	K.	A/K.		A.	K.	A/K.	
1	2322	+12	− 0·5	24	Heat to 39°·5	+ 5	− 3·5	1·4	30—31st min. of experiment.
2	2366	+11·5	− 4	2·9	Heat to 40°	+ 4	− 7	0·57	33—34th min. of experiment.
3	2334-5	+11·5	− 2·5	4·6	Cold to −0°·5	+10·5	− 1	10·5	47—48th min. of experiment.
4	2417-8	+13	− 4	3·2	Cold to +1°	+16·5	− 3	5 7	28—29th min. and 44—45th min. of experiment.
					And to −3°·5	+16·5	− 2	8·2	
5	2363	+17	−12	1·4	Carbonic acid for 2 mins.	+ 2·5	− 3·5	0·7	Immediately and 10 mins. later.
						+19	−15·5	1·2	
6	2158	+19·5	− 3	6·5	Carbonic acid for 3 mins.	+ 8	− 3·5	2·3	Immediately and 10 mins. later.
						+24	− 5	4·8	
7	2412	+14	− 3·5	4·0	Propionic acid, $n/10$, for 1 min.	+ 6	− 4·5	1·3	5—6th min. after.
8	2354	+30	−12·5	2·4	Sodium hydrate, $n/20$, for 1 min.	+14·5	− 6·5	2·3	13th min. and 30 mins. later.
						+23	− 3·5	6·6	
9	2355	+22·5	− 7	3·2	Sodium hydrate, $n/20$, for 1 min.	+14·5	− 2	7·2	2 or 3 mins. after.
10	2360	+19	− 8	2·4	Potassium hydrate, $n/20$, for 1 min.	+18	− 2·3	7·8	4—5th min. and 30 mins. later.
						+15	− 1·5	10·0	
11	2372	+21	− 8	2·6	Ether (Et_2O) for 8 mins.	+ 8·5	− 7·5	1·1	Immediately and 10 and 30 mins. later.
						+22·5	− 7·5	3·0	
						+20	− 8	2·5	
12	2373	+28	− 9	3·1	Chloroform for 8 mins.	+11	−11	1·0	Immediately and 10 and 30 mins. later.
						+ 2·5	− 1·5	1·7	
						+ 1·5	− 1·5	1·0	

current, giving decrease of the quotient A/K; while base favours the A current and disfavours the K current. In other words, the anodic or acidic polarisation is favoured by base, disfavoured by acid; the kathodic or basic polarisation is favoured by acid, disfavoured by base. Anæsthetics (CO_2; Et_2O; $CHCl_3$) act like acids and like rise of temperature, causing, at certain strengths, a greater relative diminution of A than of K, and therefore a diminution of the quotient A/K—temporary in the case of CO_2 and Et_2O, permanent in the case of $CHCl_3$. In the weakest dilution that will produce any effect at all there may be increase of A, no increase, or a relatively smaller increase, of K, and therefore increase of the quotient A/K. These effects are, however, at present under examination, and will form the subject of a future communication. The tabular summary (p. 391) will at this juncture be sufficient to enable a comparison to be made between the effects of heat and cold and those of acids and alkalies.]

"On the Occurrence of Gallium in the Clay-ironstone of the Cleveland District of Yorkshire: Determination of Gallium in Blast-furnace Iron from Middlesbrough." By W. N. Hartley, F.R.S., Professor of Chemistry, and Hugh Ramage, A.R.C.Sc.I., F.I.C., Assistant Chemist, Royal College of Science, Dublin. Received December 2,—Read December 17, 1896.

In the month of April of this year, we had the honour to submit to the Royal Society* a preliminary notice of the evidence we had obtained of the existence of gallium in the Yorkshire ironstone smelted at Middlesbrough-on-Tees.

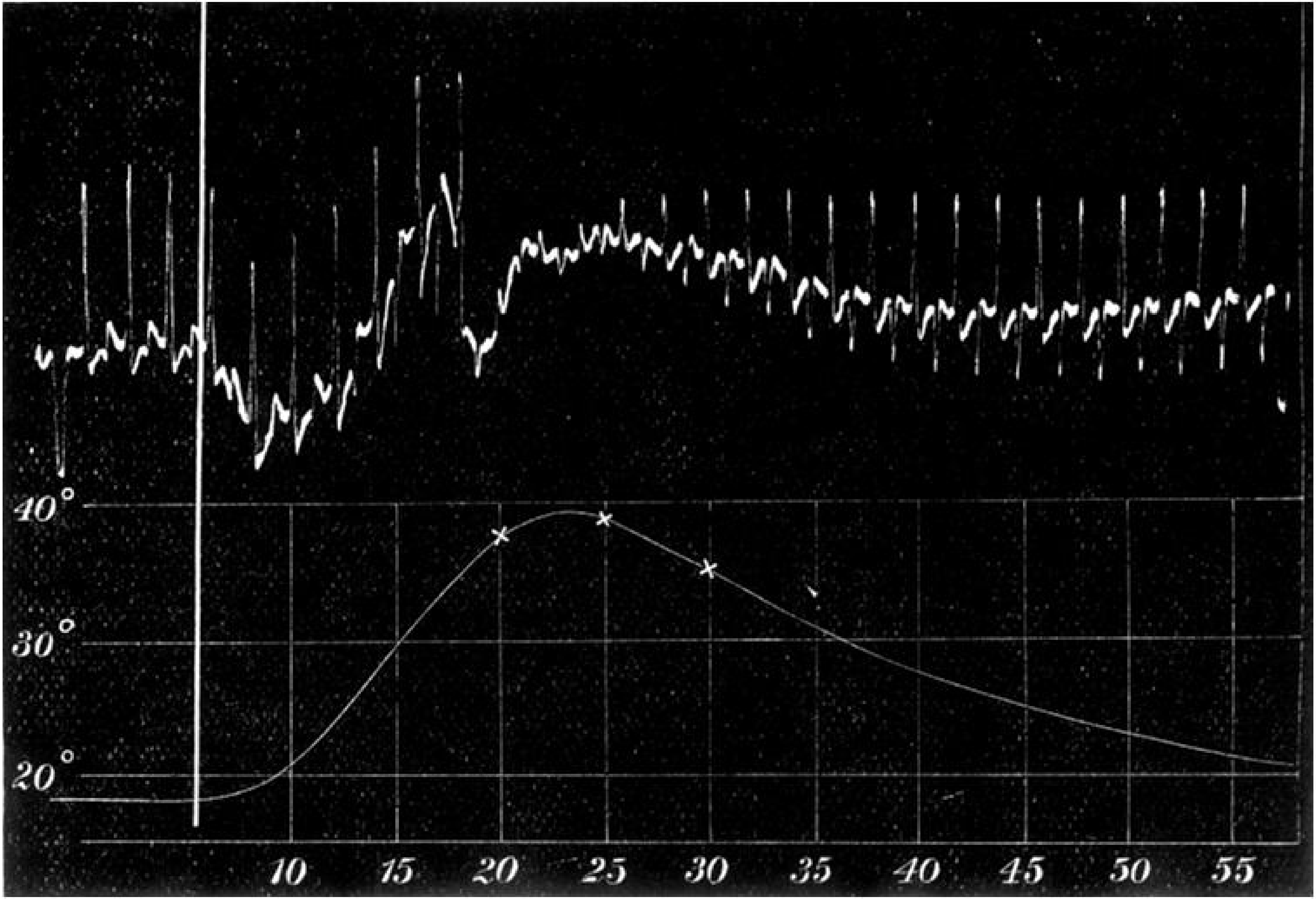
We propose now to give a concise but detailed account of the methods of analysis carried out on the metal and the ore, and the determination of the quantity of gallium present.

Examination of the Blast Furnace Metal.

Method of Analysis.—The very large proportion of iron rendered the application of some special method of analysis necessary for the separation of metals present in minute proportions, and for the qualitative and quantitative examinations of the separated substances. We have successfully employed fractional precipitations and the spectrographic analysis of the precipitates, supplemented by gravimetric determinations of the purified gallium sesquioxide.

The sample of metal first received consisted of two small ingots, each weighing about 230 grams; small pieces, broken with difficulty

* 'Roy. Soc. Proc.,' vol. 60, p. 35, 1896.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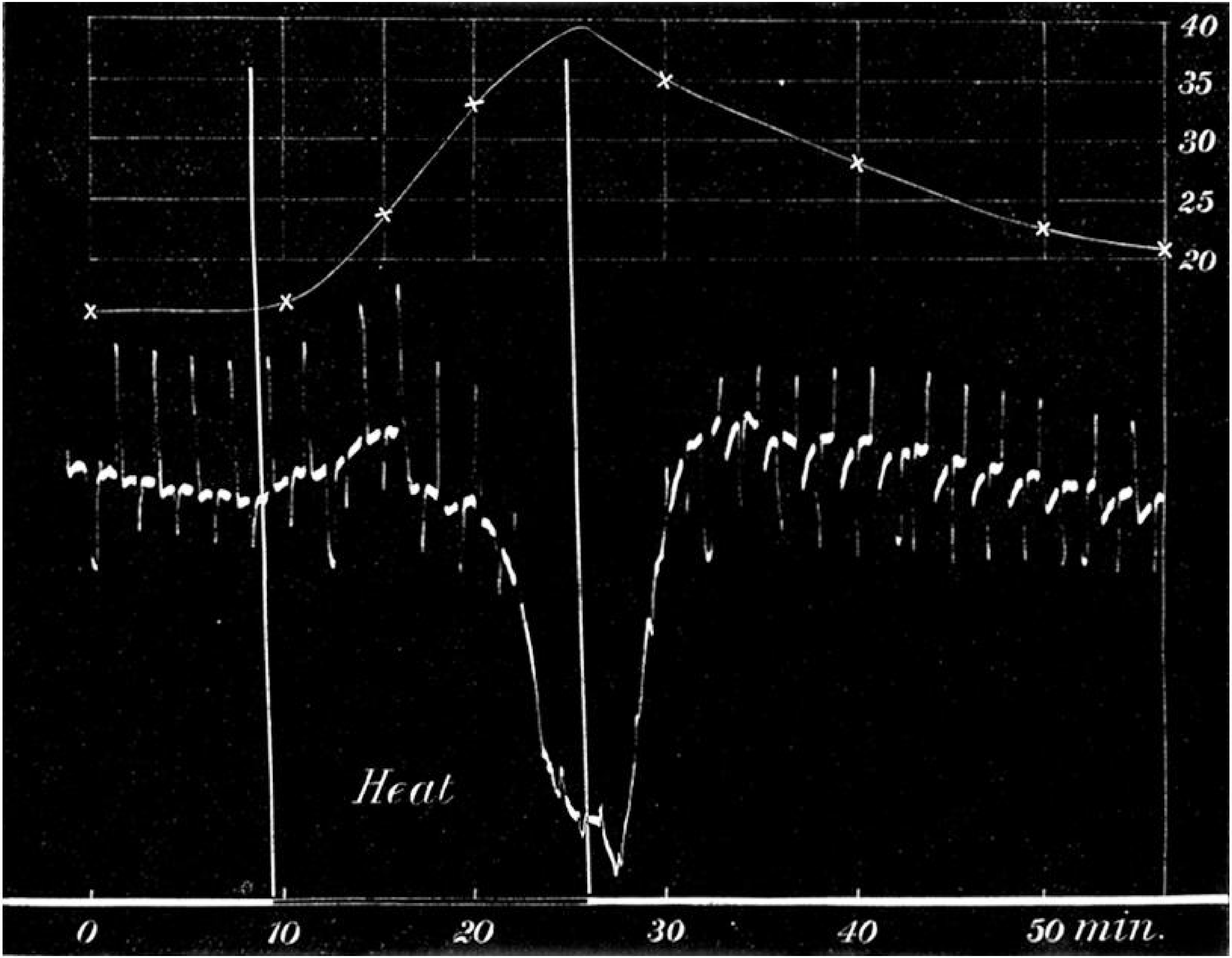
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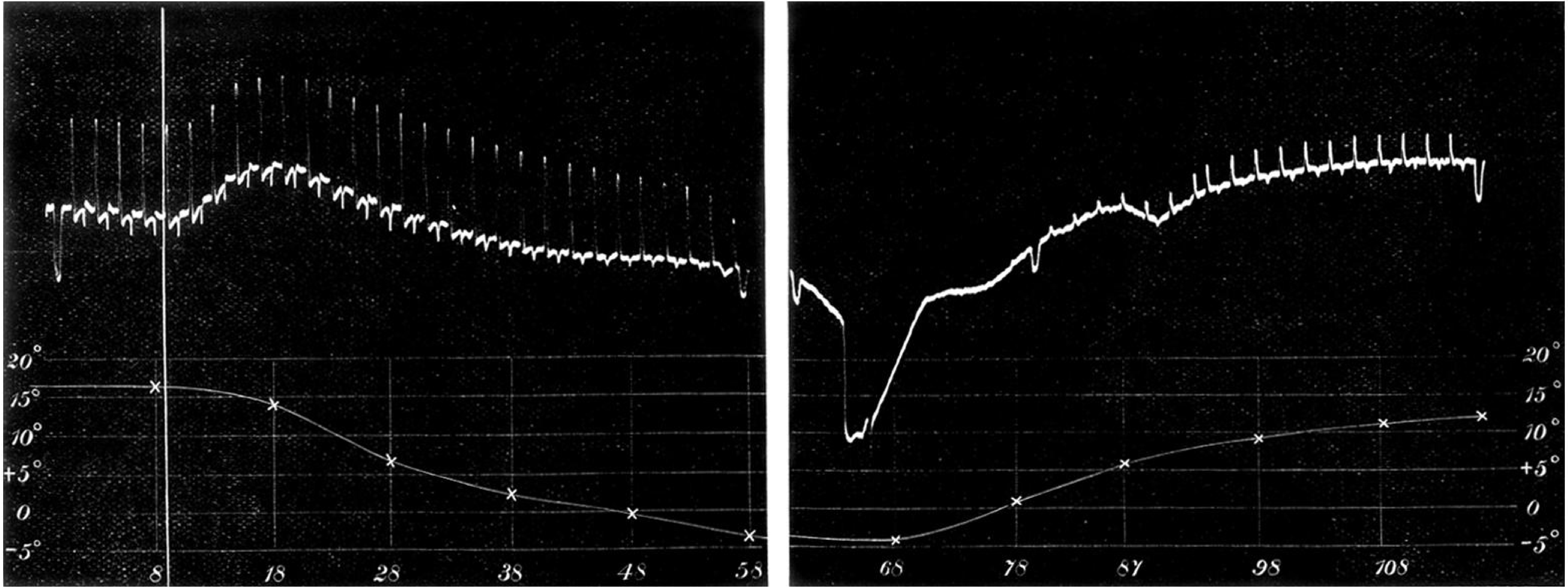
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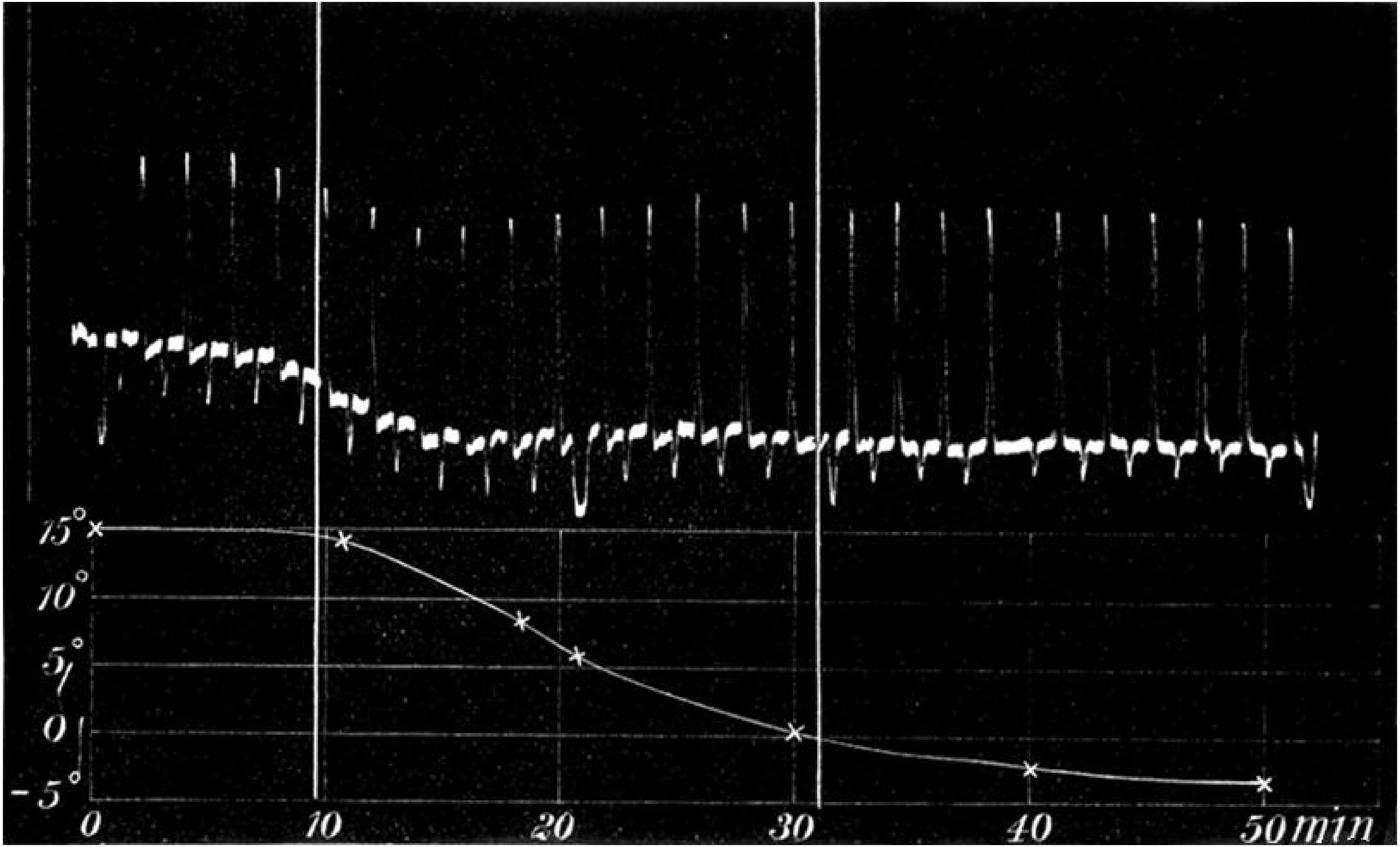
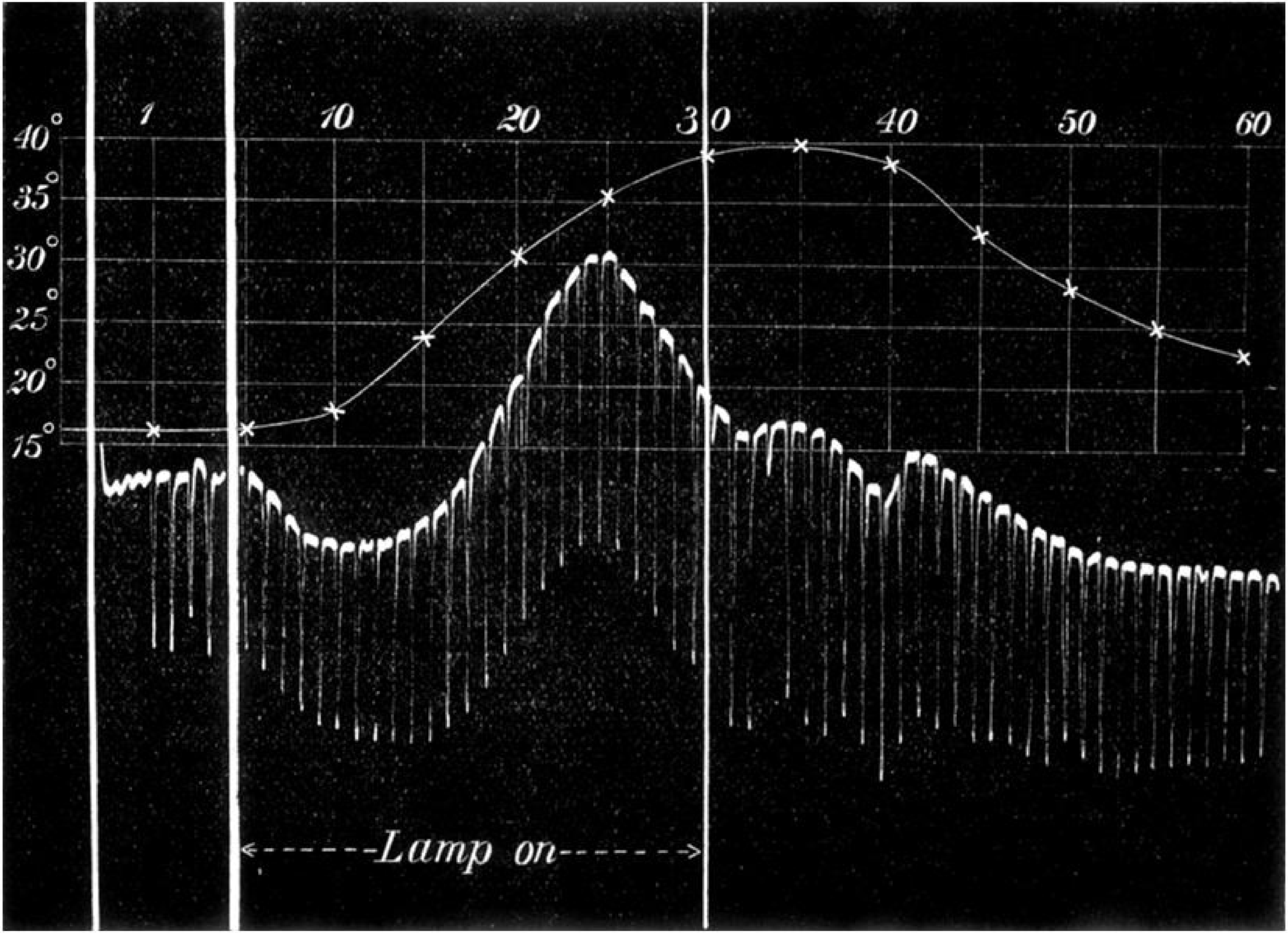


Exp. 2344.—Influence of Alterations of Temperature upon the Electrical Resistance of Nerve.



1
10
20
30
40
50
60
40°
35°
30°
25°
20°
15°
Lamp on