The Liquefaction of Gases.

—By—
PROFESSOR EASTERFIELD,
(Victoria College)
Wellington.

In many cases the historical method of treatment leads most easily to a clear understanding of the subject under consideration ; this is certainly the case with the subject of gas liquefaction.

Northmore, of London, liquefied chlorine gas in the year 1805 by compressing the gas by means of a brass syringe. Eighteen years later Michael Faraday rediscovered the fact that gases could be liquefied by pressure, and the apparatus he employed was so simple that it is worth describing.

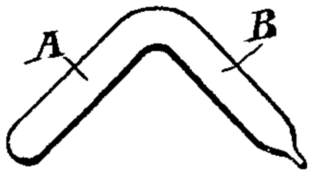


FIGURE 1.

In the limb, A, of a bent glass tube was placed some substance which would give off the desired gas on warming. The end of limb, B, was then hermetically sealed before the blowpipe. Upon heating the limb, A, so that gas was evolved, great pressure was developed within the apparatus, and some of the gas was liquefied and collected in the cold limb, B.

With this simple apparatus Faraday demonstrated that pressure alone would liquefy sulphuretted hydrogen, cyanogen, carbonic anhydride, chlorine, sulphurous acid, ammonia and laughing gas. The last five gases are liquefied by pressure on a commercial scale at the present day. The ascertained pressures in Faraday's tubes were as high as sixty atmospheres, and explosions were not unfrequent.

Faraday quickly recognised that cold was just as great a factor as pressure in producing liquefaction, and aided the process by surrounding the limb, B, of his tube with ice, ice and salt, or some other convenient freezing mixture. In his later experiments he compressed the gases by means of powerful compression pumps, and cooled the compressed gases by a mixture of solid carbonic anhydride and ether. He was unable to liquefy oxygen ; and this gas, together with hydrogen, nitrogen, and a few others, resisted all attempts at liquefaction for many years. They were therefore classed together as permanent gases Faraday believed that the failure to liquefy these gases was due to his inability to obtain sufficiently low temperatures, rather than an inability to generate high pressures. This view was confirmed by Natterer, who failed to liquefy the "permanent" gases at pressures of two thousand atmospheres.

A most interesting observation had been made in 1822 by Cagniard de la Tour, viz — that if a sealed tube partly filled with water be slowly heated to a temperature of 360° C, the tube appears to be perfectly empty owing to continuity between the liquid and gaseous states Thomas Andrews, of Belfast, showed in 1869 that there must be such a "critical" temperature for each liquid, and that above the "critical" temperature no amount of pressure could cause liquefaction. From this time onwards, therefore, experimenters directed their attention mainly to the procuring of low temperatures.

At the meeting of the French Academy on December 24th, 1877, it was announced that Pictet of Geneva had liquefied oxygen, by surrounding a tube of highly compressed oxygen with a bath of liquid carbonic anhydride, the temperature of which was kept at – 140° C by means of rapid evaporation. At the same meeting it was stated that Cailletet ,of Paris, had liquefied oxygen by allowing the highly compressed gas to suddenly expand. For great heat is developed when a gas is compressed, and conversely a fall of temperature occurs if a compressed gas be allowed to expand.

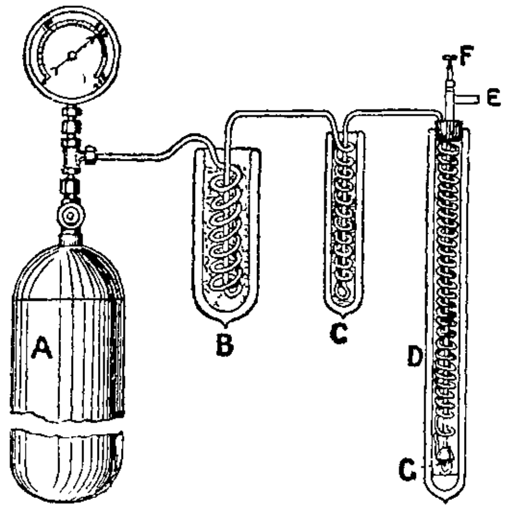
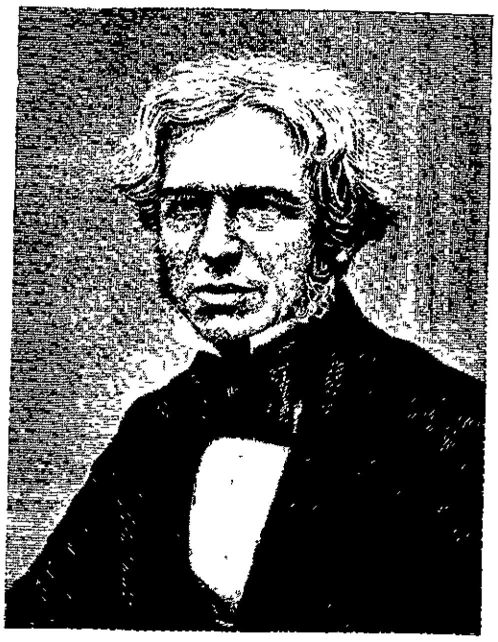


FIGURE 2.

Perhaps the most notable experiments upon gas liquefaction in recent years are those of Dewar, carried out in the Royal Institution in Faraday's old laboratory (see fig. 2) By allowing compressed hydrogen to expand through a fine nozzle,G, at the end of a long spiral tube, around which the expanded gas was allowed to circulate, and thus employing the principle of "reversed currents," Dewar has succeeded in liquefying hydrogen, a task which had defied the labours of all previous investigators. By boiling hydrogen under reduced pressure in one of his well-known vacuum vessels the temperature fell so low that the hydrogen froze to a solid mass, the temperature of which was only 13° above the absolute zero. At these low temperatures india rubber becomes as brittle as glass, lead as elastic as steel, most chemical reactions cease, and eggshells acquire the property known as phosphorescence—truly a wonderful change in the properties of matter.

It is not improbable that many of Faraday's contemporaries wondered that a man of his abilities should devote much time and labour to such a non-utilitarian subject as gas-liquefaction. Neither he, nor the men of his time can have forseen that, based upon his discoveries, a system of freezing machines would be constructed without which the frozen meat industry could never have originated. They could not have anticipated that by the partial liquefaction of air the oxygen would be separated from the nitrogen, and become an every-day article of commerce. In this respect, however, the liquefaction of gases is only an example of the fact which is now realised by thinking men, and must sooner or later be recognised by our educational authorities, viz :— that the scientific toy of to-day is the power giving machine of to-morrow.

Scientific researches, however abstruse and apparently useless, have an immense technological importance, and a still higher educational value ; and no system of education can be considered sound which does not regard the development of the spirit of original investigation as one of its highest ideals.



Michael Faraday.

The Straker Steam Wagon.

The progress made during the last few years in the Old World has not been long in extending itself to these shores, and from the success attained by the Straker 5-ton tipping wagon, imported at the beginning of the year by the Auckland City Council, it is evident that this mode of traction for cartage of road metal and heavy goods will be adopted by all progressive councils, contractors and carriers in the near future. A machine that is successful in negotiating the very steep grades in and around Auckland cannot fail to be successful in any other part of the colony, and the following report on the working of the Auckland Straker will prove of interest. The amount carried per day has varied somewhat according to distance, but as an instance this wagon has taken 6 loads of 5 yards each to Ponsonby, 2½ miles each way, and 6 loads of 5 yards each to Cox's Creek, about 3½ miles each way. The cost of running, taking the average during the three months, works out at 2d. per ton per mile, reckoned on the following basis of weekly expenses .—

	£	s.	d.
Fuel consumption ..	1	5	0
Lubricating oil		6	0
Wages	3	0	0
Repairs, so far, have only been of a very trifling nature, but would be amply carried out at 10/– per week		10	0
Depreciation @ 15% ..	2	2	0
Interest on Capital @ 5%		14	0
	7	17	0

From the above figures it will be seen that this wagon, costing under £8 per week, including all working expenses, depreciation and interest, is doing the work of six two-horse carts, the cost of which would be £6 per day or £36 per week ; so that a saving is made of £28 per week, or over £1,400 per year. In other words the wagon will be paid for and a saving of £500 made in the first year's working. The chief features of the Straker machine are its water-tube boiler with its 474 tubes, enabling steam to be made very rapidly ; and the wonderful pair of 45-h p. compound engines with their patent reversing gear ; but the whole of the mechanism in this machine is up-to-date, and is carried out in a workmanlike manner.

The "Journal du Petrole" states that water only quickens the flame of petroleum or of gasoline.