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ON SOME PROCESSES FOR THE SURFACE PROTECTION OF METALS.

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Lecture delivered on May 20th, 1909.

I AM venturing to give this paper, not because of my knowledge of the subject (which is small), but because of our lack of knowledge. The whole matter is one for a technical chemist, but I hope that this brief paper will draw attention to a matter that needs attention—the finish of our work. Of course, the colour of a lacquer or tone of a bronze does not improve the accuracy of a theodolite, but it does improve its selling value.

Further, the subject of surface protection is one that should interest others besides ourselves. When we see rusty girders painted over and used in the construction of skyscrapers, and when we are able to kick a hole through the girder plate of a railway bridge (this is possible in London) we realise that the whole matter is one of importance.

The protection of metal surfaces may be divided into two main types: First, protection against friction; second, against corrosion.

Under the second heading we may place ornamental protection and change of colour for purely ornamental purposes. And the second type may be further subdivided into three further types:—(1) A surface may be protected or ornamented by a coating of material, such as paint, varnish, or lacquer, or (2) by a chemical change of its surface, or (3) by the deposition of some other metal upon its surface.

Protection against corrosion, again, must be divided into two sections:—(1) Where the metal

is in contact with the human skin as in spectacle work, (2) where it is exposed to the atmosphere.

We will deal first with the protection and ornamenting of such surfaces as are used in optical instruments. For this purpose a coat of paint or lacquer is generally used. A paint or japan consists of a solvent such as oil, a medium such as asphaltum, or bitumen, and a colouring pigment. It must be applied to a cold surface and subjected to a period of heating to evaporate the solvent and leave the medium and pigment as a thin and more or less even layer upon the surface. A lacquer consists of an easily evaporated solvent, such as alcohol, a medium of shellac (which may be used in conjunction with other gums, such as mastic), and either a pigment or stain, such as lampblack or gamboge. Another lacquer is used in which the solvent is amyl acetate, and the medium celluloid.

The shellac lacquer is applied to a hot surface, which immediately evaporates the alcohol and leaves the medium and colouring matter as a thin layer on the surface, while the celluloid lacquer is applied to a cold surface, leaving the medium to evaporate slowly of itself.

Various metals and conditions of service will determine the choice of japan or either type of lacquer. Where the surface has to be rubbed a japan is best, since it is harder and in a thicker layer, but where a surface has only to be protected against the atmosphere, or blacked to prevent too great a reflection of light, a lacquer is preferable. Whichever is used, it must be hard enough to withstand friction and sufficiently elastic to follow the expansion and contraction of the surface with varying temperatures. Also, the effect of heat on the pieces to be treated, must be considered. A piece which has been soft soldered together must not be subjected to too great a heat.

It is often necessary to render a surface black,

and a lacquer is unsuitable. A chemical change of surface is then required, termed bronze. The method adopted must depend entirely upon the piece to be blacked and the metal of which it is made. We will take the brasses first. Where heat may be applied, a bronze, consisting of nitric acid, copper, and silver, may be used, but where heat may not be used an ammonia bronze, or a bronze giving a deposit of iron, should be used. If the piece be of steel it may either be coppered first, and then treated with a cold brass bronze, or a sulphur, or phosphoric acid bronze may be used.

In cases where the metal is in contact with the skin, as a spectacle bridge, a deposit, or coating, of an incorrodible metal must be used. Sometimes where an instrument is to be used in extremes of temperature it is absolutely necessary to cover each part which comes into contact with the skin with vulcanite, india-rubber, or leather. The metal absorbs heat more readily than vulcanite, and in very cold climates the loss of heat by the skin may be so rapid as to act almost precisely as if the skin were brought into contact with a very hot surface.

For protection against friction, we may either face the wearing surface with a harder metal or, in the case of steel, harden the surface; while iron may be case hardened. At the same time, for instrument work, the provision of sufficient bearing surface and the exclusion of grit, will not only save expensive hardening, but also expensive adjustments to take up wear.

In the case of spectacle frames made of base metal, we have a protective covering of gold which is an integral part of the material from which the frame is made, and which, during all the processes of manufacture, must be preserved intact on the outer surface of the material. The methods of, and machinery for, doing this work are most interesting; and a paper on the subject before this Society might help to establish gold-filled manufacture on a firm footing in this

country. The ideal spectacle frame, however, would be a steel frame with a substantial hard coat of gold.

Among other methods of protection against both friction and corrosion, by means of a metallic coat, may be mentioned electroplating, which is an industry by itself; and galvanising, both by the hot process and the zinc dust process.

To turn to bronzes, for the brasses I have found the following useful for different purposes.

(1) The silver nitrate bronze. I have found this work best when used as follows. Make a saturated solution of silver nitrate, and add an equal amount of nitric acid, as one solution. The second is nitric acid, which has dissolved as much copper as possible. The piece to be bronzed is dipped successively in each, and steadily heated until black.

(2) The ammonia bronze. This is an excellent bronze, and is made and used as follows. Take 8 ozs. ammonia .866, add 1oz. copper carbonate, and 4ozs. water. Work is to be cleaned and immersed until black, and then wiped dry with cotton waste, and lacquered or not as desired. The only precaution to be taken is to see that no soft solder is on the surface.

(3) For darkening a surface antimony chloride may be used with good effect. This can be applied with a soft brush.

(4) Platinum chloride applied as No. 3.

(5) The ordinary iron bronze. 1lb. hydrochloric acid, $\frac{1}{4}$ lb. white arsenic, and $\frac{1}{4}$ lb. iron perchloride. The worker should be protected against the fumes of this, and the work must be brushed dry with sawdust and bran or black-lead.

(6) The mercury sublimate bronze used as No. 5. This bronze has the peculiar effect of rotting drawn or rolled brass, but for cast work it works well.

Numerous colouring effects may be obtained by the use of hypo. reduced with sulphuric acid;

mercury nitrate, iron nitrate, and other materials, but the above selection in skilful hands will give every effect desired for optical work.

For iron or steel we may use the new phosphoric acid bronze, which not only gives a good black, but affords an excellent protection against rust. A steel spectacle frame protected by this method is exceedingly good. Also the various nitric acid and sulphur blacks are good.

For such work as iris diaphragm leaves, the work may be dipped in a copper sulphate solution and bronze number 2, 3 or 4 used afterwards.

For aluminium I have found No. 5 useful, but it must be washed in plenty of running water. Also dipping in copper sulphate and finishing with No. 2 or 4 gives a good effect. There is room for a good deal of work on aluminium protection and soldering.

As regards an actual coating, I shall not spend time in discussing the various japans and blacks; but one method is exceedingly useful. That is to give the work a coat of medium, such as colourless lacquer, allow it to cool, blacken it evenly by the smoke of an acetylene gas (or candle) flame, and warm till bright. All lacquers and blacks of the lacquer type are improved by the addition of a little boracic acid and a few drops of ammonia.

I think that this matter of surface protection and colouring might well be made a special study by one who has the time and knowledge, since it is not only of interest to us but to everybody who has to deal with metals at all.

In conclusion, I can only trust that my remarks, though not dealing with original research, may at least arouse an interest in the finish of our work. Also I must thank you for your patient attention.