ELECTRIC SCRUBBER FOR CLEANING SHIPS' BOTTOMS WITHOUT DRYDOCKING.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Innumerable devices have been invented to clean a ship's fouled bottom without the necessity of docking. The success achieved has been only moderate. The old-fashioned hogging brushes, with which the submerged parts of wooden ships used to be scrubbed, palliated matters somewhat, but did not quite surmount the difficulty, simply because sufficient force could not be applied to the brushes, and for the reason that with equal force their scrubbing power is very much less for reasons to be explained.

As the old-fashioned hogging brush was dragged along, the brooms had the tendency to be bent aft, and thus to a certain extent to ride over at any rate the harder patches of fouling matter. This was due to the principle of the process of scrubbing, the brush, like the ordinary carpet broom, being pushed in advance of the sweeper. As is well known, it is not possible to sweep a carpet quite clean in this manner without going over the ground several times. If, however, the carpet broom be turned in the hand and used against the lay of the bristles, it sets up a flick. It is this latter principle which has been adopted in the design of the electric scrubber to be here described.

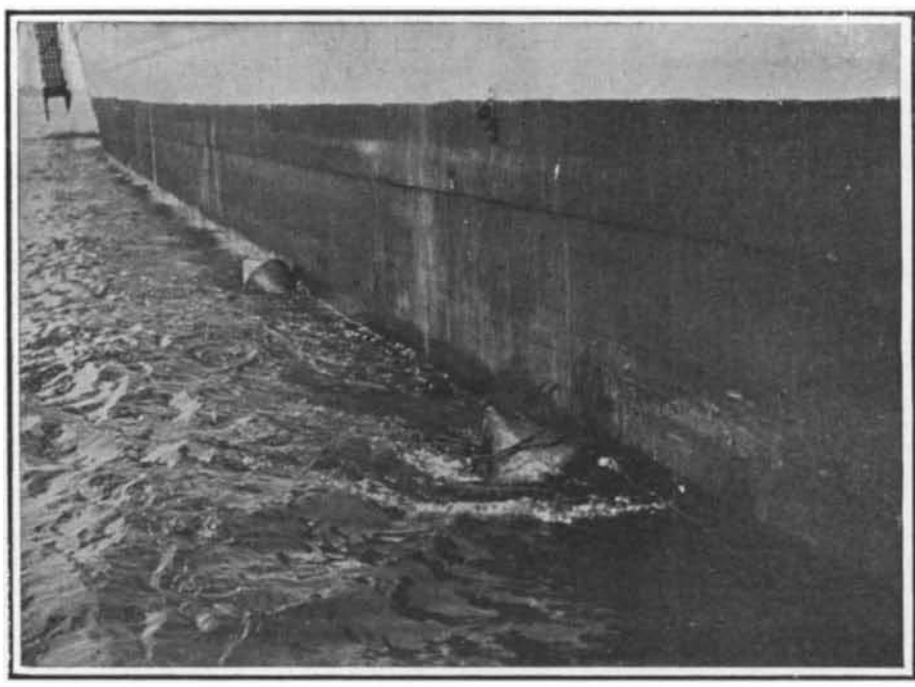
The principle of the appliance is very simple. It is in effect a flexible hogging brush, which is dragged up and down under the hull of the ship by ropes. By the use of electricity the brush is made to cling to the ship's side like a magnet. The "mat," as the group of brushes is called, comprises a series of battens carrying the brushes and magnets. These are threaded at either end on chains, and separated from one another by cork disks, also threaded on the chain, to assist in giving the necessary buoyancy to the apparatus, and to avoid injury to the battens from short-circuiting, which would result if two battens came into contact. At each end of these threading chains is a chain bridle, to which the hauling hawser is shackled. The hawser at each end passes through a fair-leader block, which is shackled to a position chain, and so is taken to a steam winch. One position chain passes right round the ship near the bow, and the other near the stern, while the hauling hawsers are seen fore and aft on the ship's side, with the mat in working position amidships.

The mat itself has a leading batten without a magnet at either end, and six ordinary battens each fitted with two magnets and a set of brushes between. In the mat illustrated there are also two dumb battens, which are incorporated to adjust the buoyancy. In the photograph of the mat itself, it will be observed that the leading battens have each two large brushes set square and in way of the magnets upon the other battens. These brushes clean those parts of the ship which would otherwise be untouched by the brushes of the central battens, and also clear a path for the magnets. On the central battens the brushes are set diagonally, one-half being skewed to the right and the other half to the left. In this manner any tendency on the part of the mat to run crooked is counteracted.

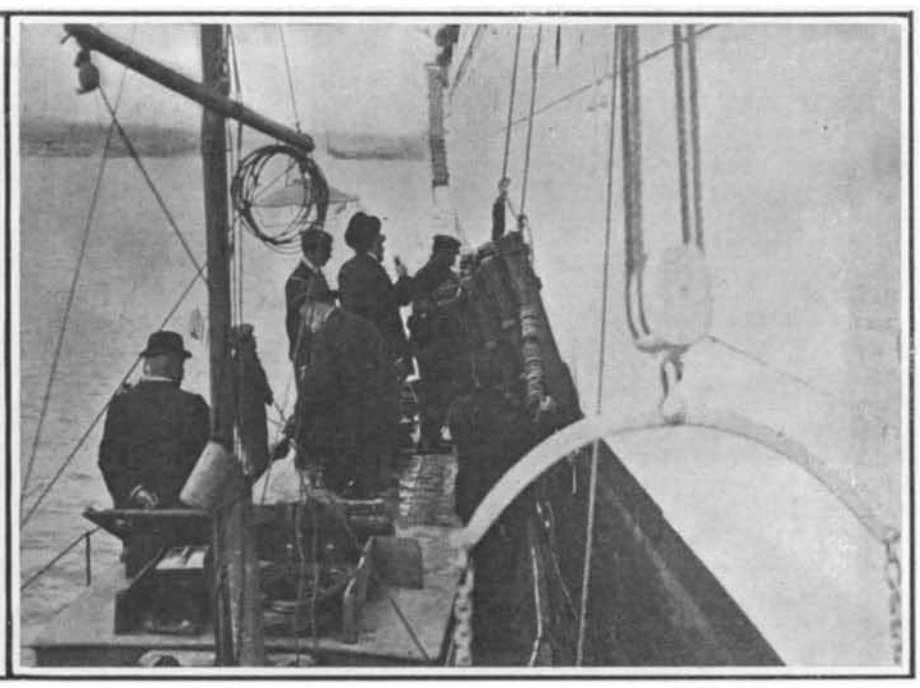
When the mat is slung over the vessel's side and lowered into position, the electric current is switched on. In this position the apex of the curve of each magnet comes into contact with the ship's side and secures a grip thereon, but the brushes are not touching. As soon as hauling commences, however, the battens cant, thus bringing the fore edge of each brush into touch with the hull of the ship. As it is dragged over the fouled surface, the accumulated matter is flicked off. At the same time, of course, the fore side of each magnet becomes engaged. The backs of the battens are so designed as to insure this canting or rocking; and since the mat has to travel indifferently fore and aft, the arrangement has to be double ended. Thus each leading batten has its back made with one bevel on its outer edge, but each middle batten has both edges beveled.

The requisite current is furnished either from the ship itself or from a special tender equipped with the apparatus lying alongside. From actual experience it has been found that the total magnetic grip of the whole mat is well over one ton. A test made with a single magnet on the hard-steel cover of an ammunition hoist proved that the pull amounted to 280 pounds. It was also found that a single batten when attached by its magnets to a ship's side was able to support safely the combined weight of two men. Experience has shown, moreover, that a greater grip is requisite for the very hard steel of modern armor plates than for ordinary steel plates used in the construction of a mercantile vessel's hull. The strain on the hauling hawsers fore and aft is approximately 1.5 tons.

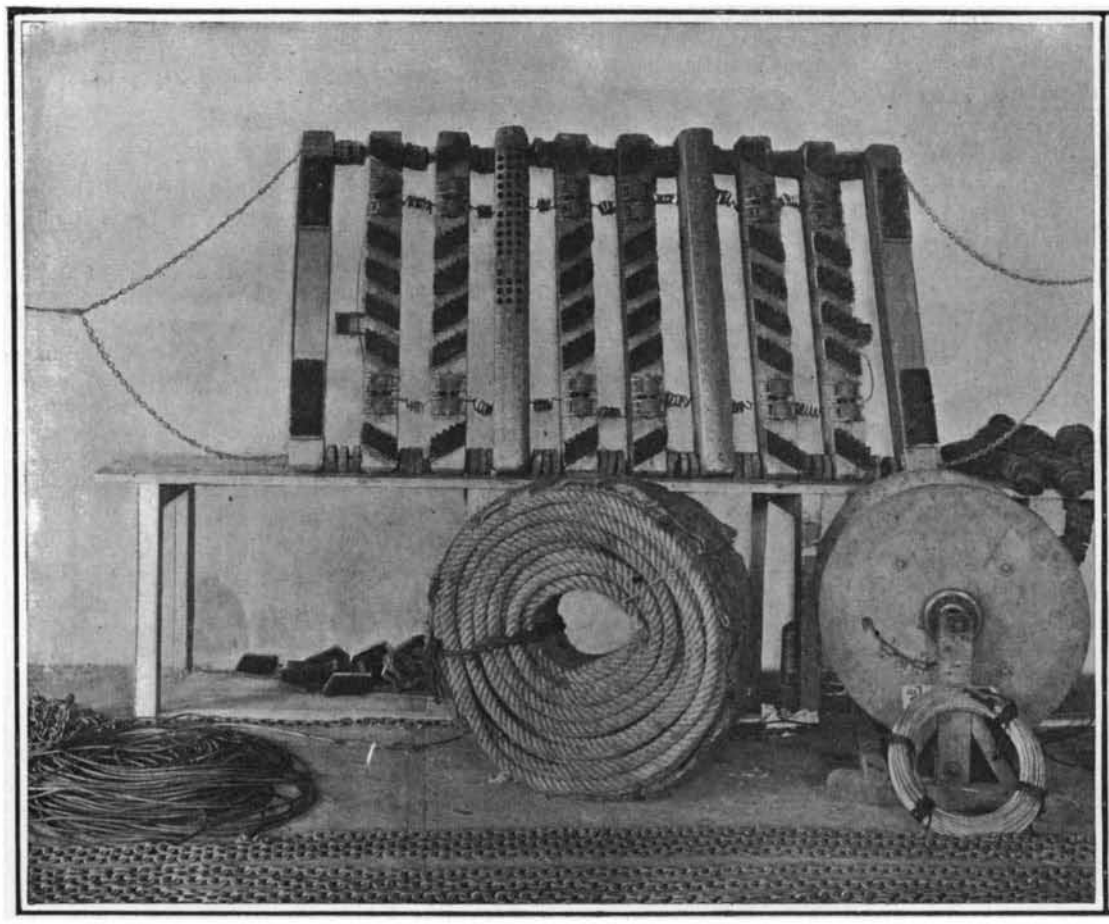
The scrubber requires the attention of only two or three men to work it, and it carries out its task quickly and thoroughly. An 18,000-ton battleship can



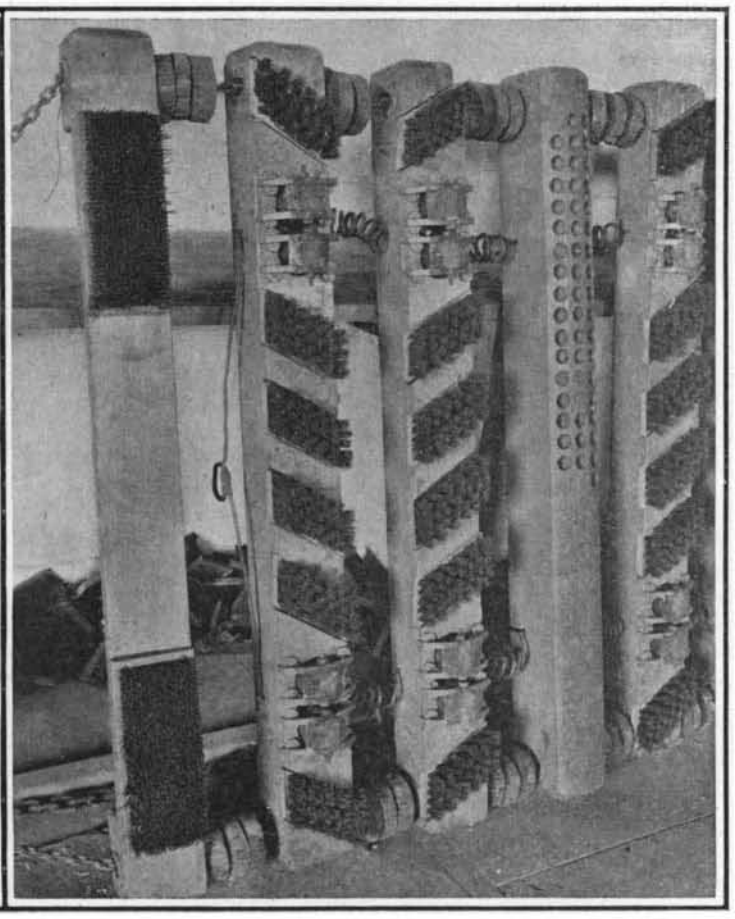
Floating the scrubber fore and aft. Ten tons of shell and weed were removed from one side alone of this steamer.



Lowering the electrical scrubber from the tender. Current in this case is supplied by the tender. It may also be supplied by the ship itself.



The complete gear, showing the mat carried on chains with insulating cork disks between to prevent short circuiting.



Details of mat, showing outer battens with diagonal brushes, magnets, and dumb battens in center.

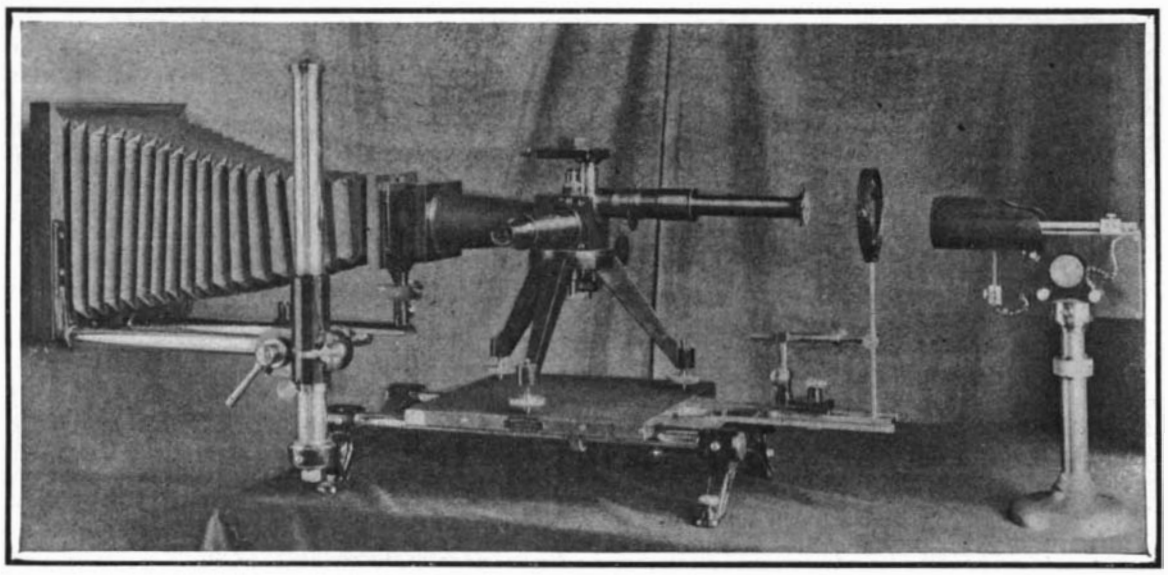
be completely scrubbed in twelve hours, and vessels drydocked after being cleaned by this method have been found to be entirely free from any marine growth. The gear itself is simple and strong. Its manipulation does not call for any special skill. This enables it to be used by a ship's company if desired; in fact, in connection with warships the sailors have successfully carried out the operation. As, however, in the case of merchantmen the services of the whole crew are generally required for other duties, small tenders equipped with the requisite gear are being stationed in ports ready for instant service. It is then only necessary for the cleaning tender and crew to make fast alongside the vessel and carry out the scrubbing operations, while the crew themselves are occupied in the loading or the unloading of the ship under treatment.

The cost of cleaning a vessel by this method is low. A 4,000-ton ship can be cleaned, inclusive of the provision of labor, current, and all gear, for $100 in approximately eight hours, though this cost would be appreciably lower were the vessel being cleaned to supply the requisite current and had steam on her own winches to operate the hawsers.

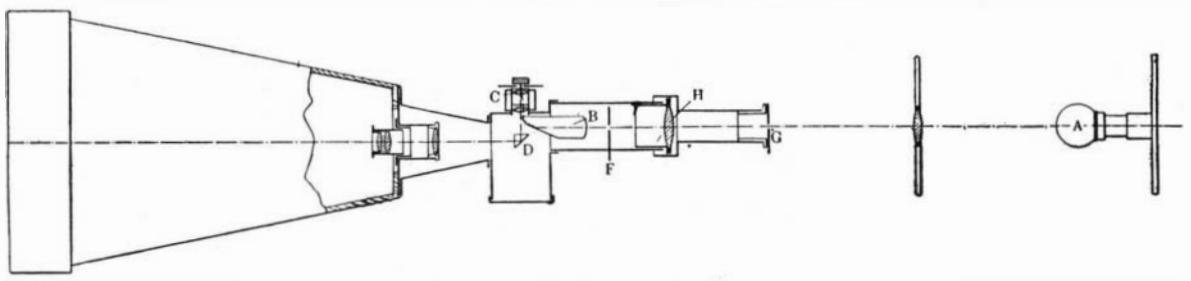
METALLOGRAPHS, OR PHOTOGRAPHS OF THE STRUCTURE OF METAL SPECIMENS.

BY J. F. SPRINGER.

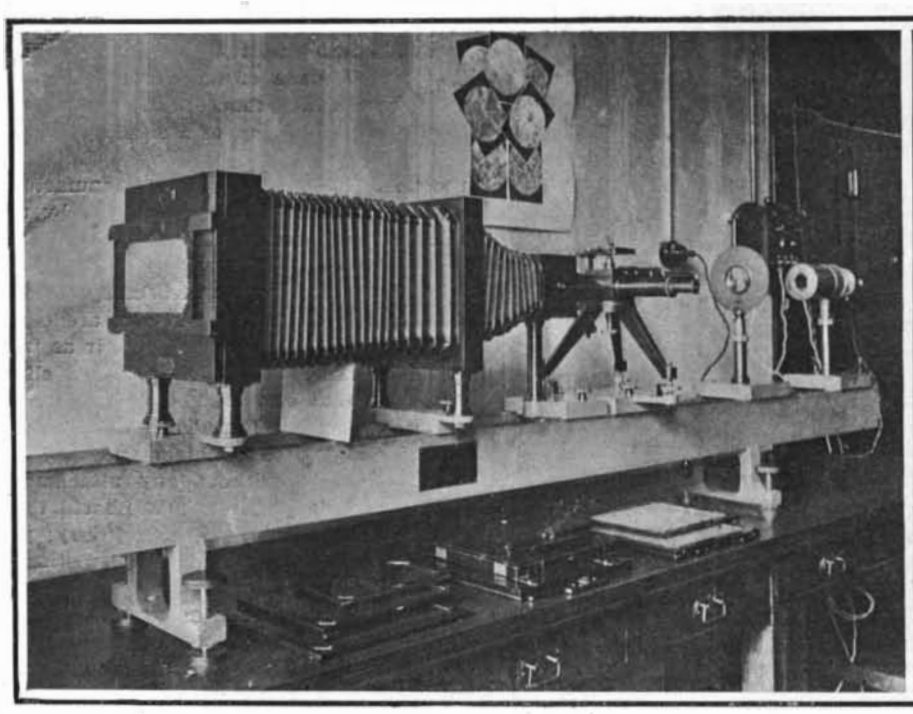
In recent years an entirely new branch of practical science has grown up, to which the name of *metallography* has been given. A *metallograph* is a pictorial representation disclosing the structure of a metal specimen. It has long been known that much might be learned of the characteristics of, say, a piece of steel by the mere optical examination of the structure disclosed by a fracture. The difference in appearance of a fresh fracture of hardened and tempered razor steel from a fracture of, say, cast iron is quite apparent to the eye. But in order to study this line of things with effectiveness, some means of recording these appearances was necessary. This has been filled by photography. An unmagnified representation — made by photography or otherwise —of a metallic fracture is called a *macrograph*. One of the illustrations shows a photographic apparatus suited to the production of macrographs. This vertical arrangement is especially desirable, as thus the sunlight may readily illumine the surface of a fracture. The specimen is seen in the figure lying—fracture side up—upon the table. The whole camera may be adjusted vertically along the post rising from the base by means of the locking arrangement. The focusing is accomplished in connection with the rod on the upper right hand.



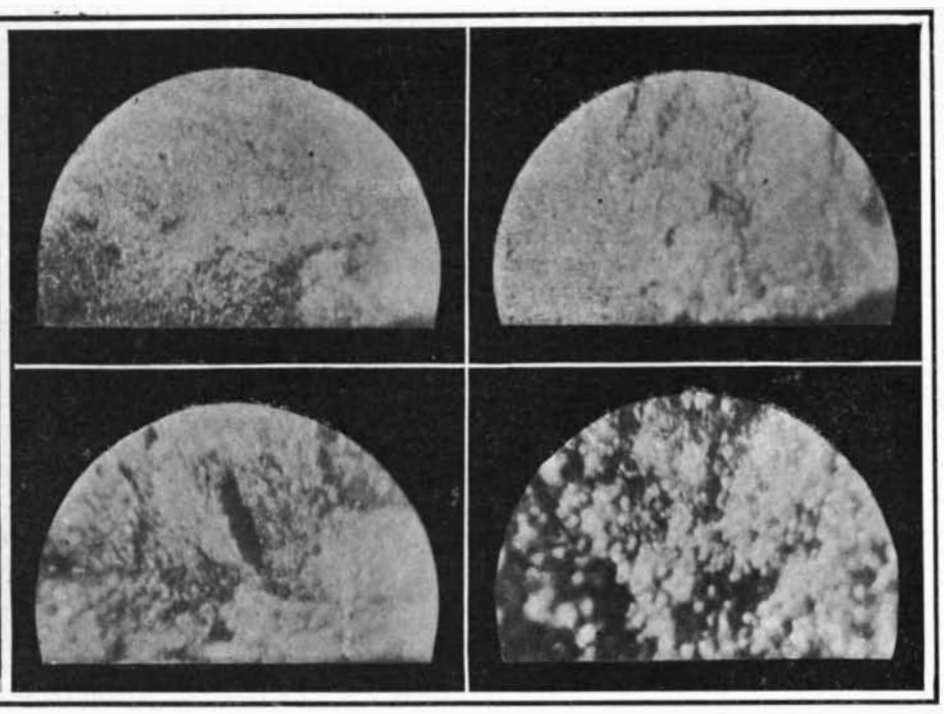
Chatelier apparatus for making metallographs using "Liliput" focusing arc lamp as source of light.



Diagrammatic view of the Chatelier system of microphotography.

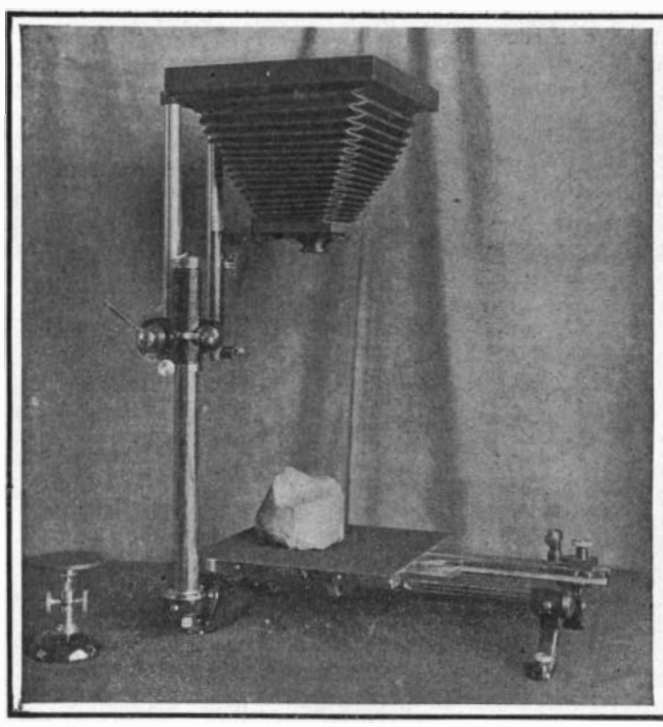


Nernst lamp used with the Chatelier microphotographic apparatus.

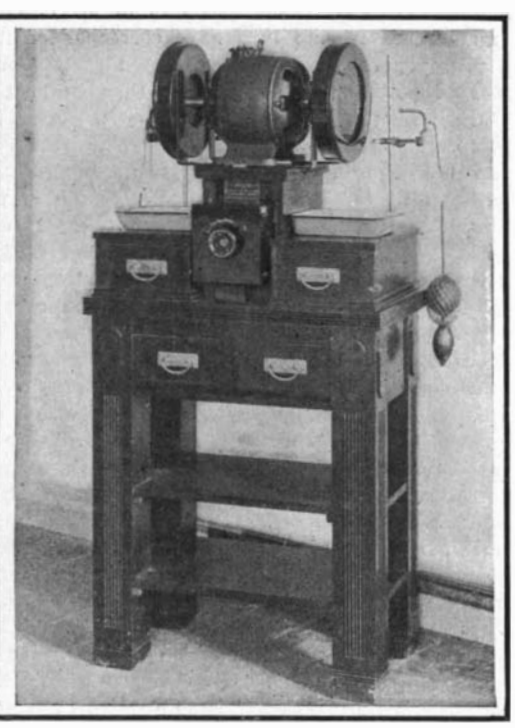


Micrographs of 1.65 per cent carbon steel, showing effects of overheating.

The loud and manifold complaints against the London motor omnibus have impelled the leading companies to action. A new species of inspector has been created—a speed inspector. His duty is to watch for omnibuses traveling at a speed beyond the companies' maximum of 12 miles an hour, and to report the offenders to headquarters. For purposes of identification each motor omnibus will carry a distinctive mark, a small board with certain capital letters—ON—S, for example — clearly painted upon it. This is fixed at the side of the omnibus above the window, at the end near the driver. The General and Vanguard motor omnibuses wore their identification boards for the first time last month.



Camera taking macrograph of a fracture of specimen.



Electric polishing machine for preparing specimens to be microphotographed.

However, while the study of macrographs is no doubt of considerable importance, the present state of the study of metallic structures would have been hardly possible of attainment through them alone. The microscope has been brought into this line of research, and with the most important results. A magnified representation of a metallic fracture is called a *micrograph*.

Now it might seem to some that with chemical analysis on one hand and mechanical testing on the other, there would be little that could not be learned about metals by means of one or the other of these processes. That this is not the case may be seen from the fact that metallography