

University of Glasgow, Physiological Department : collected papers / edited by D. Noël Paton, M.D., B.Sc., F.R.C.P. Ed., Regius Professor of Physiology.

Contributors

Paton, Diarmid Noël, 1859-1928.
University of Glasgow. Department of Physiology.
University of Glasgow. Library

Publication/Creation

[Glasgow] : University Press, 1910.

Persistent URL

<https://wellcomecollection.org/works/uqmew258>

Provider

University of Glasgow

License and attribution

This material has been provided by The University of Glasgow Library. The original may be consulted at The University of Glasgow Library. where the originals may be consulted. Conditions of use: it is possible this item is protected by copyright and/or related rights. You are free to use this item in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s).



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

University of Glasgow

PHYSIOLOGICAL DEPARTMENT

COLLECTED PAPERS

No. I

EDITED BY


D. NOËL PATON, M.D., B.Sc., F.R.C.P. Ed.

REGIUS PROFESSOR OF PHYSIOLOGY



UNIVERSITY PRESS

1910



Digitized by the Internet Archive
in 2016

<https://archive.org/details/b2493477x>

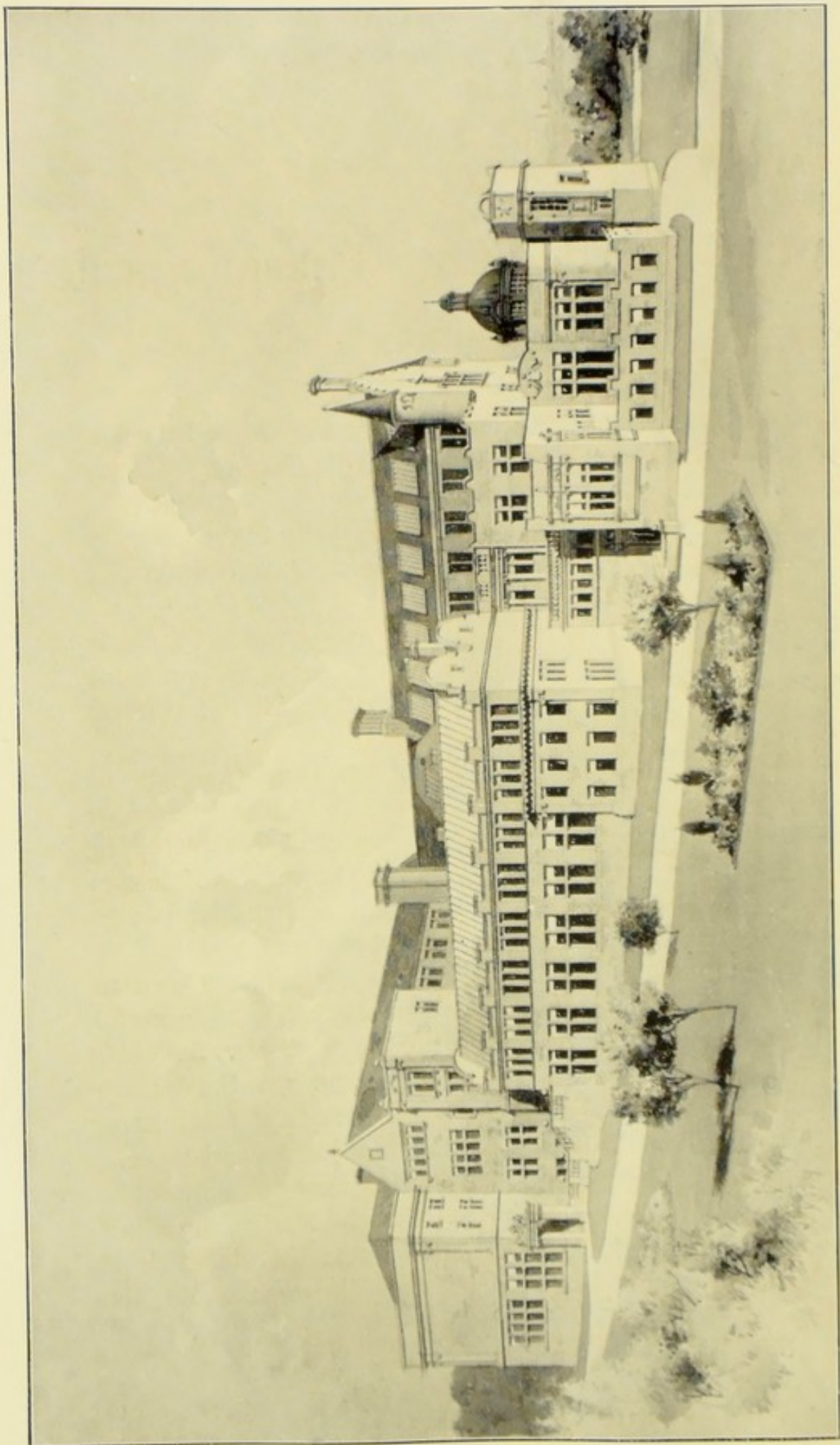
List of Papers.

Description of New Physiological Department.

1. On the Source of the Amniotic and Allantoic Fluids in Mammals. By D. NOËL PATON, M.D., B. P. WATSON, M.D., and JAMES KERR, B.Sc. (*Transactions of the Royal Society of Edinburgh*, vol. xlvi. Part I. (No. 3), 1907.) In separate cover.
2. On Metabolism during Starvation. Part I. Nitrogenous. By E. P. CATHCART, M.D. (*Journal of Physiology*, vol. xxxv, 1907.)
3. Metabolism during Starvation. Part II. Inorganic. By E. P. CATHCART, M.D., and C. E. FAWSITT, D.Sc. (*Journal of Physiology*, vol. xxxvi, (No. 1), 1907.)
4. Über die Zusammensetzung des Hungerharns. By E. P. CATHCART. (*Biochem. Zeitschrift*, vol. vi, 1907.)
5. On the Effects on the Metabolism produced by Chloroform Administered by Different Channels. By D. NOËL PATON, M.D. (*Proceedings of the Royal Society of Edinburgh*, vol. xxviii. Part IV. (No. 32), 1908.)
6. On the Rate of Elimination of Chloroform when Administered by Different Channels. By DOROTHY LINDSAY, B.Sc., and D. NOËL PATON, M.D. (*Proceedings of the Royal Society of Edinburgh*, vol. xxviii. Part IV. (No. 33), 1908.)
7. On the Histological Changes in the Liver and Kidney after Chloroform Administered by Different Channels. By G. HERBERT CLARK, M.B. (*Proceedings of the Royal Society of Edinburgh*, vol. xxix. Part V. (No. 26), 1909.)
8. On the Creatin-Creatinin Contents of Frog's Muscle. (Preliminary Communication.) By T. GRAHAM BROWN and E. P. CATHCART. (*From the Proceedings of the Physiological Society*, March 21st, 1908. *Journal of Physiology*, vol. xxxvii.)
9. The Effect of Work on the Creatin Content of Muscle. By T. GRAHAM BROWN and E. P. CATHCART. (*Biochemical Journal*, vol. iv, 1909.)
10. The Influence of Carbohydrates and Fats on Protein Metabolism. By E. P. CATHCART. (*Journal of Physiology*, vol. xxxix, 1909.)
11. Creatin Excretion in the Bird and its Significance. By D. NOËL PATON. (*Journal of Physiology*, vol. xxxix, 1910.)

12. A Method for the Estimation of the Urea, Allantoin, and Amino Acids in the Urine. By DOROTHY E. LINDSAY, B.Sc., Carnegie Scholar. (*Biochemical Journal*, vol. iv, 1909.)
13. Studies in the Reflexes of the Guinea-Pig. I. The Scratch-Reflex in relation to "Brown-Séquard's Epilepsy." By T. GRAHAM BROWN. (*Quarterly Journal of Experimental Physiology*, vol. ii, 1909.)
14. II. Scratching Movements which occur during Ether Anaesthesia. By T. GRAHAM BROWN. (*Quarterly Journal of Experimental Physiology*, vol. iii, 1910.)
15. III. Effect of Removal of the Cortex of One Cerebral Hemisphere. By T. GRAHAM BROWN. (*Quarterly Journal of Experimental Physiology*, vol. iii, 1910.)
16. A Scratch-Reflex in Guinea-Pigs after Removal of Parts of the Cerebral Cortex. By T. GRAHAM BROWN. (*Proceedings of the Physiological Society. Journal of Physiology*, vol. xxxviii, 1909.)
17. The "Anaesthetic Scratch" in Guinea-Pigs. By T. GRAHAM BROWN. (*Proceedings of the Physiological Society. Journal of Physiology*, xxxviii, 1909.)
18. Binaural Localisation of Sound. By T. GRAHAM BROWN. (*Proceedings of the Physiological Society. Journal of Physiology*, xl, 1910.)
19. On the Development of the Plexiform Nerve Mechanism of the Alimentary Canal. By S. JEAN MEIKLEJOHN, M.B. (*Preliminary Communication.*) (*Journal of Physiology*, xxxvi, 1908.)
20. The Development of the Autonomic Nervous Mechanism of the Alimentary Canal of the Bird. By WILLIAMINA ABEL, M.D. (*Proceedings of the Royal Society of Edinburgh*, 1910.)
21. On Delay or Retardation of the Pulse as a Sign of Aneurysm. By LEONARD FINDLAY, M.D. (*The Practitioner*, December, 1909.)
22. The Significance of Certain Changes in the Composition of the Urine. By D. NOËL PATON. (A Lecture delivered to the Glasgow Medical Chirurgical Society.) (*Glasgow Medical Journal*, March, 1910.)
23. The Results of Ligature of the Fallopian Tube in the Rabbit. By A LOUISE M'ILROY, M.D. (*Journal of Obstetrics and Gynaecology*, March, 1910.)





NORTH ELEVATION OF THE MEDICAL BUILDINGS—UNIVERSITY OF GLASGOW.
THE PHYSIOLOGICAL DEPARTMENT IS TO THE RIGHT.

Description of the New Physiological Department.

IN sending out this first collection of papers from the new Physiological Department of the University of Glasgow, it may be of interest to give a short description of the Department.

For many years the teaching of Physiology in the University had been conducted under adverse conditions, the facilities for practical teaching being inadequate.

In 1902 it was decided that an endeavour should be made to provide suitable laboratory accommodation for Physiology as well as for Materia Medica and Public Health, and for Natural Philosophy.

A sufficient sum having been provided by the generosity of the public of Glasgow and the neighbourhood, and by the Carnegie Trust, the new buildings were begun in 1903 and completed in 1907. The buildings were formally opened by their Majesties King George and Queen Mary, then Prince and Princess of Wales, on April 23, 1907. Mr. J. Miller was the architect.

The general plan of the Physiological Department we owe to my predecessor, Professor M'Kendrick, and we must be grateful to him for the care and trouble which he gave to the work. For the fittings and equipment I am responsible, and my thanks are due to Dr. Cathcart, Grieve Lecturer on Physiological Chemistry, and to Dr. Clark, Senior Assistant, for much valuable assistance.

The Physiological Department forms the western part of a building in which the Departments of Materia Medica, Medical Jurisprudence, and Public Health are also housed, and which is situated between the main building of the University and the Western Infirmary.

GROUND FLOOR.

This consists of (1) a large Lecture Theatre which, with some necessary rooms, projects from the west gable of the main building

(see elevation—extreme right, and plans). The students' entrance is on the west end. It opens into a small vestibule from which, to the right, a spiral stair leads to the back of the class room, and a students' cloak room and lavatory (situated under the seats of the class room) opens. A passage leads along the north side of the lecture room, and from this opens a **Diagram Room**, 14 ft. by 14 ft., and the **Professor's Retiring Room** and lavatory.

The **Lecture Theatre** is 47 ft. by 45 ft. and 27 ft. in height. It is lighted by two large windows on the south wall, by two smaller windows on the north wall, and by a cupola. The windows are provided with light proof blinds. The theatre is seated for about 200 students, the seats being hinged wooden chairs which can be thrown back, arranged in rows with a desk in front of each row. They rise from the floor at a high angle, so that the back row is 16 ft. above the floor. The lecture table is on the east side of the room. It consists of (i) a fixed part 8 ft. 2 in. by 3 ft. 2 in. fitted with a deep sink with hot and cold water, a short piece of shafting running across one end and driven by a small motor placed below, a switch board with terminals similar to those to be described in the Experimental Laboratory, and supplied from there, and suitable drawers and cupboards. (ii) A similar table mounted on casters, so that it may be moved from place to place to make room for a third table, also mounted on casters, which may be placed between the first two and thus give an additional 5 ft. 2 in. by 3 ft. 2 in. of table space.

This third table may be withdrawn from the lecture room through an opening in the east wall 6 ft. 10 in. in width and 6 ft. 6 in. in height, which may be closed by a sliding door and which gives entrance from the lecture room to the Lecture Preparation Room. Demonstrations may thus be prepared on this table in the Preparation Room and then wheeled into the Lecture Theatre.

The white distempered wall above this entrance is used as a lantern screen, the lantern being mounted in the middle of the room.

On each side of this entrance are two ground glass black boards, 9 ft. by 4 ft. 6 in., while a sliding wooden board may be drawn over the entrance giving an additional 28 square feet of space.

From the upper part of this wall are suspended the diagram screens.

The students' entrance is at the top of the tiers of seats. The lecturer's entrance is on the north wall opposite the door of the Professor's room. A door communicates with the Preparation Room, while a fourth door opens upon the central vestibule of the Department and is used by women students.

Lecture Preparation Room. This is 35 ft. by 12 ft. and is lighted by a large window on the south wall. Along the east wall run glass cases with cupboards for material required for lectures and demonstrations. The window is fitted with a bench, 11 ft. 11 in. by 3 ft. 4 in., provided with hot and cold water and gas.

Library and Museum. This room lies to the east of the last, with which there is a door of communication. It is 36 ft. by 27 ft., and is lighted by three large windows on the south wall. This side of the room is divided into three bays by double bookcases projecting 7 ft. 6 in. from between the windows. Along the east side of the room runs a large glass case containing apparatus and specimens, and further accommodation for these is afforded by a table along the north wall upon which are small glass cases of various sizes, and by a glass case in the middle of the room.

This room opens off the **Central Vestibule**, which is 25 ft. by 21 ft. A passage from the students' entrance opens into this, while a second entrance from the outside is situated on the north wall, beside which is the cloak room and lavatory for women students. From the vestibule the main staircase ascends.

A passage passing east from the vestibule leads to a **Metabolism Room**, 37 ft. by 35 ft. It is lighted by three large windows on the south side, and by a window on the east side. It has a concrete floor sloping to an aperture in the centre, covered by an iron grating and leading through an earthenware trap to a wide drain to allow of a thorough flushing of the floor. It is fitted with cages for metabolism experiments.

The south-east corner of the room, including two windows, has been divided off, 14 ft. 7 in. by 12 ft. 5 in., to serve as a room for **Respiration Experiments**, and this is fitted with a respiratory calorimeter and a bullion balance. Beside the Metabolism Room is a **Research Room**, 17 ft. 6 in. by 13 ft., and a large **Store Cupboard**.

The **Service Stair** to the first floor is beside the door of this room. A passage runs along the north side of the Metabolism Room. This gives access to the **Centrifuge Room**, 14 ft. 8 in. by 13 ft. 2 in., fitted with large Runne Centrifuge and motor and with a dry air **Refrigerator**. From this opens a room used for preparing distilled water, and on the north side of this is built an **Incubating Chamber**, consisting of a vestibule, 6 ft. long by 3 ft. 3 in. broad, from which opens the chamber itself, 6 ft. 7 in. long, 6 ft. broad, and 8 ft. 6 in. high, furnished with four shelves on each side and heated by means of an automatically regulating gas stove checked by a Hearson's regulator.

Further along the passage are the **Service Room** and the **Attendants' Lavatory**.

A door at the end of the passage opens upon a small yard, on the north side of which is an **Animal House**, 16 ft. 4 in. by 22 ft., and on the east side another 15 ft. by 7 ft. The passage also communicates with the outside by a door in the south wall used for coal, etc., for the heating and ventilation of the building, the furnaces and engines for which are placed just to the east of the Department.

FIRST FLOOR.

A corridor, 84 ft. in length, runs along the north wall, and is lighted by a series of windows, one in the west wall, the others in the north wall.

Immediately opposite the top of the stair are (1st) the Retiring Room of the Grieve Lecturer on Physiological Chemistry, (2nd) the Assistant's Lavatory, and (3rd) the Balance Room.

The Service Stair opens at the east end of the passage. Half-way up it is a **Workshop**, 24 ft. by 18 ft., from which opens another room, 16 ft. by 15 ft., with concrete floor and a slow combustion stove, and fitted with a large cage for monkeys. Beside the top of the service stair a short stair on the north side of the passage leads to three **Research Rooms**, each about 18 ft. by 12 ft., and each provided with suitable window benches for work, and with sinks, hot and cold water and gas. Two of the rooms are fitted with slate shelves, with slate slabs on the wall behind for paraffin ovens.

Beyond the stair to these Research Rooms the passage opens upon a vestibule, 21 ft. by 12 ft., on the north side of which is the **Experimental Laboratory**, on the south side the **Chemical Laboratory**, on the east side the **Optical Room**, and on the west side the **Attendants' Room**. The **Assistant's Room** opens to the left of the Chemical Room.

The **Attendants' Room** is 20 ft. by 18 ft., and is lighted by two large windows on its west side. It is fitted with a long working shelf with hot and cold water and gas. Between the windows is a slate slab with slate back for a paraffin oven. Shelves and glass cases are placed on the north and south walls.

The **Assistant's Room** measures 22 ft. by 15 ft.

Experimental Laboratory. In the original plan this was intended to be one single room, 75 ft. long by 36 ft. broad, but it was subsequently divided, by means of a wood and glass partition, into a **Junior Class Experimental Room**, 50 ft. long, and a **Demonstration Room**, 25 ft. long, and fitted with four tiers of seats capable of seating 40 to 50 students. In this room are a large

kymograph, a Palmer's respiration pump, and a short shafting with a pulley for driving recording gear.

These laboratories are 18 ft. high, and are lighted from the north side by 12 windows arranged in pairs (see elevation above double tree), while two double windows open into the central well on the south and light the adjoining parts of the rooms. The windows extend from 4 ft. above the floor to about 1 ft. from the ceiling, and are 4 ft. broad.

The walls are tiled 6 ft. from the floor and white distempered above.

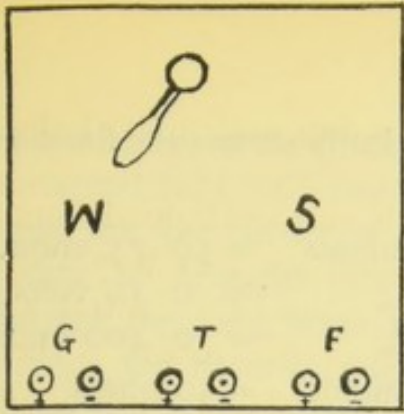
Junior Class Experimental Room. Four tables, each 23 ft. 4 in. long, 4 ft. 6 in. broad, and 2 ft. 9 in. high, run across the room, and each accommodates eight students, working in pairs, on each side, places for sixty-four students thus being provided. The ends of the benches have a tiled area 2 ft. by 4 ft., and under the tables are drawers and lockers. On the west wall of the laboratory, beside the door opening to the passage, are three wash-hand basins fitted with hot and cold water, and a sink, similarly fitted, and surrounded by a lead covered table which extends for 10 ft. towards the north windows. Extending from this to the north wall is a set of glass-doored cupboards with lockers below for storage of apparatus. Another sink is placed at the south side of the Demonstration Room, and a double frog tank with water supply and drainage stands in the window at the east end of the south wall of the Junior Laboratory.

A blackboard and diagram screen are placed against the middle of the south wall of the main laboratory.

For the purpose of supplying motor power to the recording cylinders, a $\frac{1}{4}$ h.p. electric motor is placed underneath the north end of the table nearest to the entrance door, and a belt passes from this to a gear wheel on a length of shafting running across the window ends of the tables, fixed 6 ft. 9 in. above the floor, supported on uprights on each table, and passing from the west table through the east wall of the laboratory to the Demonstration Room.

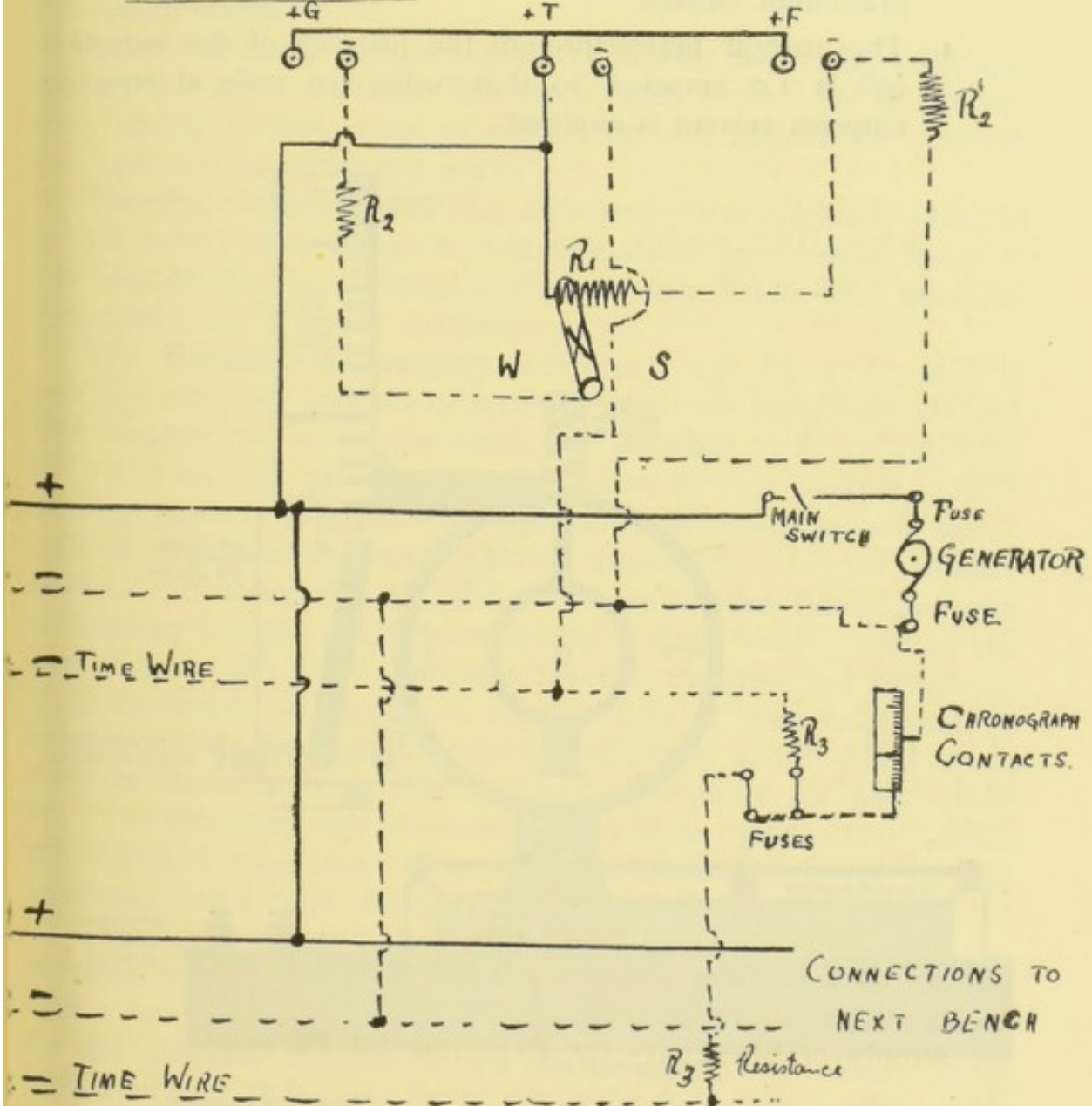
The power is taken from this shaft to three-gear driving pulleys on a shafting placed along the middle of each of the four tables at 7 in. above the table top.

Supply of Electricity for Experimental Purposes. Alongside the driving motor is a motor generator with a maximum output of 1000 watts, and supplying current at from 15 to 30 volts. From the motor generator wires pass as in Fig. 1 to vulcanite switchboards four of which are placed on each side of each table (Fig. 1). Upon these are three pairs of terminals, marked F, for the induction coils G, connected with a sliding resistance marked R_1 in the diagram for galvanic and T for time marking. The last is connected with a chronograph giving seconds, tenths, and hundredths of a second.



SWITCH BOARD CONNECTIONS

UNDER TABLE



+ WIRES — CONTINUOUS LINES
 - WIRES — BROKEN LINES

FIG. 1. Plan of switchboard as used in the Experimental Laboratory. (1) Shows the vulcanite slab with three pairs of brass terminals labelled G, T and F, and each marked + or - as required. The small handle figured at the upper part of the switch is connected with the metal tongue shown in the second figure and marked X.

(2) Shows the under-table wiring. The resistances R_2 and R_3 are simply placed in circuit to prevent injury to the apparatus by accidental short-circuiting. The resistance R_1 is in the G circuit, and by moving the metal tongue X towards S the current is increased.

The continuous lines represent the positive wires, while the broken lines represent the negative wires.

With the arrangement diagrammatically shown, the following results are obtained.

1. Resistance between G terminals = 50-75 ohms.
E.M.F. between " " = 0-10 volts.
Current between " " = 0-400 milliamperes.
2. Resistance between T terminals = 50 ohms.
Maximum current = 0.4 amperes.
3. Resistance between F terminals = 13.3 ohms.
Maximum current = 1.5 amperes.
4. The current taken through the primary of the induction coil is 1.0 amperes, so that, using 30 coils at once 30 amperes current is required.

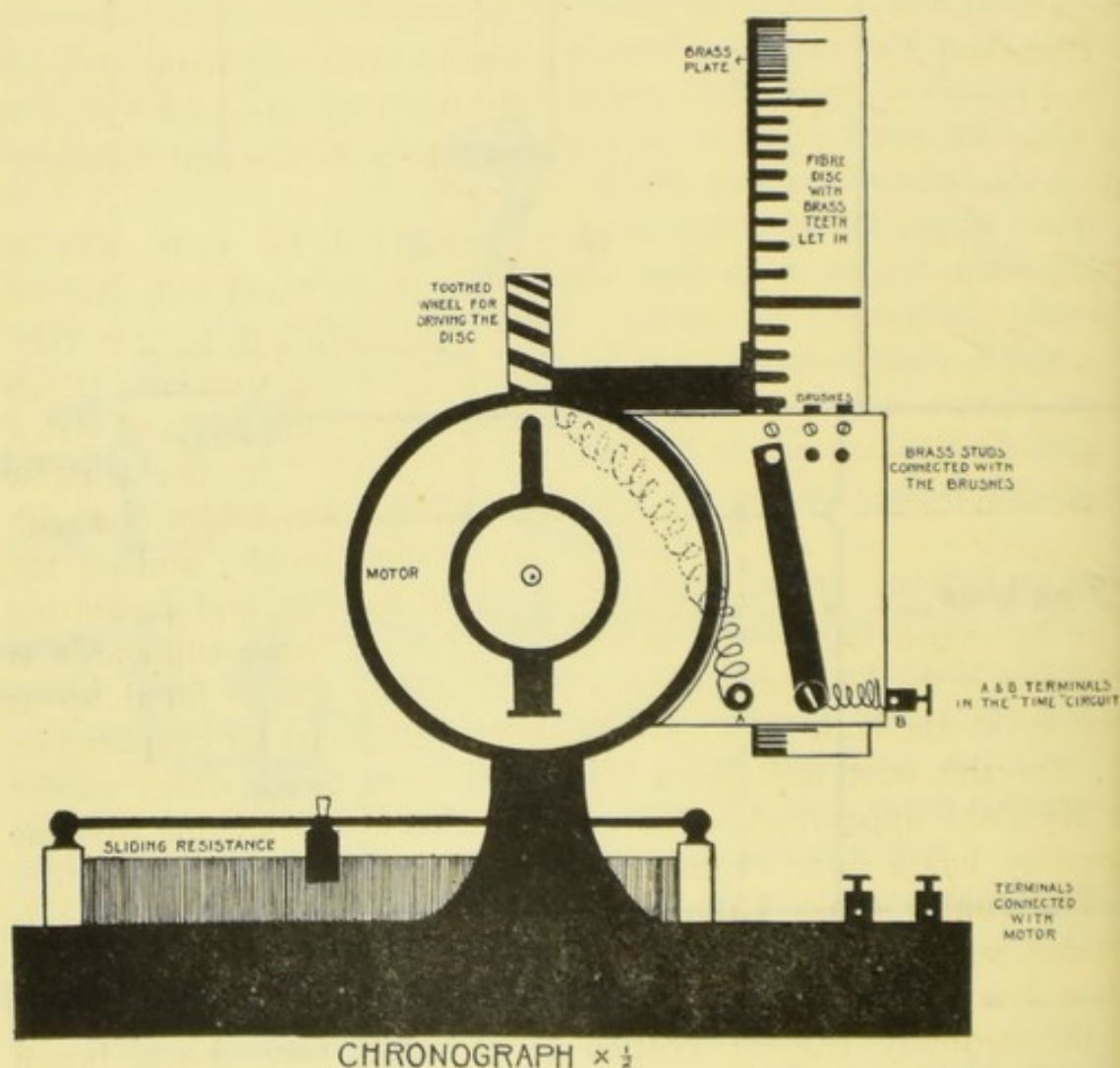


FIG. 2. Chronograph arranged to record one-hundredths of a second.

The **Chronograph** (Fig. 2) consists of a revolving disc 2 in. thick at the free margin, actuated by a small motor whose speed can be modified by moving a small sliding resistance. The disc itself is made of fibre with a brass plate round one side, and a hundred teeth extending from this plate on the surface of the disc perpendicularly to the border and equidistant one from another.

Of the teeth, one extends almost to the other border of the disc, nine more extend fully half-way across, and the remainder are short. Playing upon the free border of the disc are three brushes, any one of which may be brought into the circuit, and thus the current passing through the axle, brass plate and teeth to the brushes may be broken once, ten times or one hundred times per second.

Adjoining the Experimental Laboratory, and at the south side of it, is the **Optical Room**—23 ft. 6 in. long by 12 ft. wide. This room is painted black and the two windows are covered with light proof blinds.

Upon the north wall is a table 15 ft. long and 18 in. wide, and against the south wall are four stalls, each fitted with an electric lamp having a wide range of movement, and suitable for ophthalmoscopic and laryngoscopic work.

Chemical Laboratory.—This Laboratory was originally planned as one room, 76 ft. by 35 ft., but like the Experimental Room it has been divided by a similar partition into a Senior and Research Laboratory and a Junior Laboratory.

The **Research Laboratory** measures 35 ft. by 31 ft., and is provided with two benches with centre partitions fitted with shelves. The benches run across the room and measure 22 ft. by 4 ft. 6 in. by 2 ft. 9 in., and provide accommodation for 14 workers. Each working place is supplied with high pressure steam, gas and water, as well as three drawers and two cupboards. In the window recesses and along the east wall there are wooden tables, one with a dialysing trough; on the north wall a slate bench; and on the west wall are the fume cupboards, three in number, and measuring 58 in. in length and 33 in. in depth. One of these cupboards is connected with the high pressure steam supply and is fitted up as a copper steam bath (in four independent sections) for evaporation, etc. On this west wall there is another slate bench which carries the Kjeldahl apparatus. One of the windows belonging to this laboratory has a fume chamber fitted outside,

The **Junior Class Laboratory** measures 45 ft. by 35 ft., and is provided with four working benches running across the room, each with a low partition (one foot high) carrying a shelf on each side for the ordinary reagent bottles in common use. Each bench measures 20 ft. 8 in. by 4 ft. by 2 ft. 9 in. in height, and provides accommodation for 16 workers—thus 64 can be taken in one class. Each working place is supplied with gas, water and one drawer and one cupboard. The lecturer's table stands to the north side of the room. It is provided with gas, steam and water.

Both laboratories have the walls lined from floor to ceiling with white glazed tiles. Each bench is provided with an acid trap which ensures any acid waste being well diluted before it

reaches the waste pipe. From each table-sink to the acid trap the waste is carried in an open wooden trough rendered water tight with tar. The waste is led away from each table to the main waste pipe, which runs down the outside of the building, by means of channels cut in the concrete floor (beneath the wood lining) and coated with asphalt. The main waste pipe itself is lined with glass enamel. The gas supply is distributed in pipes of $1\frac{1}{2}$ in. diam. The taps, more particularly at those places where a good supply of gas is desired, *e.g.* Kjeldahl bench, are of wide bore ($\frac{1}{2}$ in. at mouth of tap).

In addition to the laboratories there are attached to the Chemical Department (1) a **Balance-Room** equipped with three Bunge balances and a large weighing machine for metabolic work. (2) A room used as a **Blow-pipe** and **Combustion Room** fitted with a slate table and an abundant supply of gas and water. In this room one of the windows is fitted as a fume chamber. (3) The **Chemical Lecturer's Room**.

TOP FLAT.

In the original plan a room ran the whole length of the north side of the department and was 100 ft. in length by 40 ft. in breadth. It has been divided by a wooden and glass partition into two equal parts, one of which, that to the west is reserved for **Histology**, and the other fitted for **Experimental Psychology**.

Histology Laboratory. This is 50 ft. by 40 ft. It is lighted by a continuous range of windows along the north wall and by roof lights. The roof is a double tilt, the north side of each tilt being glazed (see Elevation). A line of steam pipe is carried under each window to prevent condensation. This laboratory is fitted with a long bench below the windows, 10 ft. of which is of slate for paraffin ovens.

The students' working tables run along the room, a distance of 5 ft. intervening between them. Each is 36 ft. long, 2 ft. 6 in. broad, and 2 ft. 7 in. high. The top is of teak, and at the back of the table runs a lead covered gutter, $4\frac{1}{2}$ in. broad, which slopes to the middle of the table and opens through an earthenware trap into the drain. There are places for sixty-four students, and between each pair is a water tap with a two-way jet, each opening of which is above the gutter and opposite a student. A three-way gas jet is placed between each pair of students—the central small tube being used to heat a metal plate for melting paraffin on slides, etc.

A glass case with cupboards below runs along the south wall and is used for storing microscopes, etc., and a large slate sink, 6 ft.

long by 2 ft. 8 in. broad, is placed at the south-west of the corner room for injections and similar purposes.

To the right of the top of the stair is the **Histology Preparation Room**, fitted with a working bench, sink, water, and gas in the windows, which open to the east. Store shelves and a working bench run along the south and west walls. This room is generally used as a Research Room.

At the west end of a short passage there is a **Research Room** fitted with working bench and fittings in the window. From this, the **Photographic Room**, 12 ft. by 8 ft. 6 in., opens. It is fitted with a large Zeiss Photomicrographic apparatus. On its east side a dark room 8 ft. 6 in. by 5 ft. 6 in. has been divided off. It is fitted with sink and lead draining tray and three rows of shelves.

The **Experimental Psychological Laboratory** occupies the same extent of floor as that of the Histological Laboratory, viz., 50 ft. by 40 ft. It is divided in its longer dimension into two equal parts, one of which is used as a teaching laboratory, while the other is further divided into four equal small rooms, 12½ ft. by 20 ft., for separate work. In the laboratory, movable tables, 5 ft. by 2¾ ft. by 2 ft. 10 in. high, which each seat four students, are in use. Of these four students, the two experimenters sit on the same side of the table, and are separated from the two observers by a curtain thrown over a brass chain, which is supported at a height of 18 in. from the table by two upright brass rods clamped to the table, one at each end. Shafting runs across one side of the room, and by it rotators can be run with great range of variation of speed. At four points in the floor are plugs connected with the supply of low voltage current from the dynamo in the Experimental Laboratory.

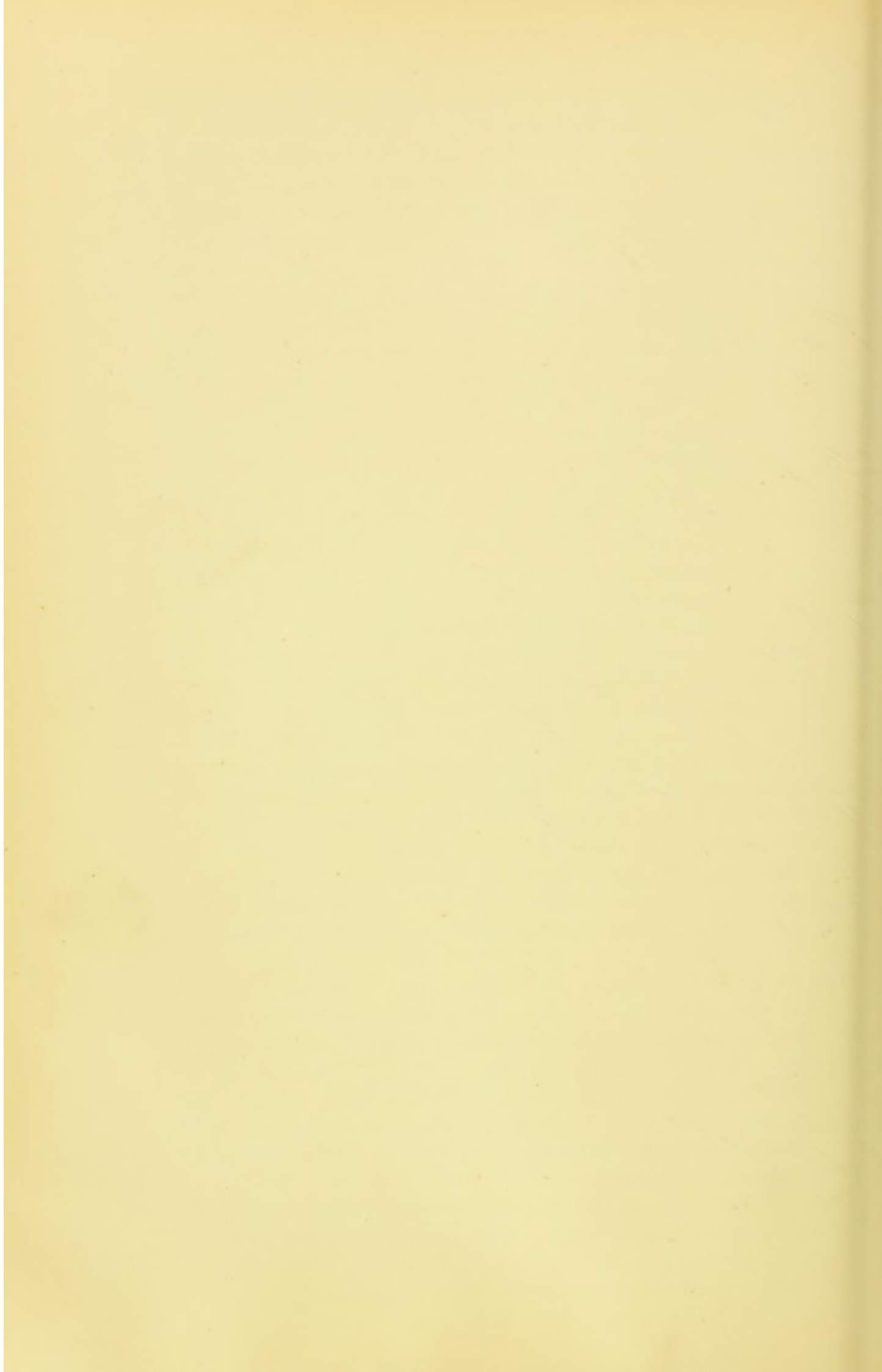
The Laboratory provides accommodation for some 40 students working simultaneously, and can be extended by the addition of one of the neighbouring small rooms separated by a sliding partition.

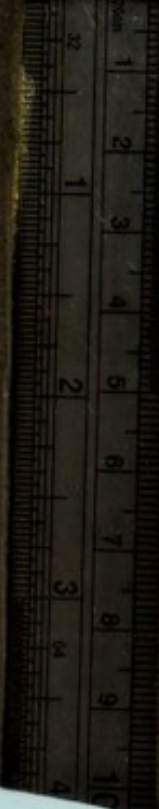
The floors throughout the Department are constructed of concrete laid upon rolled steel joists. The concrete is finished on the top with a layer of asphalt, and the floor boards are laid direct on this and nailed down to the concrete.

The ceilings are suspended from the lower flange of the floor joists, thus forming a hollow space which acts as a non-conductor of sound. They are so free of vibration that a galvanometer may be used anywhere.

The working benches and tables are covered with teak, and where there is a supply of gas and water this is controlled at the end of each bench.







DICTARY
SOME TIGHT
GUTTERS

