gauge by measurement the capacity of the space not emptied, when the piston of the pump is returned, to enable us to make the necessary calculations to find the number of particles. Perhaps the best way of gauging would be to test air which gave, say, five drops per square millimetre, when using $\frac{1}{20}$ of impure air, and working in the usual way. Then test this same air and see how many it gave when using the contents of the small space above the piston. Perhaps it might give one drop per four square millimetres. If a series of tests give these figures as the average number, we would know that the capacity of the space was $\frac{1}{20}$ of the $\frac{1}{20}$ measure, or the $\frac{1}{1000}$ of that of the receiver. So that whatever number we observed in the air of the receiver when working in this manner would require to be multiplied by 1000 to get the number in the air tested.

The instrument is so constructed, that when the different parts are unscrewed they fit into a case $4\frac{3}{8}$ inches by $2\frac{1}{2}$ inches by $1\frac{1}{4}$ inches deep, or little larger than a well-filled cigar-case. The weight of the instrument, without the case, is a little under 8 oz.

On the Action of Metallic (and other) Salts on Carbonate of Lime. By Robert Irvine, F.C.S., and W. S. Anderson.

(Read January 9, 1891.)

It is well known that pseudomorphic changes take place with many minerals. These changes may be either by alteration or displacement. In the case of carbonate of lime they are generally of the former order.

Among other work conducted at the Marine Station, Granton, during the past year, a number of experiments were instituted with the view of showing how far carbonate of lime was influenced in this direction by metallic and other salts.

Corals, preferably the more porous and soft varieties, were selected for this purpose, and these were exposed to the action of solutions of the following salts:—Chloride of manganese, sulphate of iron, chloride of zinc, chloride of chromium, nitrate of nickel, nitrate of cobalt, nitrate of copper, nitrate of lead, chloride of mercury, chloride of tin, nitrate of silver, phosphate of ammonia.

In many cases the action was very slow, especially in the case of

the salts of nickel and cobalt. On the other hand, with salts of copper and manganese, the action was sufficiently rapid so as to make a material difference, within a few weeks, in the composition of the coral exposed to their action.

In most cases there is a direct interchange between the lime (of the carbonate of lime) and the oxide of the metal which takes its place. Thus we have :—

1. With a copper salt, in seven months, 26·4 per cent. of carbonate of copper taking the place of an equivalent amount of carbonate of lime.
2. With chloride of manganese, in twelve months, 58·4 per cent. of carbonate of manganese.
3. With salts of iron practically the whole coral is altered—first, into carbonate, and ultimately, on exposure to air, into sesquioxide of iron.
4. With salts of zinc, 26·8 per cent. of carbonate of zinc had formed in six months.
5. With phosphate of ammonia the transference was between the carbonic acid of the coral and the ammonia of the salt. The lime having combined with the phosphoric acid to an extent equal to 60 per cent. of phosphate of lime.

Without doubt, phosphate of lime deposits, especially those found on old coral islands, have had their origin in this manner, the phosphoric acid being derived from the excreta of wild fowl, deposited upon dead coral or carbonate of lime, the amount of pseudomorphic change being in accordance with the quantity of guano deposited. Of course, transference between carbonate of lime and alkaline phosphates can only take place in the presence of water, so that we have no such pseudomorphs where the climate is rainless; there the guano remains as deposited, whilst these deposits in rainy zones always assume the form of insoluble phosphate of lime.

Carbonate of lime, with silver and mercury salts, seems to throw down oxides, not carbonates. But the compounds with nickel and cobalt we have, as yet, been unable to determine.

With a true pseudomorph, the structural form of the carbonate of lime, be it in the shape of *coral*, *shells*, or *calcite*, remains

unchanged; when, however, an oxide is produced, as in the case with tin and mercury salts, it forms merely a superficial coating.

From the results of numerous experiments, which it is unnecessary to record here, we have good grounds for assuming that carbonate of lime, either in a massive or comminuted condition, or in solution, carries out the most important function of withdrawing metallic and other bodies from sea-water, which may be said to hold (often in minute amount) almost every elementary substance in solution, and fixing these in a concentrated condition.

The geological significance attaching to this property of carbonate of lime is apparent, as, without question, many metallic ores owe their origin to this source.

Manganese Deposits in Marine Muds. By Robert Irvine, F.C.S., and John Gibson, Ph.D.

(Read January 9, 1891.)

Two theories have been put forward in order to explain the formation of manganese deposits in marine muds, and more particularly with regard to manganese nodules: one by Murray, in a paper read before this Society in 1876, the other by Buchanan in 1888. Murray assumes the gradual oxidation of carbonate of manganese resulting ultimately in the formation of hydrated peroxide of manganese. Buchanan first propounded his theory in 1880, and subsequently, in a paper read before this Society in December 1890, argues as follows:—

“The principal agent in the comminution of the mineral matter found at the bottom of both deep and shallow seas and oceans is the ground fauna of the sea, which depends for its subsistence on the organic matter which it can extract from the mud.

“In order to fit them for collecting their nutriment in this way, the animals have been fitted with different forms of masticating or milling apparatus, so as to thoroughly deal with the matter which they pass through their bodies. It has been shown that most silicates are decomposed to a certain extent when ground or pulverised under water; so that the mere mastication of the sand or mud in presence of pure water would have a decomposing action on