THE SUPERHARDENING OF HARD STEEL.

In a paper entitled "The Work Hardening of Steel by Abrasion," presented by Mr. E. G. Herbert, of "Sevanthums, Manchester, at the recent Glasgow meeting of the Iron and Steel Institute, it was contended that articles of hard steel, such as gears and cams of motor-cars, were superhardened by the surface action which occurred in service. The paper, and the subsequent discussion thereon, will be published, in due course, in future issues of Engineering. When presenting his contribution to the meeting at Glasgow, the author stated that the investigation of superhardening, caused by wear, had suggested the inquiry whether articles of hard steel could be superhardened beforehand, as a means of resisting wear. The result of that inquiry, continued the author, had been the invention, by him, of the "Cloudburst," process. Physicists told us, went on Mr. Herbert, that we were immersed in an atmosphere consisting of molecules travelling about with great velocity and constantly colliding with each other and with us. He would ask the meeting to imagine an atmosphere, the molecules of which consisted of small, hard, steel balls travelling superhardened surface. Any further increase of velocity would merely roughen the surface without increasing its hardness, and the whole superhardening process, of course, be applied to produce a work-hardened layer on any metal, by adjusting the initial and final ball velocities to its original hardness, and to its "maximum induced hardness."

Roevson, Mr. Herbert showed a number of slides to illustrate his process; these are reproduced in Figs. 1 to 5 on the present page. Continuing, Mr. Herbert said that Fig. 1 showed the superhardened layer in the fractured surface of a 1.25 per cent. carbon steel, hardened and superhardened. A micrograph of the same specimen under a magnification of 20 diameters was shown in Fig. 2. This specimen had been polished, etched, and tested for hardness in five places with the Pendulum and diamond. It depicted the hardness gradient of the superhardened layer, extending to a depth of 1.5 mm. The original hardness, namely, 57-7, was equivalent to 770 Brinell. The final surface hardness, namely, 75-7, was equivalent to 1,029 Brinell. On certain case-hardened steels, a maximum diamond time-hardness of 94-6, equivalent to 1,275 Brinell, had been produced by superhardening. Fig. 3 was a micrograph of a nickel-chromium steel, heat-treated and superhardened, taken under a magnification of 120 diameters. Eleven Pendulum test impressions were shown over a depth of 1-7 mm, and the average surface hardness, in the case of the initial indentation, was found to be 715 Brinell, and the original surface hardness, which was 38-8, was equivalent to 525 Brinell.

The atmosphere of steel balls was invented and investigated as a means of superhardening. The density, therefore, of the steel balls, and the actual hardness that could be produced depended on the superhardening capacity of the steel, which property was easily measured by means of the Pendulum hardness tester. The ball velocity required to produce this hardness could be determined by experience, just as there was a relationship between the original hardness of the steel and the initial ball velocity, which compressed the surface without indenting it, so there was a relationship between the "maximum induced hardness" of the steel, as measured with the Pendulum, and the final ball velocity, which was sufficient to produce maximum hardness, but was insufficient to indent the

**NEW PUMPING STATION, HAVANT.**

The source from which the town of Portsmouth and the surrounding district derive their water supply distinguishes themselves in the provision of the other large communities in the country. Neither river water nor wells are used, but springs emanating from the chalk, from which the flow is collected in surface basins. These springs not only break out within a restricted area, having a length of about half a mile in an east and west direction, but are capable enough to meet the needs of about 280,000 people. In developing these resources, the Borough of Portsmouth Waterworks Company, Limited, have organised the springs in two groups, which are dealt with at pumping stations at Havant and Bedhampton respectively, these stations being interconnected by conduits, so that water from either group of springs can be pumped at both places. Without going into the history of the undertaking in too great detail, it may be said that operations were first begun with a pumping station at Havant, in 1886, and that this was subsequently enlarged and replaced by a superhardened station at Bedhampton, which was opened in 1889. The latter station has since been practically superseded by a new station at Havant. This is built on a line of original works, which were originally opened by the Mayor of Portsmouth (Councillor Frank J. Privett, J.P.), on Wednesday, September 21.

The water pumped from the springs by this plant is delivered to the Farlington reservoirs on the southern slope of Portsdown, about 150 ft. above sea level. Here it is filtered through eight open sand-filter beds, each nearly half an acre in extent, and thighs flows in...