407. *The Lubrication of Taps with the Phosphoric Acids.*

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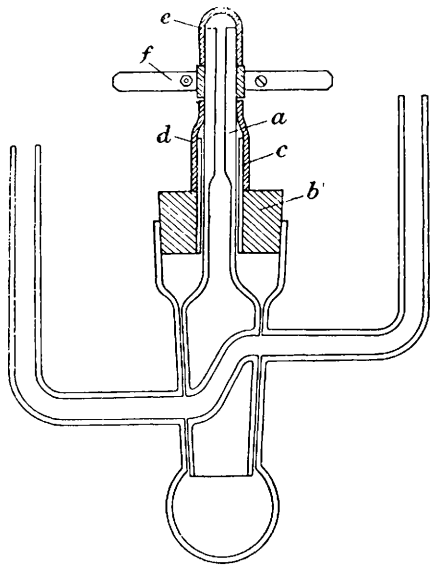
A new tap is described in which phosphoric acid is used as lubricant. Details are given for the preparation of the latter and for using the tap.

HITHERTO the lubricant used for taps has been made from one or other of the phosphoric acids or from a mixture of the acids when it has been required to exclude from the

apparatus the vapours of organic compounds, as in spectroscopic investigations and in work with corrosive gases. However, the difficulties encountered when these inorganic lubricants are employed are considerable. If the lubricant is of such a composition that the tap will turn at room temperature, it is gradually pressed out from between the key and the barrel, and in a week or so the tap seizes or the mercury, which must be used to protect the lubricant from the moisture of the air, creeps down to the bore and enters the apparatus. Moreover, the pressure of the water vapour of such a lubricant is not inconsiderable, and commercial specimens of phosphoric acid and its anhydride are liable to contain volatile impurities which in several investigations have been shown to affect the results appreciably.

These difficulties have been overcome by the use of a specially prepared lubricant and a suitably designed tap. The latter can be used continuously with or without turning for months with very little danger of its ceasing to function satisfactorily.

The Lubricant.—The lubricant is prepared entirely from fused metaphosphoric acid, since the fused ortho-acid is liable to be contaminated with organic impurities. About 35 g. of metaphosphoric acid (sticks) are thoroughly rinsed several times with distilled water, transferred to a porcelain basin, and covered with water. The whole is heated at about 110° with occasional stirring until the acid is dissolved, and the clear solution obtained is maintained at the same temperature for 2 hours. The solution is thereby completely converted into an aqueous solution of orthophosphoric acid. The temperature of the oven is then kept at 140—150° for another 2 hours in order to concentrate the solution. The liquid is then transferred to a heavy-weight "Monax" boiling-tube, and heated with the flame of a Bunsen burner until the b. p. indicated by a thermometer immersed in the solution rises to 310°. After this the thermometer is removed, and the boiling continued for a definite time depending on the temperature at which the lubricant is required to soften. We find that with the quantities given, fairly vigorous boiling for a little under 2 minutes will provide a lubricant for a tap required to turn smoothly at 80°. The mouth of the tube is then closed with a rubber stopper through which a well-fitting glass rod has been previously inserted so that the rod reaches almost to the bottom of the tube.



The Taps.—These are of the usual mercury-sealed type, modified as shown in the diagram. The stem of the key, *a*, is a thick-walled glass tube, which is open to the cavity of the key. The key is not, as is usual, provided with a hole in its shoulder for the admission of mercury to the interior of the tap. The mercury can be introduced through the tubular stem of the key. The cup of the barrel of the tap is fitted with a rubber stopper, *b*, through which a short length of thin-walled glass tubing, *c*, is inserted so that the stem of the key when in position does not touch the inner surface of the tube. To prevent the entrance of air to the cup of the tap, a rubber tube, *d*, which fits but does not grip the stem of the key, is passed over the glass tube inserted through the stopper. Air is prevented from entering the cavity of the key by fitting on to the end a rubber cap, *e*. A metal handle, *f*, is clamped to the stem when the tap is being used. As shown in the diagram the key should extend beyond the barrel so as to protrude about 1 mm. into the mercury reservoir at the bottom of the latter.

Method of Lubricating the Taps.—The outside of the tap is heated by its being partially immersed in hot water, at the temperature at which the lubricant will become moderately mobile. The tube containing the lubricant is suspended in the same bath. When the lubricant is sufficiently soft, the key of the tap is removed and liberally smeared with lubricant, especially at the top and the bottom, the glass rod previously mentioned being used for the purpose. It is then inserted into the barrel, which has been removed from the bath, and pressed thoroughly home with much slow turning and repeated heating until there is close

optical contact between the barrel and the key. Excess lubricant will have been squeezed out at the top and bottom of the key and at the entrances to the bore. If the passages to the bore have thereby become stopped, they must be opened while the lubricant is still soft by drawing a current of air through the tap with the water pump. The tap is allowed to cool, and then hot distilled water is sucked through the tubes until all phosphoric acid has been removed from the bore and side tubes. After this operation the drying of the tubing can be easily accomplished. The surface of the lubricant pressed out at the top of the key is liable during manipulation to become moist, and this may determine crystallisation, which, however, can be prevented by pouring molten lubricant into the cup.

Use of the Tap.—The tap is sealed into place. Mercury is introduced through the hollow handle until it reaches a position just below the bore, and the cap is replaced at the top of the stem. The tap can be turned conveniently by surrounding it with water warmed to an appropriate temperature, and slowly rotating the key after the lubricant has become soft. During this operation the temperature of the tap should not be higher than that at which the key will turn smoothly although lowly without the application of force.

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