

A slow stream of tap water suffices for "heating" the bath of the "retort." We use a Nelson two-stage vacuum oil pump of a capacity of 5 cu. ft. of free air per minute for vacuum, for the high capacity saves many minutes in starting and eliminates the necessity for bothering about leaks around rubber stoppers. If the bath is heated by a flame, one must watch for a rise in temperature near the end of the evaporation, when the rate has slowed down.

For a capacity of, say, two 12-liter flasks in parallel as "retorts," each containing, say, 7 liters of serum, a condenser of a capacity of 25 to 30 gallons is required. Such steel tanks are used commercially for hot water storage, and may be insulated with 6 inches or more of shavings. If used only occasionally one may use a commercial insulated hot water storage tank, as the insulation dries out when not in use, but an insulation which does not easily rot should be selected. On this scale a vacuum pump of several cubic feet per minute capacity of free air should be used. Tubing for carrying the water vapor should be 1.25 inch or preferably more in diameter. The vacuum pump must naturally give better than the vapor pressure of water at -10° , under *service* conditions. Naturally one will select a condenser giving a large surface above the ice and salt, to increase the condensing rate. The operator should guard against possible serious injury due to collapse of a 12-liter flask under vacuum.

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Inorganic Lubricants. III. Mixtures of Aqueous Liquids with Non-Reacting Solids.—When water is mixed with a finely divided insoluble powder in the correct proportions a cream is produced which has the power of forming a thin, continuous film over a surface capable of being wet by water, is "viscous" in proportion to the amount of solid present, and so may act as a lubricant between two moving surfaces.¹ For purely temporary inorganic lubrication such a mixture may operate satisfactorily, but because the water quickly evaporates, leaving a non-lubricating cake of solid, lasting lubrication is not obtained.

When, however, a hygroscopic inorganic liquid, such as a concentrated aqueous solution of a deliquescent salt or acid, is employed instead of water, drying out does not take place, the creamy state persists and lubrication is maintained for an indefinite length of time depending on the relation between the average atmospheric humidity and the relative hygroscopicity of

¹ See, for example, various U. S. Patents, such as Colby, 49,983, Sept. 19, 1865; Farkas, 1,253,362, January 15, 1918, and others.

the liquid. I have prepared many such mixtures, using solutions of calcium, zinc and ferric chlorides, antimony pentachloride,² sulfuric and orthophosphoric acids and similar substances as liquids, and kaolin, bentonite, talc, graphite, carbon, precipitated silica, etc. (all sieved to pass a 100-mesh screen), as the non-reacting insoluble solids. Bentonite and talc could not be used with acid liquids because a gas-forming reaction takes place resulting in a frothy mixture. Successful lubricants were obtained in considerable variety. Typical examples are listed in Table I.

TABLE I
LUBRICATING MIXTURES
10 g. of solid used in each experiment

Solid	Kaolin	Kaolin	Kaolin	Bentonite	Graphite	Silica
Soln., 50% concn. of	H ₂ SO ₄	CaCl ₂	ZnCl ₂	CaCl ₂	CaCl ₂	ZnCl ₂
Cc. taken	6.0	6-6.5	6.5	8.0	6.5	6.5

MATERIALS.—The kaolin was the N. F. V. product; the silica was an anhydrous, amorphous material (electro-silicon); the bentonite and graphite were fine, commercial powders; and the calcium and zinc chloride solutions were prepared from anhydrous c. p. granules.

Of all the mixtures prepared, the best for general use were those of kaolin and of graphite with calcium chloride solution. After three months, although exposed surfaces of these mixtures had fluctuated in liquidity considerably, lubricating films between ground glass surfaces still operated satisfactorily.

Lubricants of this general kind are distinctly limited in usefulness. Their pasty nature permits clogging of small passages; and too great pressure may thin the lubricating film excessively. Nevertheless, they are useful in organic work when protection against leakage of water-insoluble organic liquids and gases is desired; and some of them can be employed with certain inorganic gases (such as those which may attack the common organic lubricants), particularly when it is not important to maintain great purity of these gases. They offer the advantage of being easily and quickly prepared; and the range of possible mixtures is wide enough to permit a considerable degree of choice in both liquid and solid constituents and so enable any specific requirements to be more suitably met.

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² Mixture of antimony pentachloride solution and kaolin forms a colloidal material, the properties of which will be investigated.