under the microscope, there was no difference between a fibrous and a crystalline specimen of iron.

We are inclined to offer a fresh explanation of the deterioration of iron under vibration, and of the partial restoration of its tensile strength by annealing. Each bundle of fibres in a bar of wrought iron consists of a number of very small crystals. We might compare a piece of good wrought iron, properly forged or rolled, to an assemblage of strings, each string being composed of a thread of small crystals. An exaggerated picture could be afforded of this by imagining a bundle of glass threads. If the iron has been burnt in the manufacture, instead of these threads being continuous, they are broken in different parts of their length. The same effect is produced after a long-continued jar; there is a solution of continuity in the fibres—they are shaken apart, and the fibres of the iron threads are broken up into shorter pieces. Deflection will produce a similar effect. Frost, or a sudden chill, will contract the fibres, and they will be pulled asunder. On the application of a low red-heat—the process of annealing—the ends of the crystal threads again come into contact through the resulting expansion. The expansion of the whole mass favours the ultimate coherence of the fibres; and, on contracting, the wrought iron returns to its pristine state—that of a bundle of crystal fibres. Thus, under long-continued vibration—before it receives its *coup de grâce*—it is already partly broken; its intimate structure, inaccessible to the eye or to atmospheric influences, is already partially in fragments. The application of a *gradual* strain to iron thus deteriorated and brittle, would have the effect of drawing out the fibres that were still entire, leaving undisturbed the parts that had already given way in the interior. According to this it will be evident that the face of the fracture—at a right angle to the axis—of a bar of iron injured by vibration, would show no signs of injury; but if it were possible to examine the structure in a like line parallel to the axis of the bar, it would, perhaps, be seen that the fibres was broken up into pieces of different lengths.—*Mechanic's Magazine.*

FORGINGS IN IRON.

BY MR. MUIR, OF WOOLWICH ARSENAL.

After some preliminary observations, Mr. Muir said that the primary condition for obtaining a good forging, whether from under the tilt or the steam hammer, was, undoubtedly, the employment of good material.

In fagotting from slabs it should also be a rule to place invariably the thinnest slabs in the heart of the fagot, so as to ensure that the heat applied should permeate the whole mass equally. The proper construction of the furnace was another consideration of much moment, as was the employment of a skilful furnace-man. So great was the diversity of forging, both with regard to size and purpose, that it would be impossible to refer to each kind. It was only possible in a brief paper to mention some of the most important, and they in this case would be those which seem of the most difficult character, and which required the greatest amount of care and caution in their production. Such forging as were to have collars and projections were among the class named. In these it was of the highest importance to take down sufficient "stuff" to allow for finishing off, and to make sure that the projections were in their proper places. If the space between the collars were too little, the chances were that, in drawing out, the forging would become too small to turn up to the right size. If the space were too great, it involved the necessity of "upsetting" or staving up, and the grain of the iron was thus deranged and the forging would be consequently weakened.

It was a well-known fact that heavy shafts—for example, propeller shafts—which have to be coupled by means of large collars or flanges, are very difficult to forge soundly. Not unfrequently the collars were, after great care had been taken, found to be so hollow that a two-foot rule might be concealed in the central cavity. He (Mr. Muir) objected to having those collars rounded in forging, although he could find few who agreed with his views. It was far better, he believed, to forge the collars or flanges of such shafts as those he had referred to square, and to round them up afterwards. It was his impression that solidity would be found to result from this process in almost all cases; for if a proper heat were taken upon the the work, it was next to impossible for a square forging to be made hollow. On the contrary, a circular forging could scarcely be made solid. The advantages arising from the mode of procedure he had indicated were, he thought, undeniable; the objection to it was its extra cost.

In one remarkable instance he had been permitted to forge a propeller shaft with a square flange. At four heats the four corners of the square were taken off, the flange was rounded up, and the work proved, as he had anticipated, a great success. He entertained, moreover, a very strong opinion that the great difficulty which had been experienced in obtaining a sound malleable iron gun might be overcome by first forging it in the square instead of of the round form. There were many reasons for supposing—and, indeed, he might say that he knew—that many an important forging had been lost, or at least was sadly deteriorated, by the fagot having been composed of different kinds of iron: say, for example, hard and soft. In this case, there would be a natural resistance to amalgamation. Great care and practical judgment, therefore, were required in assorting the irons to be employed for particular forgings, and in putting them into classes in accordance with the special purpose to be served.

He would also recommend that, in any forging requiring taking down, well-rounded setts should be employed, so as to leave always a gusset or fillet which would save the grain of the iron, and could easily be turned off afterwards if required. It was desirable, also, to put the last wrought heat into the furnace, after it has been worked either by planishing or swaging, and thus bringing it to a low red-heat. This was a kind of annealing process which equalized the consistency of the surface. Beside if one part of the latter had happened to get a larger share of hammering than another, the forging would, while undergoing this ordeal, manifest a tendency to bend, and this would be the fitting time to straighten it. Whatever the nature of the piece of work in hand, only so much of it should be made hot, or at least be brought to a welding heat, as can be at the same time operated upon. The