I wish to draw attention to it—all the more since so competent a writer as "D. H. S." seems in a review in NATURE (April 27) to be unaware that he theory of variation by amphimixis [1] has ceased to exist as a 'Difficulty in Weismannism."

Cork, May 1. MARCUS HARTOG.

Medical Biology.

G. B. H. HAS, I am glad to see, criticised effectively the syllabus of Elementary Biology put forth by the Conjoint Board (NATURE, vol. xlvii. p. 530). A less fortunate course of study could hardly have been devised. The students who take the course include a number whose previous education, energy and ambition are not sufficient to encourage them to attempt a university course, and the average quality is therefore not very good. They work through a number of unicellular types, which give no training for the hands, though they are no doubt useful in other ways. Then come Hydra and the Leech. Hydra is of course a good subject. The Leech is not instructive to a student who has no knowledge of similar animals, and the untrained man cannot possibly dissect it for himself. The rest of the course consists of parasitic worms and certain generalities. The parasitic worms commonly have the nervous system, heart, and sometimes even the alimentary canal absent or poorly developed, while the reproductive organs are of extraordinary complexity. From these the student has mainly to derive his notions of the plans of structure which are found among animals. Such a course of study looks practical, but it is almost pure waste of time. It does not teach the student to dissect, nor does it introduce him to those problems of Nature which are most accessible to a beginner. In fact, the whole course may be expected to evaporate shortly, leaving behind nothing more valuable than a recollection of the outward appearance of certain parasitic worms.

When the teacher attempts to introduce more instructive subjects, the class, solely bent upon satisfying the Conjoint Board, are too apt to scamp the work, with this excuse, that their prescribed course cannot have aroused any interest in Biology. Educationally, the syllabus of the Conjoint Board is a sin.

L. C. M.

Afterglows in Spain.

I HAVE read Mr. Backhouse's note in NATURE (vol. xlvii. p. 582) on the afterglows as seen by him in Spain during February last, and the doubts he expresses on the question whether this phenomenon has always occurred when the sun has been near the horizon. I have observed for many years the setting of the sun in Cadiz on the sea horizon with the purest sky, and never remarked the pink tint, but always the rosy tint in the west and the purple, or *Cegensghein*, in the east. After the Krakatão eruption, in the clear sky of Madrid, the pink colour of the segment was always more or less visible; and it has been more marked in these later afterglows. The phenomenon is of the same character as that of 1883, but much less brilliant. The apex of the segment rises frequently to 40°.

I have also many times observed the *green ray* (rayon vert) in very different conditions of the atmosphere, but nearly always with calm air; this is not precisely a ray, but a flash of green light that has a very perceptible duration of some tenths of a second. AUGUSTO ARCIMIS.

Madrid, April 24.

Soot-figures on Ceilings.

THE phenomenon noted by Mr. Poulton in NATURE (vol. xlvii. p. 608) is a matter of very common observation; except in the detail of the nail-heads it has been often noticed. The explanation is, I fancy, simpler than that suggested by Prof. Lodge. It is probably a simple case of *sifting of air*, as it passes by upward diffusion through the porous plaster, where its passage is not barred by contact of the plaster with the wood on the upper side. The plaster acts as the plaster of Paris plug does in the classical researches of Graham on the diffusion of gases, and as the plug of cotton-wool does in the common process of sterilising air in biological work. That warm air does stream up through a plaster-ceiling in this way is a matter of experience to every householder, when in the winter a bedroom over a sitting-room in which a fire is kept burning all day and a lamp or gas-flames for some hours in the evening, is always found to be drier and warmer than another room in the same house not so situated. We can scarcely classify dry wood and iron together as conductors of heat. A. IRVING.

Wellington College, Berks, April 29.

THE soot-figures on ceilings described by Mr. Poulton remind me of the appearance of very similar figures brought out by hoar-frost. The first time I noticed this effect was on the surface of a smoothly-boarded gate, where the parts behind which the bars of the framing ran were marked out by a much thicker coating of hoar-frost than the rest. Subsequently I noticed the same effect on a wooden pier where the planking was crossed by broad belts of white, exactly outlining the timbers to which the boards were nailed. On another occasion thick hoar-frost had formed on the roof of the after-cabin of the steam yacht *Medusa*, composed of a close pile of fine needles of ice about one-eighth of an inch high, inclined at various angles. At first the places where the thin teak boards were nailed to the cross-beams were covered only a little more thickly than the rest, but as the warmth of the day increased the ice spicules disappeared—evaporated rather than melted—from the unsupported parts, but remained in a broad band outlining each beam except above the nail-heads, over each of which a small clear space had melted.

At the time I satisfied myself that the phenomena were due to peculiarities of melting rather than of deposition. Supposing the whole surface to have been coated uniformly, the thicker parts would take longer to heat up by the sun, and so tend to prolong the life of the ice spicules resting on them. If this were so, conversely the thickened parts of the structure, cooling more slowly, should have received a lighter coating to begin with, but this I was never fortunate enough to observe. Is the similarity to the soot-figures accidental? HUGH ROBERT MILL.

1, Savile-row, April 28.

AS this subject has been under discussion lately in NATURE, it seems worth while recording a striking instance which must be well known to many who have been in the large mess room of the Royal Engineers at Chatham. This room has a lofty, highly ornamented ceiling, which was for many years bordered with a deep cornice with a plain moulding either in plaster or papier maché, mostly stuck on one simple template, and coloured either white or some very pale tint. The room was lit by three sunlights in the roof, containing about 190 gas jets. In the course of time the whole of the white moulded cornice became grey with soot-deposit *marked at intervals with light bars*, which were apparently the outline of the wooden ribs carrying the mouldings. This pattern was fairly conspicuous, and was often a subject of discussion at mess (1885 to 1890). Dr. A. Lodge's explanation of the cause seems to be the true explanation. ALLAN CUNNINGHAM.

Kensington, April 28.

THE mapping out of the heads of nails driven into the joists of the ceiling at Felixstowe seems to be inexplicable by the theory of filtration, although this may very probably account for the more common cases of a deposit between but not upon the joists of a ceiling. I am endeavouring to get a photograph of the best part of the Felixstowe ceiling. Dr. Mill's observation seems to be due, as he suggests, to a different process.

E. B. POULTON.

THE APPRECIATION OF SCIENCE BY GERMAN MANUFACTURERS.

RECENTLY, when giving evidence before the Gresham University Commission, I had occasion to speak of the attention devoted in German chemical laboratories to higher studies, and when asked what were the results of this instruction I drew attention to an article published a short time before in that most enterprising of chemical periodicals, the *Chemiker-Zeitung*, edited by Dr. Krause. In this article a description is given of the research laboratory provided to accommodate *six and twenty skilled chemists*, attached to the works of the Farbenfabriken,

[1] As regards the origin of new species, the author, like Prof. Weismann, attributes the greatest importance to sexual reproduction, and especially to cross fertilisation" (see ante, p. 606).

vormals F. Bayer and Co., of Elberfeld, who are manufacturers of dye-stuffs and other products derivable from tars. I told the Commissioners that if, at the present time, it were desired to fit up a research laboratory for chemical purposes in London, we could not do better than take these plans and reproduce them in their entirety, and that we should then, I believed, have reason to congratulate ourselves on possessing the best-appointed public research laboratory in the world.

In addition to the two dozen skilled chemists in the research department at the Elberfeld works, a large number are engaged in other departments, the total number employed being, I believe, over *sixty!*

The Elberfeld works do not stand alone: the world-renowned Badische Anilin and Sodafabrik probably has in the aggregate far more laboratory accommodation than is provided even at Elberfeld. I learn from my friend Dr. Caro, that of the *seventy-eight* chemists in the employ of this firm fifty-six have the Ph.D. degree.

At many other works equally ample provision is made—in fact the colour works throughout Germany are simply laboratories on a very large scale.

As an antithesis, I may add that I told the Gresham Commissioners that I did not think that any English colour works had six skilled chemists in its employ; at all events six was the maximum number.

Is it then surprising that, notwithstanding that a very large proportion of the coal-tar used is of English origin, and that both the "aniline-colour" and the alizarin industry were first established here, according to a statement in the Chicago Exhibition Catalogue of the German Section, about nine-tenths of the total quantity of artificial colouring matters now produced is manufactured in Germany? Whatever the proportion, in 1891, Germany exported aniline-colours of the estimated value of no less than 44,269,000 marks, and alizarin valued at 12,906,000 marks—or little short of three millions sterling—a very large proportion of these manufactured colouring matters being sent to the East Indies, where they are fast displacing those of natural origin. Dr. Caro in a comprehensive monograph just published in the *Berichte* in which the gradual development of the coal-tar colour industry is fully traced out, speaks of it as a German *national industry*. *Manufactured in Germany* is certainly now the recognized trade mark for chemicals throughout the world.

Not many years ago Wurtz wrote, with reference to the origin of the science, "La chimie est une science française;" at the present day we may say, without fear of contradiction, that, whatever its origin, it is now a German science; that it is to this fact that the Germans owe their supremacy; and that it is to our failure to feel the pulse of the times, and to educate ourselves up to the proper point that we owe our downfall. It is to be feared, moreover, that unless we realise this without further loss of time, and hasten to fit ourselves to do our fair share of the work, other industries in which chemistry plays an important part, ere another twenty years are past, will also have quitted our shores. To do this we must put aside the idea that University extension and County Council lectures, or even polytechnics and technical schools for the multitude, are to bring about the necessary reform; and we must rise above the belief that a degree given for text-book knowledge and an acquaintance with the ordinary methods of analysis is evidence of competency. A true conception of what a chemist is—what he is called on to do and to know in this age of progress—must arise in high quarters and especially among our manufacturers.

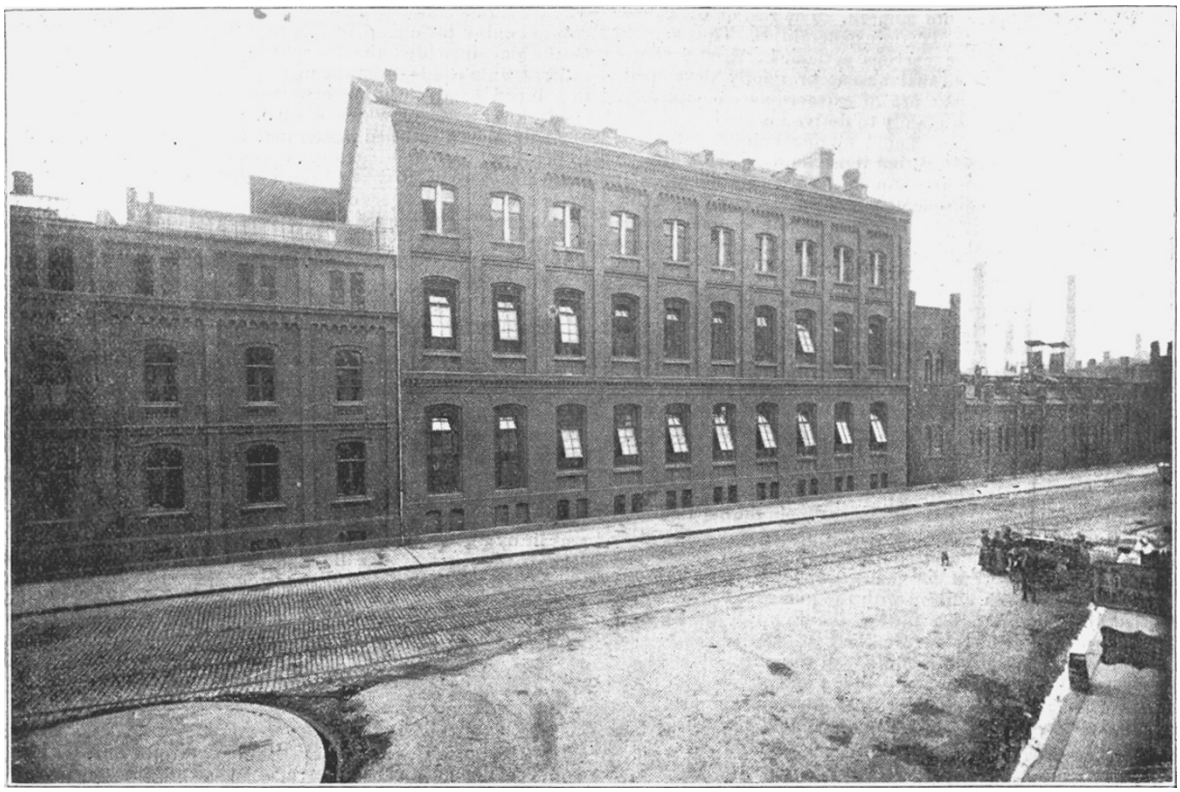

FIG. 1.—Laboratory as seen from the street; Works on right, Offices on left.

Our children must be properly taught at school and trained to work as well as to play, and we must cease to worry their lives at college by insisting on the study of a multiplicity of subjects, and no longer attempt to develope a Chinese system of examinations. Surely it is time that we realised that our examination system is a fraudulent failure. In Germany the victory has been gained wholly and solely through the agency of the Universities—here we are still dominated by influences which had their origin in the monkish cell, and our ancient Universities do nothing to help us. The intolerant individuality which has enabled us to conquer and to govern where other nations have failed is of little use in an industrial war against the most systematically instructed people in the world, whose weapons are scientific research and scientific method, and who have been careful to "organise victory," to use Huxley's expression in his remarkable letter to the *Times* at the time that the proposal to establish the Imperial Institute was under discussion. Huxley warned us six years ago of the fate that awaited our industries if we did not organise victory. I fear that so far as chemistry is concerned our insular conservatism still leads us to turn a deaf ear to all such warnings, and that the only change is that we are six years nearer to our fate.

The following particulars are mainly taken from the number of the *Chemiker-Zeitung* above referred to. I am indebted to the Farbenfabriken, vormals F. Bayer and Co., for photographs from which the illustrations to this article have been prepared. I may add that I have had the very great pleasure of inspecting the laboratory.

The opening passage of the *Chemiker-Zeitung* notice is very significant, and is as follows :—

In any industry at the present day standing still involves retrogression, and this is especially the case in the colour industry, which has developed to such an extent in our country during recent years, and which owes its development in the first instance to the extreme attention paid to chemical science in Germany at the universities and technical schools. Whereas formerly, however, the colour industry owed its progress almost entirely to the schools and their celebrated leaders, of late years knowledge in this great field has become so specialised that a determining influence can be exercised only by one who is within the industry. Since the colour works have begun to pay attention to derivatives of coal and wood tar not only in the dyers' interest, but have also placed them at the service of medical science; and since it has been recognized that the protection afforded by a patent does not retard, but, on the contrary, promotes an industry, and is therefore to the general good, and patent laws have been introduced into Germany, of which, in comparison with those of other countries, we have reason to be proud, competition has so increased that all the works concerned are forced to make every effort to prevent their destruction in the struggle for existence. Consequently all the larger colour works within recent years have erected laboratories in which a large number of disciples of chemical science are unceasingly engaged in the endeavour to meet the growing wants of the dyer by adding to the already large number of artificial coal-tar colours, not only with the object of producing colours of increased beauty, but also to meet the growing desire for colours of greater fastness, and especially with the object of entirely displacing the natural dye stuffs which were formerly exclusively used. These technical laboratories are necessarily arranged with special reference to the requirements of the industry, and therefore differ in many respects from the laboratories at the universities and technical schools which are used for teaching purposes.

The laboratory of the Farbenfabriken, vormals Friedr. Bayer and Co. at Elberfeld, opened towards the close of 1891, is the newest institution of its kind.

Fig. 1 is from a photograph of the building taken from the street. The object in view was to provide all necessary rooms for twenty-six chemists. In order to make full use of the site, however, rooms for certain other purposes were also included. The laboratory adjoins the offices of the firm and the dye house, and also the physiological laboratory. The new building is 35·66 m. long and 16·14 m. deep.

A large portion of the basement is fitted up as a store for apparatus, &c., and is connected with the laboratories above by a stairway and lift. Luxurious provision is made here for the comfort of the staff, two rooms being provided in which they can change their clothes, along one side of each of which there are twelve clothes cupboards, and a bench with cupboards for boots underneath extending along the opposite side; and also of twelve separate bath rooms with hot and cold water, and a lavatory with twenty-four basins. The heating apparatus for the baths, and a low pressure steam heating apparatus, are placed next to the wall at one end of the building, and here also niches are constructed for autoclaves—*i.e.* vessels in which materials can be heated under pressure.

The ground floor is 6 m. high from floor to floor, excepting at the eastern end, where it is 1·28 m. deeper. The eastern higher portion is divided by a floor into two low apartments fitted up for experimental dyeing. Next to this and beyond the stairway on either side of a corridor are two rooms, 2·96 × 5·61 m., one of which is a combustion room, the other containing balances and other physical apparatus. The whole of the remaining space, 24·18 m. long by 14·6 m. deep, is fitted up as a laboratory for twelve chemists, and comprises twelve separate working places, and two for large operations for common use. This arrangement has the advantage that each chemist has had placed at his disposal a separate laboratory for his own use without the room having been deprived of its uniform character. Fig. 2 is from a photograph of the laboratory, Fig. 3 representing one working place.

The first floor includes a room 8·13 m. by 3·21 m. for the use of the director of the laboratory; a room 9·82 m. by 5·61 m. used as a library;[1] a room 5·61 m. by 2·96 m. for special use; and a large laboratory corresponding to that on the ground floor with places for thirteen chemists. A gallery carried on iron brackets is constructed along the side of this room on the outside of the building, in which experiments involving the production of specially unpleasant odours can be made. This gallery is approached through a glazed doorway constructed in one of the window places, but experiments going on in it can be overlooked from the laboratory within, through the windows.

The second floor is divided into two by a partition wall, one part being occupied by the printers engaged in preparing the various labels, notices, &c., required by the firm; the other being used by the bookbinders who make up sample-books, &c.

The attics are used as store rooms.

The building is simply constructed of brick, stone being used only for the window-sills; in fact, it is characterised throughout by simplicity and solidity of construction. The basement floor is cemented; the remaining floors are covered with antilaeolith, a clay asphalt which withstands hot strongly acid liquids.

The drainage water is carried away in open channels constructed in the floor.

The electric light is used throughout, the large laboratories being each illuminated by means of four arc lamps, and the other rooms by glow-lamps.

It has not been thought necessary to introduce any

[1] Probably there are few, *if any*, libraries attached to educational institutions so fully provided with the current literature and works of reference as are the libraries at the chief colour works.

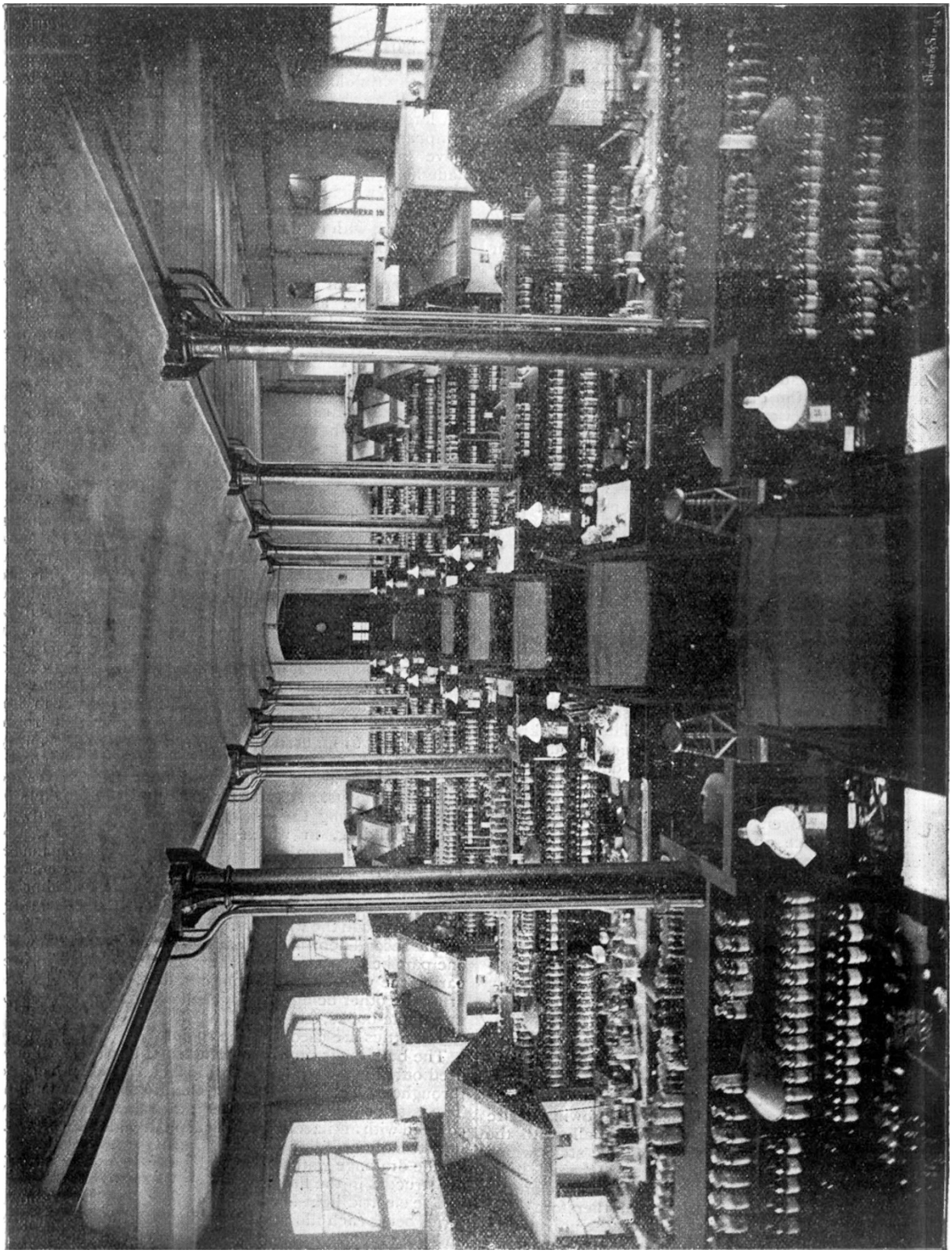

FIG. 2.—Laboratory for twelve chemists, six on either side of main passage.

mechanical system to secure general ventilation. Air is admitted through openings in the upper part of the windows, the foul air finding sufficient means of escape up a shaft in which there is a spiral staircase, at the end of the large laboratories, and which terminates in a large opening in the western gable. Special care, however, is taken to remove fumes evolved in the chemical experiments. For this purpose a large number of earthenware pipes, 15 ccm. in diameter, are built into the walls between the windows in the large laboratories and elsewhere; these are carried up and connected with asphalted flues, which eventually terminate in a large air shaft carried out above the roof; the necessary draft is secured by means of a large fan placed at the base of the shaft, and driven by the engine in the printing department. At right angles to the walls at both sides of the rooms, between the windows, hollow walls are built out about 2·5 m.,

FIG. 3.—Working place of one chemist.

on either side of which draft closets are constructed (see Fig. 2), flue pipes such as have been referred to being let into these walls.

Passing over numerous interesting details of construction, the arrangement of the laboratories may now be referred to. Each place is so arranged as to constitute a complete laboratory with every necessary provision, while at the same time there is nothing to prevent the various chemists working together or to hinder the general supervision of the laboratory. The arrangement is best understood by reference to Figs. 2 and 3, of which the latter shows a single working place. The two side benches are connected by the window bench, so that each chemist has command of a bench about 15 m. long! The bottles on the shelves of each place contain 180 different agents—among these being all the substances in use or produced in the works, so that, if desired, any combinations tried in the laboratory may at once be effected on the large scale in the works. The pipes for gas, water, compressed air and vacuum are carried in a space behind the shelving, and can be easily got at for repairs, the shelving being made removable. The benches, except at the windows, are covered with lead. Under the bench there are numerous drawers and cupboards, containing all apparatus that can possibly be required, and also chemicals such as salt, potassium chloride, sodium acetate, &c., which are used in large quantities. Thus in Fig. 3 a sliding stand will be seen projecting from a cupboard on the right-hand side, carrying measuring cylinders inverted over pegs. Each drawer or cupboard, in fact, has its special purpose, and is carefully labelled, the same arrangement being maintained throughout the laboratory, so that the attendants are able to see that each chemist is supplied with all necessary apparatus. On either bench next the window there is a closed draft-closet, and next to it a hood, it being possible to connect these by a moveable window In one of the closets there is a large copper water bath, in which steam, previously cleaned from rust, condenses and can be drawn off as boiling distilled water; this bath has the usual openings above with rings, &c., and has within it a drying oven surrounded by boiling water, a wooden drying closet being placed below in which things can be dried by heat radiated from the water bath above. The waste water and steam pass away through the hollow wall at the back of the closet, in which there is a channel communicating with the drain.

On either side of the window a pipe connected to the general ventilation system is let into the wall, to which a funnel-shaped hood can be attached, so that experiments involving the evolution of fumes can be carried on at the

window-bench. This bench, however, is chiefly used for titration work, and therefore shelves are affixed to the wall some distance above it on either side, on which large bottles are placed containing the standard solutions.

It will be seen from Figs. 2 and 3 that a sink is placed at the end of the bench on the one side, and that there is a desk on the opposite side; adjoining this desk is an ice cupboard let into the bench, on the cover of which a balance for weighing out substances used in the experiments is placed. By the provision of such an ice cupboard at every place a great saving of ice has been effected: it is not only available for the storage of ice—nowadays an indispensable laboratory agent—but things can be kept cool in it even over long periods, over Sunday for example.

Four differently coloured pipes for water, gas, compressed air and vacuum run along the ceiling, and from these branch pipes are carried down the columns to the benches; taps are provided in a convenient situation, so that, if necessary, the supply of water, &c., to a bench may be at once shut off. The water pipes are covered with flannel to prevent the water which condenses on them from dropping down. Each working place is provided with 4 taps for compressed air, 4 vacuum taps, 11 water taps, 14 gas taps for heating purposes, and 9 gas burners in case of a failure of the electric light. A steam pipe runs along the wall, from which there are branch pipes connected with "purifiers," conveying steam to each of the large water baths before referred to, and to a valve under the hood adjoining the closet.

A shower bath depends from the ceiling at either end of each of the large laboratories for use in case of the clothes of any of the chemists or laboratory attendants catching fire.

Every bottle on the shelves is not only clearly labelled, but is also numbered, so that it is easy for the lad who has to keep the place clean and in order, however ignorant he may be, to arrange them properly, and moreover, each particular chemical occupies the same position in the row of bottles in every place in the laboratory.

Each chemist has a lad to assist him who washes all vessels, keeps the benches clean and the apparatus in order; in fact, does generally what he is told, even helping in the experiments. In addition, there are three lads under the supervision of an older laboratory servant in each laboratory, who at once avail themselves of any opportunity offered by the absence of the staff to "tidy up" in regions not specially committed to the charge of the young assistants. The order and cleanliness—extending even to keeping the leaden bench tops polished—thus secured is most remarkable.

Each chemist is so completely screened from his neighbour "next door," that he is not only able to work undisturbed, but practically in secret; he is only open to observation from the place on the opposite side of the main gangway, and the chemists are usually so placed that of the two working at these benches either the one is a junior under the direction of the other, or they are working in co-operation.

As a further illustration of the perfection of the arrangements I may quote from an account before me of a visit to the laboratory a description of the steps taken to put out a fire. A crack is suddenly heard and flames and a dense cloud of smoke are seen to ascend from one of the benches; all the chemists in the room at once rush to the spot. The particular chemist is found to be unhurt, but the clothes of his laboratory boy are on fire; instantly he is dragged to the shower bath, and the fire is at once put out. Meanwhile the laboratory servant has given the alarm by means of the electric fire alarm provided in the room, and within two minutes the twelve men on duty of the twenty-four members of the works fire brigade appear in full uniform. Those present, however, by turning on all the water taps in the neighbourhood of the fire and directing the water on to the burning bench had already extinguished the flames. The room is filled with a dense black fog, but by opening the windows and a valve in the main ventilation system near the ceiling this is very soon got rid of. The origin of the accident was simple enough: a young chemist, fresh from the University, unaccustomed to work with large quantities, had allowed his laboratory boy to heat a couple of litres of the hydrocarbon toluene, which he was using in recrystallising a substance, in a glass flask, over a bare flame.

Another striking feature in the large laboratories is a series of brass valves arranged along the wall under a hood opposite the bench for general use; the labels under these valves bear the names oxygen, carbon dioxide, chlorine, sulphur dioxide, phosgene, methyl chloride, hydrogen and ammonia. These various gases, compressed in cylinders enclosed in cupboards in the basement, can be used at any time by communicating through a speaking tube to the man in charge of the store department, who then opens the valve on the cylinder containing the required gas, so that it only remains for the chemist to open the valve in the laboratory.

In the lower laboratory one place only is distinguished from all the others, being fitted up for electro-chemical work with the necessary current-measuring instruments, a series of about fifty glow lamps being arranged as resistances.

In the balance-room, besides balances, there is a large arc lamp with special lenses designed by Prof. von Perger, of Vienna, used in ascertaining the effect of light on colours—in these days sunlight can no longer satisfy the needs of German industrial enterprise! Colorimeters, spectroscopes, and other apparatus are also to be found in this room. Colour chemists are not fond of making analyses if it be possible to characterise substances by any other means; the combustion furnaces are therefore but little used, and a number of ovens in which pressure tubes are heated have supplanted most of them.

Adjoining the research laboratories there is a "technical laboratory" full of apparatus exactly like that in use in the works, but of much smaller size. Here experiments are carried out on a somewhat larger scale than in the laboratory prior to the processes being effected on the large scale in the works; and the staff in this laboratory are also engaged in making many of the chemicals required to replenish the stores for use in the research laboratories.

The stores are in charge of two superintendents, one of whom is educated as a glass-blower. It is worth mentioning also that all thermometers, prior to their issue from the store, are there compared with a normal thermometer.

The laboratory was designed by my friend Dr. C. Duisberg, the director, the necessary architectural assistance being afforded by Herr Bormann, architect to the works.

The foregoing is but a very imperfect account of this marvellous works research laboratory. A more typical and concrete illustration of the appreciation of the value of science by German manufacturers, however, could not possibly be found. but yet it is only one of many that might be brought forward. Personally I can only say, that while lamenting the criminal short-sightedness of my countrymen, I am lost in admiration of the enterprise displayed by their foreign competitors: it cannot be denied that they deserve to succeed!

HENRY E. ARMSTRONG.

ELECTRO-OPTICS.

THE experimental and theoretical investigations of the last twenty years have lent a new interest to what, I venture to think, is one of the most fascinating branches