80 and systolic B.P. 135 mm. of mercury. The abdomen was rigid, lateral pressure on the pelvis elicited free movement and catheterization revealed pure blood. 1,000 c.c. of Stored Group IV blood were given and laparotomy performed. The intestines were undamaged, there was an intraperitoneal rupture of the fundus of the bladder which was sutured from the peritoneal aspect and the peritoneum closed; an extraperitoneal rupture near the left ureteric orifice was sutured with non-chromic catgut from inside the bladder and the dislocated prostatic urethra was rail-roaded on a catheter and the surfaces of the ruptured urethra apposed. The lateral vesical space was drained and a large tube left in the bladder and the catheter splint was anchored to the suprapubic wound.

The urethral catheter was left in site for ten days and then removed. He passed urine on the fourteenth day and the bladder healed within a month. The treatment of the fracture dislocation of the pelvis necessitated eight weeks' recumbency, basal pneumonia complicated convalescence and the urine was heavily infected with *B. coli* and contained pus. Constant efforts to maintain an adequate fluid intake, to produce an acid urine and to sterilize the urine, failed. Multiple recumbency calculi developed which had to be removed at two operations. A right pyelolithotomy and suprapubic lithotomy were withstood and fourteen days later left pyelolithotomy was performed. A further stone was present in the left side at the region of the pelvic brim and as the kidney showed some evidence of hydronephrosis a nephrostomy was performed. This wound soon healed and he was well enough to be repatriated.

SUMMARY.

The diagnosis of traumatic hæmaturia is discussed in an attempt to present a simple system for diagnosis.

Cases of rupture of the kidney, simple and compound, ruptures of the bladder and prostatic urethra are described.

My thanks are due to Colonel F. Whalley, *D.S.O.*, *T.D.*, K.H.P., who commanded the hospital in which the patients were treated, and to Colonel A. S. Heale, *M.C.*, D.D.M.S. of the Command abroad, for permission to submit this article for publication.

ADAPTING THE FIELD BOYLE'S ANÆSTHETIC APPARATUS FOR CARBON DIOXIDE ABSORPTION.

BY MAJOR REX BINNING,

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THERE are many advantages that may be claimed for the principle of carbon dioxide absorption during anæsthesia, such as economy of anæsthetic gases, prevention of heat and water vapour loss from the patient and quiet respirations during anæsthesia. In wartime, when the value of shipping space has to be measured, not in terms of money but of men's lives and available tonnage, the question of economy is pre-eminent.

If the apparatus, Boyle, Field Service pattern, be used with the normal

semi-closed technique a hundred gallon cylinder of nitrous oxide will give about one and a quarter hours anæsthesia. If the carbon dioxide absorber that is about to be described is used a hundred gallons will last at least ten hours, representing a saving of 800 per cent. The saving of oxygen and ether is proportional. Gas cylinders are bulky and difficult to transport, empty cylinders have to be returned and if this saving is considered in relation to the requirements of a number of general hospitals and C.C.S.s it will be seen that it represents a very real economy.

In evolving this apparatus two factors were kept in mind. The apparatus must involve no structural alteration to the existing apparatus so that the machine is readily available for either the semi-closed or the absorption techniques. The design must be such that its construction can be effected with the tools supplied to the sappers attached to a general hospital.

There are two types of absorber, the to-and-fro type that was designed by Waters, in which the absorption canister is close to the patient, and the circle type with the canister remote from the patient that was developed by Sword. The Waters' type is the simpler and lends itself more to improvised construction and is the type that is described.

The canister is made from a tin 6 by 3½ inches. To the inside of the lid is soldered a cigarette tin lid pierced with holes to form a baffle to retain the soda lime. The bottom of the tin has a hole cut in it and a piece of 1 inch tubing soldered into it. This tube projects almost the whole length of the tin and is pierced with holes. This ensures that a large surface of soda lime is in contact with the exhaled gases and that resistance to breathing is reduced to a minimum. To the length of tubing that projects outside the tin is fixed a rebreathing bag from a nitrous oxide apparatus. This bag has a small opening at the opposite end of the bag and through this are led the fresh gases from the machine. Into the lid of the canister is soldered the three-way valve from a nitrous oxide apparatus and this will fit either into an anæsthetic mask or an endotracheal connexion.

The carbon dioxide absorption technique demands an oxygen flow of between 200 and 400 c.c. a minute to meet the patient's basal requirements. The "bubble bottle" of the Field Boyle will not measure such a small flow. A flowmeter was therefore devised. This works on the water depression principle. A bottle fitted with a long and a short glass tube is filled four-fifths with water and strapped to the "bubble bottle" as shown in the illustration. The long tube is connected to a T-piece. To one arm of the T is led the oxygen from the cylinder and the other is attached to a 14 gauge needle which is pushed through a cork and fixed into the filler of the "bubble bottle" in place of the usual cork. The short tube is connected to the normal oxygen inlet on the top of the "bubble bottle."

Flows of between 100 c.c. and 1,000 c.c. a minute are read by the amount that the column of water in the long tube is depressed while the oxygen passes into the machine through the needle. If a litre or more of oxygen per minute is required it bubbles through the depression tube and through

the bubble bottle in the ordinary way. The flowmeter was calibrated by means of a measuring cylinder and a stop watch. The cylinder was filled with water and inverted over a basin of water. Oxygen was bubbled into

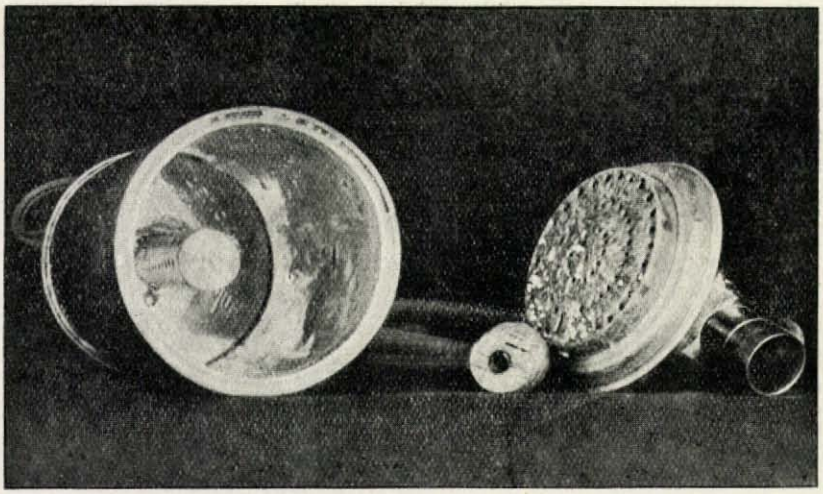


FIG. 1.—Showing canister open and arrangement of baffles.

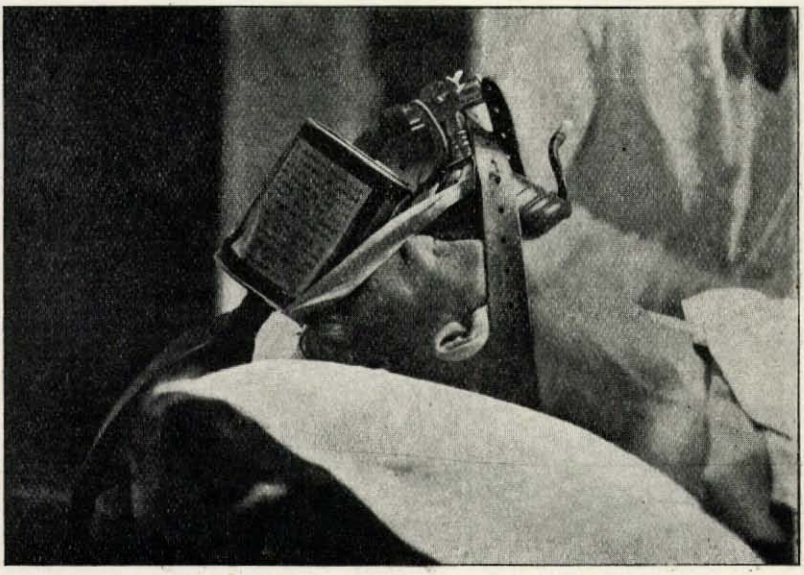


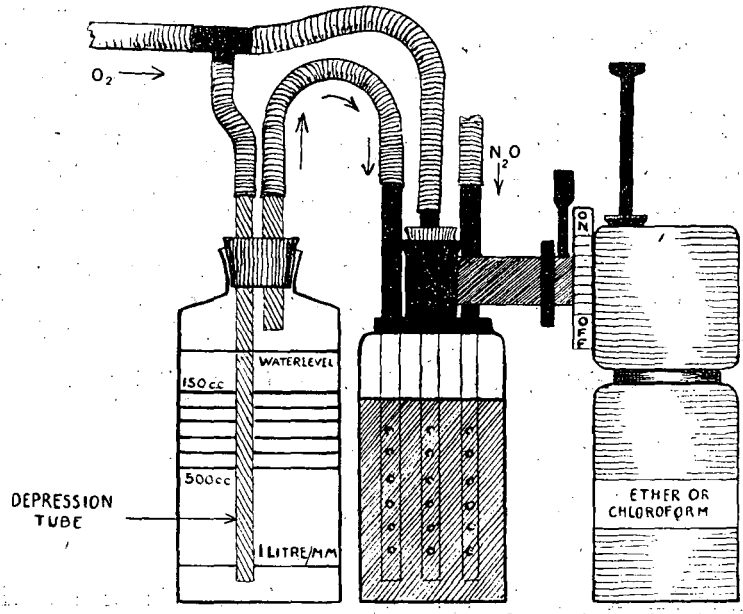
FIG. 2.—Absorber in use. (This is the first absorber that was made.)

the cylinder and from the amount of water displaced in a given time the rate of flow for various degrees of depression of the column was easily

calculated. This was recorded on a cardboard scale and strapped to the back of the flowmeter.

If the apparatus is required for use with the semi-closed technique it is merely necessary to connect the oxygen tube to the bubble bottle in the normal position and replace the cork with the needle through it by the proper cork and the apparatus functions in the ordinary manner.

When using the absorption technique the patient is induced with the semi-closed technique and when the required plane of the third stage is reached the absorber is fitted, the flow of nitrous oxide is cut off and the oxygen flow reduced to about 350 c.c. according to the amount required to



Drawn by Captain Waugh, R.A.M.C.

FIG. 3.—Showing the connexions to the Field Boyle. (The tube bringing CO_2 to the connexion on top of the bubble bottle is hidden by the tube bringing O_2 to the needle.)

keep the bag just full. During the first fifteen minutes the bag is emptied two or three times in order to get rid of the nitrogen from the circuit but after that time it is merely necessary to add a little nitrous oxide from time to time to replace leakages.

It will be obvious that I am indebted to Dr. Pask for the idea of using a needle to provide the necessary resistance in a water depression flowmeter.

My thanks are also due to Sapper Hicks, the R.E. attached to this General Hospital. He has constructed and modified two canisters and has shown a ready appreciation of the problems involved in their construction.