after filtration through clean sand, is conveyed 30 or 40 miles through steel or masonry conduits to covered reservoirs, whence it is drawn as needed through cast-iron pipes to the building where it is to be used, and there distributed to all parts of it, chilled nearly to the freezing point through one system of pipes or heated nearly to the boiling point, through another system. Another set of pipes carries steam, which, passing through radiators, keeps the temperature of the air throughout the building at the proper standard for comfort. Sanitary conveniences are provided everywhere, and all wastes are consumed within the building by the surplus heat generated, leaving only ashes to be removed. Wires convey electric currents to all points, so that the occupant of a room, sitting at his desk, can by the touch of a button ventilate his apartment, illuminate it, call a messenger, be kept informed of every fluctuation in the markets, converse with anybody who is not 'busy' within 40 miles of where he sits, and if entirely 'up to date' can require his autograph and portrait to be reproduced before his eyes for identification. He dictates his correspondence and his memoranda, and 'takes his pen in hand' only to sign his name. He need not leave his seat except to consult the photograph hanging on his wall, which shows to him the latest condition of the mine, the railroad, the arid lands irrigated, the swamps reclaimed, the bridge in progress, the steamship, the water-works, the tunnel or the railroad, the dam, the filter or the sewage works, the town, the machine, the power plant or the manufacturing establishment in which he is most interested.

Entering the brilliantly lighted hallway of this building, the air of which is kept in circulation by the plunging up and down of half a dozen elevators, the visitor is lifted at a speed of 500 feet a minute, past floor after floor, crowded with the offices of financiers, managers and promoters of traffic and of trade, lawyers, chemists, contractors, manufacturers, to the headquarters of the controlling genius of the whole organism, the civil engineer. For he it is to whom all the members of this microcosm must apply for aid and advice in the successful operation of their respective occupations. It is not his to mechanically transform elements into matter, or matter into other forms, or to show how energy may be produced, but to direct the application of energy to the various forms of matter, original or produced, in such way as to bring about the most satisfactory results in the most speedy and economical manner.

He has grown with the growth of the nineteenth century, and is, so far as the relations between man and matter are concerned, its most striking product. And so, while the definition given in the 'American Edition of the Encyclopedia,' which appeared at the beginning of the century, that "civil engineers are a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments and eminently useful under this appellation," is still true, it is hardly probable that the compiler of the Twentieth Century Encyclopedia will be content to let it stand without further explanation.

But the end is not yet; there are still many problems of nature unsolved. The experience of every day shows that there are sources of power not yet fully developed, and we cannot but say with the great poet:

"I doubt not through the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns."

J. James R. Croes.

THE BRITISH NATIONAL ANTARCTIC EXPEDITION.

Dr. George Murray, F.R.S., keeper of the Department of Botany in the British

Museum, has been appointed director of the civilian staff of the British expedition, to fill the vacancy caused by the resignation of Professor J. W. Gregory. Dr. Murray will not, however, take part in the expedition, except in so far as he will proceed with the ship to Melbourne. He will edit the scientific results. A geologist is to be appointed to do the work in this direction that would have been carried on by Professor Gregory. The other members of the scientific staff are Dr. R. Koettlitz, Mr. Hodgson, Mr. E. A. Wilson, Mr. William Shackleton and Mr. R. Skelton. Full instructions to the commander and to the scientific director of the civilian scientific staff have been drawn up and are signed by Sir William Huggins, president of the Royal Society, and Sir Clements Markham, president of the Royal Geographical Society. They are as follows:

INSTRUCTIONS TO THE COMMANDER.

1. The Royal Society and the Royal Geographical Society, with the assistance of his Majesty's Government, have fitted out an expedition for scientific discovery and exploration in the Antarctic regions, and have entrusted you with the command.

2. The objects of the expedition are: (*a*) to determine, as far as possible, the nature, condition and extent of that portion of the South Polar lands which is included in the scope of your expedition; and (*b*) to make a magnetic survey in the southern regions to the south of the 40th parallel, and to carry on meteorological, oceanographic, geological, biological and physical investigations and researches. Neither of these objects is to be sacrificed to the other.

3. The scientific work of the executive officers of the ship will be under your immediate control, and will include magnetic and meteorological observations, astronomical observations, surveying and charting, and sounding operations.

4. Associated with you, but under your command, there will be a civilian scientific staff, with a director at their head. A copy of his instructions accompanies these instructions to you.

5. In all questions connected with the scientific conduct of the expedition you will, as a matter of course, consider the director as your colleague, and on all these matters you will observe such consideration in respect to his wishes and suggestions as may be consistent with a due regard to the instructions under which you are acting, to the safe navigation of the ship, and to the comfort, health, discipline and efficiency of all under your command. Those friendly relations and unreserved communications should be maintained between you which will tend so materially to the success of an expedition from which so many important results are looked for.

6. As the scientific objects of the expedition are manifold, some of them will come under the immediate supervision of the director and his staff; others will depend for their success on the joint cooperation of the naval and civil elements; while some will demand the undivided attention of yourself and your officers. Upon the harmonious working and hearty cooperation of all must depend the result of the expedition as a whole.

7. The expedition will be supplied with a complete set of magnetic instruments, both for observations at sea and on shore. Instructions for their use have been drawn up by Captain Creak, R.N., and yourself and three of your officers have gone through a course of instruction at Deptford with Captain Creak and at Kew Observatory. The magnetic observatory on board the *Discovery* has been carefully constructed with a view to securing it from any proximity to steel or iron, and this has involved considerable expense and some sacrifice in other respects. We, therefore, impress upon

you that the greatest importance is attached to the series of magnetic observations to be taken under your superintendence, and we desire that you will spare no pains to ensure their accuracy and continuity. The base station for your magnetic work will be at Melbourne, or at Christchurch, in New Zealand. A secondary base station is to be established by you, if possible, in Victoria Land. You should endeavor to carry the magnetic survey from the Cape to your primary base station, south of the 40th parallel, and from the same station across the Pacific to the meridian of Greenwich. It is also desired that you should observe along the tracks of Ross, in order to ascertain the magnetic changes that have taken place in the interval between the two voyages.

8. Geographical discovery and scientific exploration by sea and land should be conducted in two quadrants of the four into which the Antarctic regions are divided for convenience of reference—namely, the Victoria and Ross Quadrants. It is desired that the extent of land should be ascertained by following the coast lines, that the depth and nature of the ice cap should be investigated, as well as the nature of the volcanic region, of the mountain ranges, and especially of any fossiliferous rocks.

9. A German expedition will start at the same time as the *Discovery*, and it is hoped that there will be cordial cooperation between the two expeditions as regards magnetic and meteorological observations, and in all other matters if opportunities offer for such cooperation. It is understood that the German expedition will establish an observatory on Kerguelen Island, and will then proceed to explore the Enderby Quadrant, probably shaping a course south between the 70° E. and 80° E. meridians, with the object of wintering on the western side of Victoria Land, whence exploring sledge parties will be sent inland. The Government of the Argentine Republic has undertaken to establish a magnetic observatory on Staten Island.

10. You will see that the meteorological observations are regularly taken every two hours, and, also, in accordance with a suggestion from the Berlin committee, every day at Greenwich noon. It is very desirable that there should, if possible, be a series of meteorological observations to the south of the 74th parallel.

11. As regards magnetic work and meteorological observations generally, you will follow the program arranged between the German and British committees, with the terms of which you are acquainted.

12. Whenever it is possible, while at sea, deep-sea sounding should be taken with serial temperatures, and samples of sea water at various depths are to be obtained, for physical and chemical analysis. Dredging operations are to be carried on as frequently as possible, and all opportunities are to be taken for making biological and geological collections.

13. Instructions will be supplied for the various scientific observations; and the officers of the expedition will be furnished with a manual, prepared and edited by Dr. George Murray, on similar lines and with the same objects as the scientific manuals supplied to the Arctic expedition of 1875.

14. On leaving this country you are to proceed to Melbourne, or Lyttelton (Christchurch), New Zealand, touching at any port or ports on the way that you may consider it necessary or desirable to visit for supplies or repairs. Before leaving your base station you will fill up with live stock, coal, and other necessaries; and you will leave the port with three years' provisions on board, and fully supplied for wintering and for sledge travelling.

15. You are to proceed at once to the edge of the pack and to force your vessel through it to the open water to the south.

The pack is supposed to be closer in December than it has been found to be later in the season. But this is believed to depend rather on its position than on the time; and the great difference between a steamer and a sailing vessel perhaps makes up for any difference in the condition of the pack.

16. On reaching the south water you are at liberty to devote to exploration the earlier portion of the navigable season; but such exploration should, if possible, include an examination of the coast from Cape Johnson to Cape Crozier, with a view to finding a safe and suitable place for the operations of landing in the event of your deciding that the ship shall not winter in the ice.

The chief points of geographical interest are as follows:—To explore the Ice Barrier of Sir James Ross to its eastern extremity; to discover the land which was believed by Ross to flank the barrier to the eastward, or to ascertain that it does not exist; and generally to endeavor to solve the very important physical and geographical questions connected with this remarkable ice formation.

17. Owing to our very imperfect knowledge of the conditions which prevail in the Antarctic seas, we cannot pronounce definitely whether it will be necessary for the ship to make her way out of the ice before the winter sets in, or whether she should winter in the Antarctic regions. It is for you to decide on this important question after a careful examination of the local conditions.

18. If you should decide that the ship shall winter in the ice, the following instructions are to be observed:

a. Your efforts, as regards geographical exploration, should be directed, with the help of depots, to three objects—namely, an advance into the western mountains, an advance to the south, and the exploration of the volcanic region.

b. The director and his staff shall be allowed all facilities for the prosecution of their researches.

c. In carrying out *a* and *b* due regard is to be had to the safety and requirements of the expedition as a whole.

d. You have been provided by Sir Leopold McClintock and by Dr. Nansen with complete details respecting sledge work both by men and dogs, and you have yourself superintended every item of the preparations connected with food, clothing and equipment. You will be guided by the information and knowledge thus acquired.

e. Lieut. Armitage, R.N.R., who has been appointed second in command and navigator to the expedition, has had experience in the work of taking astronomical, magnetic and meteorological observations during three Polar winters. He has also acquired experience in sledge traveling and in the driving and management of dogs. You will, no doubt, find his knowledge and experience of great use.

f. Early in 1903 your ship should be free from the ice of the winter quarters, and you will devote to further exploration by sea so much of the navigable season as will certainly leave time for the ship to return to the north of the pack ice. Having recruited at your base station, you will then proceed with your magnetic survey across the Pacific and return to this country.

19. If, on the other hand, you should decide not to winter, you will bear in mind that it is most important to maintain scientific observations on land throughout the winter, and therefore if you are able, in consultation with the director, to find a suitable place for a landing party between Cape Johnson and Cape Crozier, and decide that such a party can be landed and left without undue risk, the following instructions will apply:

a. You will land a party under the command of such person as you may ap-

point. Such party shall include the director, the physicist, and one of the surgeons, and such other persons as you may consider desirable. But no person is to be left without his consent in writing, which you will be careful to obtain and preserve.

b. You will give every practicable assistance in establishing on land this party, which you will supply with all available requisites, including a dwelling hut, an observer's hut, three years' provisions, stores, fuel, sledges and dogs.

c. No landing party is to be established on any other part of the coast than that between Cape Johnson and Cape Crozier, as it is above all things essential that in case of accident the approximate position of the party should be known.

d. Before it is so late as to endanger the freedom of your ship, you will proceed north of the pack and carry out magnetic observations with sounding and dredging over as many degrees of longitude (and as far south) as possible, so long as the season and your coal permit, and then return to your base station, whence you will telegraph your arrival and await further instructions.

20. You are to do your best to let us have, and to leave where you can, statements of your intentions with regard to the places where you will deposit records, and the course you will adopt, as well as particulars of your arrangements for the possible need of retreat, so that in case of accident to the ship, or detention, we shall be able to use our best endeavors to carry out your wishes in this respect.

21. In an enterprise of this nature much must be left to the discretion and judgment of the commanding officer, and we fully confide in your combined energy and prudence for the successful issue of a voyage which will command the attention of all persons interested in navigation and science throughout the civilized world. At the same time, we desire you constantly to bear in mind our anxiety for the health, comfort and safety of all entrusted to your care.

22. While employed on this service you are to take every opportunity of acquainting us with your progress and your requirements.

23. In the unfortunate event of any fatal accident happening to yourself or of your inability, from sickness or any other cause, to carry out these instructions, the command of the ship and of the expedition will devolve on Lieutenant Armitage, who is hereby directed to assume command and to execute such part of these instructions as have not been already carried out at the time of his assuming command. In the event of a similar accident to Lieutenant Armitage the command is to devolve on the executive officer next in seniority on the articles, and so on in succession.

24. All collections and all logs (except the official log), journals, charts, drawings, photographs, observations and scientific data will be the joint property of the two societies, to be disposed of as may be decided by them. Before the final return of the expedition you are to demand from the naval staff all such data, which are to be sealed up and delivered to the two presidents, or dealt with as they may direct. The director of the civilian scientific staff will be similarly responsible for the journals, collections, etc., of the officers under his control. You and the other members of the expedition will not be at liberty without our consent to make any communication to the press on matters relating to the affairs of the expedition, nor to publish independent narratives until six months after the issue of the official narrative. All communications are to be made to us, addressed to the care of the Secretary of the National Antarctic Expedition, London.

25. The *Discovery* is not one of his Maj-

esty's ships, but is registered under the Merchant Shipping Act, 1894, and is governed by it. Copies of this act will be supplied to you. You will see that the officers and crew sign the ship's articles as required by the act. The scientific staff will not sign articles, but are to be treated as cabin passengers. You must be careful not to take more than 12 persons as passengers.

26. The vessel has been covered by insurance, and, in the event of her sustaining any damage during the voyage, to recover the claim from the underwriters it will be necessary for you to call in the services of Lloyd's agent, or, in his absence, an independent surveyor, at the first port of call, in order that the damage may be surveyed before repairs are effected. His survey report, together with the accounts for repairs and supporting vouchers should be sent to us by first mail, together with a certified extract from the official log reporting the casualty.

In the event of damage occurring after you have left civilized regions precise particulars should be entered in the log, and the damage should be surveyed and repaired as soon as you return to a port where Lloyd's agent or other surveyor is available.

27. The *Discovery* is the first ship that has ever been built expressly for scientific purposes in these kingdoms. It is an honor to receive the command of her; but we are impressed with the difficulty of the enterprise which has been entrused to you and with the serious character of your responsibilities. The expedition is an undertaking of national importance, and science cannot fail to benefit from the efforts of those engaged in it. You may rely upon our support on all occasions, and we feel assured that all on board the *Discovery* will do their utmost to further the objects of the expedition.

INSTRUCTIONS TO THE SCIENTIFIC DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF.

1. The Royal Society and the Royal Geographical Society have approved your appointment as Director of the Civilian Scientific Staff of their Antarctic Expedition.

2. A copy of the instructions to the commander of the expedition accompanies these instructions, which are supplemental to them. You will see from the instructions to the commander what the objects of the expedition are, and your position relatively to them.

3. You will direct the scientific work of the gentlemen who have been appointed to assist you.

4. The names of the gentlemen associated with you are as follows:—(1) Mr. Hodgson (biologist); (2) Mr. Shackleton (physicist). The services of the two medical officers will be at your disposal for scientific work when not engaged on the work of their own department—namely, Dr. Koettlitz (botanist), and Dr. Wilson (zoologist).

5. You will note that the commander of the expedition has been instructed to communicate freely with you on all matters connected with the scientific objects of the expedition, and, as far as possible, to meet your views and wishes in connection with them. The societies feel assured that you will cooperate and act in concert with him, with a view, as far as possible, to secure the success of an enterprise which it is hoped will be attended with important results in the various branches of science which it is intended to investigate.

6. All collections, logs, journals, charts, drawings, photographs, observations and scientific data will be the joint property of the two societies, to be disposed of as may be decided by them. Before the final return of the expedition, you are to demand from the staff under your control all such data, which are to be sealed up and delivered to the two presidents, or dealt with as they

may direct. On the return of the expedition you will be expected to superintend the distribution of specimens to specialists approved of by the two councils or their representatives, and to edit the resulting reports. You will also be expected to contribute a report on the scientific results of the expedition for the official narrative. As it may be desirable during the progress of the voyage that some new scientific discovery should be at once made known in the interests of science, you will, in such a case, inform us of it by the earliest opportunity.

7. You and the other members of the expedition will not be at liberty, without our consent, to make any communication to the press on matters relating in any way to the affairs of the expedition, nor to publish independent narratives until six months after the issue of the official narrative. All communications are to be made to us, addressed to the care of the secretary of the National Antarctic Expedition, London.

8. Should any vacancies in the scientific staff occur after the expedition has sailed from England, you may, with the concurrence of the commander, make such arrangements as you think desirable to fill the same, should no one have been appointed from England.

9. You and the members of the scientific staff will be cabin passengers joining the expedition at your own risk, and neither the owners nor the captain are to be responsible for any accident or misfortune which may happen to you. You will obtain from each member a letter to this effect.

The instructions are signed by the Presidents of the Royal Society and the Royal Geographical Society.

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*TEACHING OF CHEMISTRY IN SCHOOLS—1876, 1901.**

Before comparing, or contrasting, the teaching of chemistry twenty-five years ago with that of to-day, it seems desirable to trace briefly the evolution of chemistry from a much earlier period. This will enable us to see at what part of the evolutionary line high-school chemistry had arrived when the American Chemical Society was founded, and where it now is.

In the alchemistic age the effort was to conceal, not reveal, facts. All the language is most obscure, and writers are pervaded with the idea that the wrath of God will rest upon them if they reveal the secrets of their laboratories. Basil Valentine says he fears he has spoken so plainly that he shall be doomed at the last great day; but the modern French writer Figuier facetiously remarks that all the adepts who have ever tried to decipher his language regard it as certain that he was one of the elect. There was no teaching, as there was no science. A little later, when an alchemist disclosed the philosopher's stone or the elixir it was to a few persons for large money considerations. If he made pretended transformations into gold in presence of spectators, the *methods* were kept secret.

With the advent of scientific chemistry, even among the phlogistics, secrecy became a lost art. Experiments began to be written about and talked of, but were not at first made in public. Books contained no illustrations. The question and answer method got into chemistry as in all other teaching. Jane Marcet's little book 'Conversations on Chemistry,' first published in London in 1806—which ran through 20 editions and was revised as late as 1855—set two generations to thinking of the marvelous revelations of nature. It consisted wholly of questions and answers, only the later editions being illustrated.

With the Lavoisierian chemistry—in fact, antedating it somewhat—came the demonstrative lecture method of teaching. As the professor—for this was a feature of colleges and medical schools only—performed his

* Read at the 25th anniversary of the American Chemical Society.