The laboratory was opened by Prof. J. Perry, F.R.S., on November 24 in the presence of a large company, including members of the Corporation, prominent manufacturers, and business men. The dimensions of the laboratory are 141 feet by 42 feet, with a mean height of 20 feet. The building is fitted with two travelling cranes. It has an upper floor and a lower floor, between which are placed the lines of shafting, the piping for engines, and all similar accessories.

The installation includes steam-driven machines, electric generating plant, oil engine, gas engine, petrol engine, centrifugal pumps, turbines, and refrigerating machine. There is also a full range of smaller testing appliances necessary for the complete training of an engineer.

The detailed list of appliances is a very lengthy one. The steam generating section includes a Lancashire boiler measuring 30 feet by 8 feet, and a marine-type boiler measuring 14 feet by 11 feet, together with pumps, meters, economiser, superheater, feed-water heater, induced draught fan, pressure and temperature indicators, &c.

The steam section comprises a steam engine of the horizontal cross-compound type of 60 horse-power, built by Messrs. Combe Barbour, of Belfast; a 20 horse-power high-speed generating set built by Messrs. W. H. Allen and Co., of Bedford; a 15 kilowatt Parsons steam turbo-alternator; a De Laval turbine of 20 horse-power; a steam pump and a condensing plant.

The hydraulic section is exceptionally well designed and equipped, and includes a motor-driven high-lift turbo-pump, cast-iron channels, tank, tumbling bay, venturi meter, pitot tubes, Thomson turbine, Girard turbine, Pelton turbine, and an apparatus for experiments on pipe friction.

The testing of materials section contains a Riehlé testing machine of 68 tons capacity, on which experiments may be made in tension, compression, bending, and torsion; an Adie machine for cement testing; a fatigue testing machine, designed by the professor of mechanical engineering (Dr. Smith); appliances for the microscopical examination of metals; a "hardness of metals" tester; and various other appliances.

The section of internal-combustion machines includes a gas engine, a suction-gas plant, an oil engine, and a petrol engine. Additional fittings are a main switchboard of special design, an air-compression plant, a refrigerating plant, and an electrical direct-driven fan of "Sirocco" pattern. There are, in addition, all the necessary subsidiary appliances, such as calorimeters, micrometer, and other gauges, indicators, anemometer, &c.

The workshop adjoining the mechanical engineering laboratory is exceptionally well fitted with up-to-date machines, amongst which are a universal milling machine, a high-speed planer, a high-speed screw-cutting lathe, a boring and surfacing lathe, a Hendy-Norton screw-cutting lathe, a vertical automatic drilling machine, a shaping machine, together with grinding machines, brazing apparatus, vices, and other adjuncts found in a well-equipped machine shop. Adjoining the machine shop is a pattern shop, which contains a hand-turning lathe, circular saw, band saw, universal wood-cutter, and the requisite supply of benches.

The Plenum ventilating and heating plant also forms part of the mechanical engineering equipment of the institute, and from time to time it is used in the instruction of students and for experimental purposes.

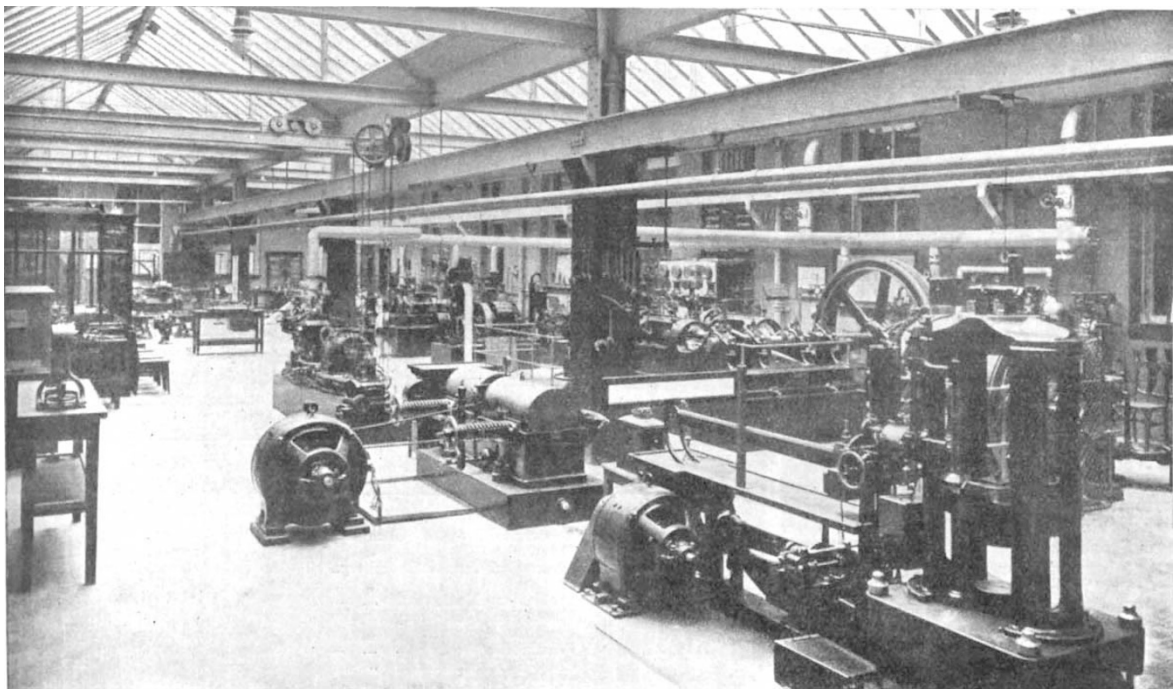

*Photo.*] New Mechanical Laboratory, Municipal Technical Institute, Belfast. [*A. R. Hogg.*

The city of Belfast can now claim to possess a mechanical engineering equipment as comprehensive as that of any technical institution of the United Kingdom.

## *SCIENCE EXAMINATIONS AND GROUPED COURSE CERTIFICATES.*[1]

CIRCULAR 776 was issued by the Board of Education on June 20, 1911, which date was near the commencement of the long vacation, and made it practically impossible for the governing authorities of technical institutions to introduce any necessary amendments into the schemes of instruction for the present session. In its general arrangements the scheme is, without doubt, excellent, and teachers familiar with certain of the local group course systems will probably at first conclude that it will fit the modern conditions of the group course system very accurately. More careful study, however, reveals the fact that there

[1] From an address delivered before the Association of Teachers in Technical Institutions on November 11 by Mr. Barker North, ex-president of the Association.

are enormous difficulties in the way of its immediate adoption, and the smaller technical institutions in particular will be very hard hit by the condition bringing the scheme into operation during the present session. These difficulties exist with reference to both day and evening work, but it is in connection with the latter that the matter is one of great urgency, and the following remarks will therefore deal only with the principal changes affecting evening instruction.

A. *Changes in Subjects and Stages foreshadowed in the Circular.*—(1) The abolition of all Stage I. and practical examinations; (2) the abandonment of all examinations held by the Board in the following subjects: sound, light, geology, mineralogy, physiology, general biology, zoology, botany, navigation, nautical astronomy, physiography, agricultural science, hygiene, and elementary science of common life; (3) principles of mining becomes coal-mining only; (4) for the purpose of constituting examining boards, to include teachers in technical schools, the subjects retained will be grouped as follows: (*a*) pure and applied mathematics, (*b*) engineering, (*c*) physics, (*d*) chemistry, (*e*) mining and metallurgy; (5) there will be two stages only in each subject, viz. "lower," corresponding to the old Stage II. examinations, and "higher," the standard being intermediate between the old Stage III. and honours examinations; (6) in each grade of each subject, one paper only will be set, with the exception of "higher" pure mathematics, in which two papers will be given.

B. *Conditions of Admission.*—(1) A fee of 3*s.* 6*d.* must be paid by the candidate for each stage in each subject; (2) candidates must be over seventeen years of age on July 31 following the examination; (3) students taking full-time *day* courses will only be admitted under special conditions; (4) in the following subjects: theoretical mechanics (solids), theoretical mechanics (fluids), applied mechanics (materials and structures), applied mechanics (machines and hydraulics), heat engines, heat, magnetism and electricity, inorganic chemistry, organic chemistry, and metallurgy, a candidate for admission to the higher examination must furnish a certificate of having completed a satisfactory amount of laboratory work, and submit laboratory note-books signed and certified by the teacher.

C. *Records of Successes.*—The issue of personal certificates will be discontinued, result lists only being published by the Board, with the following exceptions: (1) certificates for the present will be issued for coal-mining; (2) personal certificates to successful candidates at *higher examinations only*, will be awarded provided (*a*) "that they have previously received appropriate group course certificates" endorsed by the Board, (*b*) "that the examination has not been approved in connection with the course for a certificate"; (3) successes in higher and lower stages, and in other approved external examinations, such as the City and Guilds Institute, may be recorded upon grouped course certificates endorsed by the Board, but successes at internal examinations may not be separately recorded.

After studying the conditions detailed above, most teachers will no doubt come to the conclusion that evening students will not be likely to sit for the Board's new examinations. The institution of the 3*s.* 6*d.* fee will alone act as a sufficient deterrent, especially in the case of a group course student wishing to take several examinations, but this, when combined with the fact that a record of success can only be obtained by complying with certain very difficult conditions, must reduce the number of candidates almost to the vanishing point. The past few years has been a transitional period, and elaborate group courses, suited to the local industries, have been adopted by most schools in place of the system of detached classes suited to the Board's examinations. In most places, however, the syllabuses of instruction are modelled on the syllabuses of the Board's science examinations, no doubt with the view of attracting certain students who still place faith in the certificates awarded by the Board; and this is the case particularly with smaller institutions, where the local certificates have proved so far of little value. This must continue until some means can be devised of giving a definite and fairly uniform value to the certificates awarded by different institutions for corresponding years of a group course.

Undoubtedly the country is ripe for the introduction of a national group course system, and we therefore turn expectantly to the scheme which the Board suggests.

*The Scheme of Grouped Courses in the Circular.*—For evening students the Board suggests the classification of courses into three grades:—(1) Junior courses (two years), for youths leaving elementary schools at fourteen. (2) Senior courses (three years), for students who have taken either (*a*) a junior course, or (*b*) a three years' course at a secondary or higher elementary school. (3) Advanced courses (two years), for students who have taken the senior course. The Board is prepared to endorse certificates in senior and advanced courses only under the following conditions, amongst others:—(1) The group course system *must previously have been approved* by the Board, who must also be satisfied with the equipment of the school, and the steps taken to admit only properly qualified students to the course. (2) No unendorsed certificates may be issued by the local authority.

The local certificates of a few of the larger institutions in the country have already become of some value to the holders in the local industries, and therefore the question of endorsement is of little immediate importance to these places, but in the case of the smaller institutions, in view of the fact that the local certificates are not of great value, if any, where they are already given, the question of endorsement becomes of prime importance. A cursory glance at calendars of various technical institutions will show that, although each may have many excellent features, such a variety exists in the construction of the courses that the Board cannot conscientiously approve many of these, and thus a grave injustice must be done during the next few years to a great number of students who have been working towards a definite objective. Take the first three years' courses at Manchester, Bradford, Leeds, and Liverpool in chemical industries as examples. The total possible student hours in the three years are, respectively, Manchester, 660 hours; Bradford, 540 hours; Leeds, 697 hours; Liverpool, 630 hours; sufficient variation, one would think, to result in a very different standard of attainment at the end of the Board's senior course scheme, each institution admitting at the age of sixteen years. The division of the time mentioned above is apportioned as follows:—

| — | Manchester | Bradford | Leeds | Liverpool |
|---|---|---|---|---|
| | hours | hours | hours | hours |
| Theoretical Inorganic Chemistry | 60 | 90 | 97½ | 90 |
| Practical ,, ,, | 165 | 150 | 180 | 135 |
| Theoretical Organic Chemistry.. | 60 | 60 | 75 | nil |
| Practical ,, ,, | 240 | 60 | 90 | ,, |
| Preliminary Mathematics ... ... | 60 | nil | nil | 60 |
| Theoretical Elementary Physics | 30 | ,, | 37½ | 30 |
| Practical ,, ,, | 45 | ,, | 37½ | 45 |
| Principles of Analysis... ... ... | nil | 45 | 35 | nil |
| Chemical Calculations ... ... | ,, | 15 | 60 | ,, |
| Tutorial Work ... ... ... ... | ,, | 30 | nil | ,, |
| Theoretical Heat (Stage II.) ... | ,, | 30 | ,, | 30 (or Electricity) |
| Practical ,, ,, ... | ,, | 60 | ,, | 45 |
| Pure Mathematics, Stage II., or Theoretical Mechanics, Stage I. ... ... ... ... ... | ,, | nil | ,, | 120 |
| Theoretical Electricity, Stage I. or II. ... ... ... ... ... ... | ,, | ,, | ,, | 30 |
| Practical Electricity, Stage I. or II. ... ... ... ... ... ... | ,, | ,, | ,, | 45 |
| Technical Analysis ... ... ... | ,, | ,, | 90 | nil |

It should be mentioned that at Bradford the student takes preliminary mathematics, elementary physics, and Stage I. inorganic chemistry for two years in the branch technical schools as a preliminary, whereas the other institutions all begin with Stage I. inorganic chemistry in the technical courses mentioned above. Further, in the three years' course above, Bradford completes Stage III. inorganic chemistry, the other institutions completing Stage II.; in organic chemistry, Manchester and Leeds complete Stage II. work, Bradford Stage I., and Liverpool does not include organic chemistry in the three years' course.

An examination of some 200 calendars of institutions throughout the country has shown that the examples given

are typical of the group course system, a feature which is not surprising when we consider the way in which the course system has developed. It illustrates, perhaps, more clearly than any other fact the lack of "guidance from the mind that sees the needs of the country from the greater and national point of view." Cast-iron schemes and syllabuses are not required: the Board's rigid syllabuses have during recent years proved a failure from the teacher's point of view; but surely some greater degree of uniformity can be obtained than is shown above, whilst retaining the necessary pliability to suit local requirements of the industries. Before any uniform system of endorsement of certificates can be introduced, coordination of the courses in different institutions must be secured by the standardisation of the courses, as a guide to the standard to be arrived at in any one year, or at the end of a given course. A very grave injustice will be done to a great number of students, and, further, there will be a danger of the loss of many students, unless the conditions outlined in the circular are modified, either (1) by delay in the operation of the scheme for one or two years, or (2) by modifications of the conditions, such as reduction of the entrance fee, the granting of certificates by the Board, particularly in the lower stage, and the revival of examinations in such subjects as light and natural sciences, during the transitional period that must ensue until institutions can come into line with the new requirements.

The time is opportune, too, for revision of the award of Government grant on the work done by evening students. Local authorities are sufficiently hard pressed at the present time without taking over the burden of the cost of examination systems, and the time has arrived for allocating an increased amount of money in the form of a capitation grant for those taking group courses, somewhat on the lines of the grant made at present for day courses in technical institutions, thus differentiating between group courses and single-subject courses. Teachers are convinced that three nights per week, under present conditions of daily employment, are too much in the cases of youths under eighteen, and up to the end of the second year in the senior course the Board might reasonably make the full grant for two evenings (five hours) per week, extending over a thirty weeks' session, instead of encouraging, as at present, courses which are overburdened, for the local authority cannot afford to reduce the number of hours per week in the institution expected from the student, owing to the loss of grant which this would entail. A better grounding in the elementary branches of the work would at the same time undoubtedly be secured.

As to the best method of carrying out a national system of examinations, which is absolutely independent of centralised examinations such as those of the Board of Education, and City and Guilds Institute, the feeling is growing in some quarters that this will be most successfully accomplished by the cooperation of county education authorities with the local education authorities in county boroughs, to form examination boards of teachers and representatives of the local industries, acting as external examiners or assessors in conjunction with the teachers in the institutions of a given area as internal examiners. Such boards would be more in sympathy with the local requirements than any central board could possibly be, and the Board of Education, through its inspectorate, and a National Examination Board should be able to maintain a moderately constant standard throughout the country once the system is in thorough working order. Such a National Examination Board should contain representatives, who should be teachers, from the local examination boards.

Each year in a student's work marks a distinct stage in his career, and this should be recognised on successful completion of the work of each year by the award of a local certificate or record, to be exchanged at the end of the course for the full endorsed certificate, giving a national stamp, or hall-mark, to the work. At the same time, it is worth consideration whether certain single-subject courses of a highly technical character are not worth the award of a special endorsed certificate, particularly in cases where the student is able to take up the higher work without passing through the preliminary grind of the earlier years, or in cases where the subject-matter does not readily adapt itself to inclusion in a course. There is undoubtedly the need for a national evening course system, so that the smaller institutions may readily and naturally feed the larger, in which the more advanced work will be concentrated, and so that this work may lead up systematically to the day diploma work of our specialised technical institutions.

## *INDUCED ACTION OF LEUCOCYTES.*[1]

SCIENTIFIC workers may like to have a brief account of some recent researches which, I think, are likely to be of both theoretical and practical interest. The researches commenced nearly five years ago in a special study of leucocytes by a method devised by my brother, Mr. H. C. Ross, and myself. This consists in placing liquid blood under a cover-glass, not, as usual, upon another surface of glass, but upon a bed of transparent jelly with which various reagents, including stains, have been mixed. The original object of the method was to try to cultivate human leucocytes *in vitro*. At first careful studies of the rate of absorption of stains by the leucocytes under various chemical conditions of the jelly were made by Mr. Ross. Two years later he found that extract of hæmal gland, extracts of apparently many dead and decomposing tissues, and globin, when mixed with the jelly, force a large proportion of the leucocytes to divide before the eyes. Subsequently, he and his assistant, Dr. J. W. Cropper, ascertained by a series of lengthy studies that many of the substances which possess this property (in different degrees) belong to the amidine grouping. They have found, also, that a second series of substances, though by themselves they cannot produce division of leucocytes, have the power of augmenting very greatly the power of the former group of substances to do so. They give the names *auxetics* and *augmentors* to the two groups respectively. The principal auxetics are extracts of organs, creatine, xanthine, creatinine, guanidine, benzamidine, theobromine, acetamidine, caffeine, theophylline, methylamine, ethylamine, propylamine, &c., and certain aniline dyes. Some of the augmentors are various alkaloids, atropine, choline, cadaverine, neurine, &c.

The technique, though simple, requires considerable care. If a stain such as polychrome methylene blue is added, the cells become coloured progressively as the division advances. All the varieties of the human leucocytes can be made to divide; but the technique is slightly different for each variety. The proportion of cells affected in a given preparation of blood varies according to perfection of technique up to, say, 80 per cent.; but as death occurs rapidly, especially if stain be used, it usually overtakes a large proportion of them before the division has been completed. After about twenty minutes all the cells die, and by that time the process is complete in only a small percentage. Efforts to keep the cells alive longer upon these medicated jellies or in solutions of auxetics have not yet been very successful and would not be easy. After their death the leucocytes give up again most of their stain, and the jelly preparation rapidly spoils; but a method has been found of making (with some difficulty) permanent specimens of such of the blood as adheres to the cover-glass by fixing the whole preparation with osmic acid vapour, and then freezing and picking off the cover-glass from the bed of jelly.

To watch the same cell passing through the whole process requires an accurately adjusted warm stage or microscope-incubator and considerable patience, because the cell which we happen to select for observation will most probably belong to the majority which die before completion of the division; but partial division can be easily witnessed. If, however, the specimen is incubated for ten minutes, and is then surveyed rapidly from field to field, numbers of the leucocytes caught in all stages of the process can be readily seen. The fixed films just referred to show exactly the same objects, but enable us to examine them repeatedly and at leisure. And in both these cases the dividing forms are so numerous and similar that there

[1] From a paper read at the meeting of the Pathological Section of the Royal Society of Medicine on November 7 by Sir Ronald Ross, K.C.B., F.R.S.