the distinction between good and bad steel were princi­pally chemical, the production of the former would long since have been rendered easy and determinate. How little this is the case may be inferred from the fact, that the elaborate series of experiments conducted a few years since by Dr Faraday and Mr Stodart have scarcely added a new fact to the science of steel-making ; while, on the other hand, the immense value of mechanical action is shown, among numerous instances, by the increased strength of *drawn* iron wire as compared with *rolled* iron of equal size, a difference amounting sometimes to sixty or seventy per cent.

The remarkable qualities of the trowels for which a Mr. Walby was celebrated about forty years since, resulted in a great measure, if not entirely, from good and rapid hammering at a moderate temperature. The object of hammering being to condense the steel, it is evident that when at a white heat, in a state approaching to fusion, the mass is so plastic, it yields so freely, that hammering is perfectly inoperative, except to change the external form ; while, on the other hand, if the mass be cold, it is so unsusceptible of what may be called intestinal move­ment among its particles that the most violent hammering can do little more than dislocate portions of the surface, which will accordingly crack or scale off. Between these extremes a medium may be found, and was, we believe, found by Mr Walby. His hammering was principally performed at a low cherry-red heat ; and, by means of a peculiar and ingeniously mounted hammer of considerable weight, he was enabled to do all that was required before the temperature was sensibly lowered. But, as we are informed, he did more than this. It is quite certain that in hammering any mass, and especially in a thin plate, the central cannot be under the same circumstances as the exterior portions. Not only will the centre retain its heat somewhat, longer, but, what is of more conse­quence, the tendency of the central portions to spread laterally under the hammer, is resisted by the marginal parts; while these latter not being so protected by a belt, spread freely, and perhaps separate into detached pieces. If, for example, a circular disc of steel at a low tem­perature were violently beaten under a flat hammer, it would be very much condensed in the middle, while the circumference would gradually separate, showing radial splits or cracks. The most perfect way to condense a circular disc of metal would obviously be to confine it in a very strongly defended cavity, whose walls should prevent all lateral spreading, and thus the full effect of each blow would be felt in condensation. Such a process is, however, inapplicable to trowel making, and perhaps to all other purposes except the striking of medals, where we see it employed; but Mr Walby obtained nearly all the effect of such an arrangement by forging each trowel considerably larger than it was ultimately intended to be, and cutting off about an inch of superfluous metal after the hammering was com­pleted ; cutting off, that is to say, the wall which had acted to restrain the spreading of the central portion of the blade, and which had probably become loose and spongy itself fur want of such restraint, thus leaving only the close compact metal in the finished trowel.

Having thus endeavoured to direct the reader's atten­tion to some of the qualities demanded in steel, and to the causes which affect their production, we shall briefly describe some of the operations.

Steel is most frequently made from rolled bars of *good,* by which we mean *pure* iron. To communicate to these bars the desired quantity of carbon, they are formed into bundles, and are placed in a large stove or furnace alter­nating with layers of carbon, (hard-wood charcoal is preferred,) and a high temperature being maintained for a week or ten days, the iron gradually absorbs the required quantity of carbon, and becomes converted into steel. The completeness of this conversion is judged of from time to time by the examination of certain of the bars, which are so disposed as to be accessible for this purpose. If the carbon has not penetrated to the centre of the metal, this will be evident on breaking the bar transversely, as the section will exhibit a colour in the centre different from that near the surface : it will show what the workmen call a pith. Towards the end of the process, the watching requires to be skilful and constant, because, if the absorption of carbon becomes very exces­sive, the metal may be rendered so fusible as suddenly to melt; and though this would be of little consequence in a sound crucible, it would be attended with great loss in a large stove or hearth. The surface of the bars becomes so nearly in this condition that it is always blistered by the escape or rarefaction of air or gas from the interior of the metal ; and hence bars so prepared have acquired the name of blister or blistered steel. The process itself is called cementation.

The bars thus prepared do not differ very greatly from cast-iron, except in the smaller quantity of carbon which they contain, and in their freedom from impurities. They have somewhat more malleability and tenacity than cast- iron, but not so much as is imparted to that substance during its conversion to bar-iron, and which must now, except for very coarse purposes, be communicated to these bars of cementation—without, however, depriving them of their carbon. With this view the bars so pre­pared are broken up into short lengths, are made into bundles, heated almost to a white heat, hammered, welded together, re-broken and re-hammered till they are reduced as nearly as possible to a compact homoge­neous mass of greater specific gravity than in their for­mer state. In all these weldings, care is required to preserve the surfaces clean and unoxydized, as upon this depends the perfect union of the two surfaces.

This care is dispensed with in the processes for making cast-steel, the nature of which has been already indicated in describing that of cementation. The pure iron and a certain proportion of carbon are fused together in a crucible, and being cast into ingots, these are treated somewhat like the bundles of the cemented bars. They are hammered at a high temperature till they are rendered malleable and dense, and till a certain portion of the carbon is displaced, that substance being generally in excess. Various modes of applying the carbon have been pro­posed ; but it is very difficult to determine in the abstract which of these is the best. One mode of application is, by the introduction of a stream of gas. Cast-steel is free from the defects which are liable to attend the imperfect welding of the bars, and is likely to supersede all others for the finer purposes of cutlery. It requires, however, the most skilful manipulation as the point of sufficient fusion is reached, and this must be performed under the most severe exposure to heat ; so severe as to demand that the workmen should be protected, by clothing of wetted sackcloth, from the joint effects of the opened furnace and the glowing crucible. This combination of skill and severe labour secures high wages, and enhances the price of the article.

The experiments of Faraday and Stodart, before alluded to, were undertaken not so much to im­prove the mode of manufacture as to determine the effect of various alloys; it having been inferred, partly from the condensation which frequently accompanies chemical unions, and partly from the examination of certain specimens of steel which were known to possess good qualities, that a small portion of foreign matter might be beneficially introduced. With this view, alloys