

# Engineering Reminiscences

CONTRIBUTED TO

“Power” and “American Machinist”

BY

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## CHAPTER XXI

### Production of an Original Surface Plate



WILL introduce here a description of the method of producing an original surface plate.

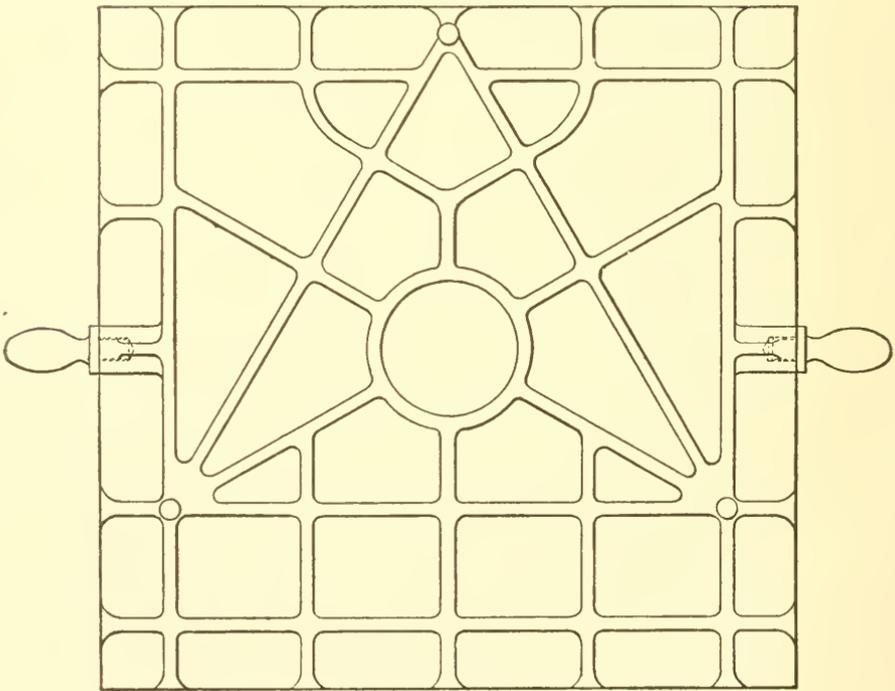
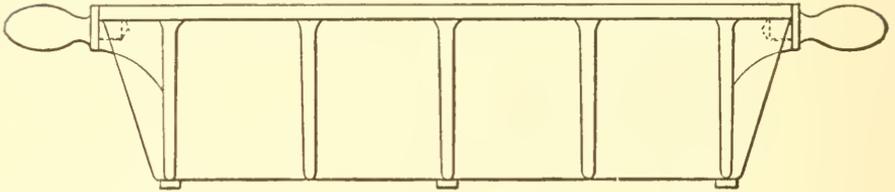
The production of mechanically true planes by the method of scraping was first suggested by Mr. Whitworth, and was brought to perfection in his works. Having had and having improved the opportunity there to study this system, and having employed it largely in the manufacture of high-speed engines, it seems to me that an account of it should find a place in these reminiscences, especially as the importance of mechanical truth is coming to be more and more realized in this country. I will therefore describe the process of producing an original standard surface plate.

The first point, of course, is the design. The square form, 30 inches square, has been found most suitable. I could not, however, use this form myself, a long surface plate being required for the guide-bars and steam-chest joints of my engine.

The plate must be incapable of deflection. To insure this it is ribbed on the under side with ribs seven inches deep, and is supported at three points, equidistant from each other and from the center, so that its equal support cannot vary, whatever may be the surface on which it stands. It is provided on two opposite sides with handles, by which it can be lifted and rotated. The arrangement of the ribs and feet is here shown.

It must be cast of hard and close-grained iron, which will possess the most durable qualities, in a baked mold without a cope, so that the gas shall escape most freely. As cast, the plate should be one inch thick. About three eighths of an inch is planed off,

removing all dirt, and leaving a perfectly sound surface, with a thickness of about five eighths of an inch. Three of these plates are made. After these have been planed, their edges squared and steel handles put in they are delivered to the fitter.



Surface Plate for Producing a True Plane.

I will first describe the tool used in scraping. Originally this was a hooked tool, and the scraping was done by a drawing motion. Two of these tools were employed, one for the roughing work, in

which the hook projected downward about three quarters of an inch, and the other for fine scraping. In the latter the hook projected downward only about one quarter of an inch, and absolute freedom from vibration was aimed at. These tools were used for a number of years, but afterwards a radical change was made. The modern method is to employ a single straight tool, like a carpenter's chisel, about an inch and a quarter wide and an eighth of an inch thick, with a square end. This end is slightly curved, and its corners are rounded to avoid scratching the plate. The scraping is done by a pushing motion.

This tool has been found preferable on all accounts. Projections needing to be removed are in front of the tool, instead of being covered by it. The tool is perfectly rigid, and can be inclined to the surface at any desired angle. The cutting edge is a square angle, and being well supported keeps sharp for a considerably longer time than when it is an acute angle, and when ground or honed two edges are formed. Moreover, the pushing motion is preferred.

Two of the plates only are first brought together. For disclosing the high points, one of these is covered with a raddle made of finely sifted red lead and oil. This is made quite stiff, and all of it that can be removed by the palm of the hand is rubbed off, leaving only a very thin uniform film on the surface. Any dust having been carefully removed from both surfaces by a soft brush, one of these plates is inverted on the other, and at one corner each plate is marked in the edge with a prick-punch. The upper plate is then rubbed about on the lower one for, say, half a minute. When lifted off, the high portions of the surfaces are shown on one plate by the raddle put on, and on the other by that rubbed off. The workman then gives to these parts of the surfaces a general scraping, giving to his tool a long sweep, say from four to six inches. This is repeated two or three times, the stroke being shortened each time, and the upper plate being placed in a position at right angles with its last one, which can be determined by the prick-punch marks. This change of position is necessary to avoid a cross-wind or spiral form. The scraping should now extend over the entire surfaces, and these should have a general uniform bearing on each other, with the points of contact uni-

formly distributed and equally distinct. The work should be continued in the same way until all these requirements are fulfilled.

Now appears the use of the third plate. The two surfaces thus formed are sure to be, one of them convex and the other concave, in some corresponding degree. The workman now numbers the plates, by numbers stamped in the edges, these being marked Nos. 1 and 2, and the third plate No. 3. No. 2 is now set aside, and No. 3 is scraped to fit No. 1. It is thus made a duplicate of No. 2. Next, No. 1 is set aside and Nos. 2 and 3 are brought together. Supposing these to be convex, they will bear together at the middle point, on which the upper plate will rock, and the degree of their convexity will thus be shown. The workman then in the same manner scrapes these plates equally to the best of his judgment, until their entire surfaces are brought together, with equal distribution of the points of contact. These two surfaces will now again be, one convex and the other concave, though in a much less degree. The next step is to apply No. 1, which is concave, to either No. 2 or No. 3, and scrape it to fit. It is then applied to the other, of which it has now been made a duplicate, and the same process is repeated, until the three plates can be interchanged in any way, and will have a uniform general bearing on each other, with equal distribution and distinctness of the points of contact. We have thus, in a general way, produced three demonstrated true planes, but the surfaces are yet far from the desired approximation to absolute truth.

Now follows the fine scraping, which is not attempted until general truth has thus been established. The object of this is to multiply the points of contact and perfect their equal distribution and prominence. For this operation no raddle is used, but the surfaces are rubbed together dry. When the plates are separated, the points of contact shine like stars. Here skill and care are pre-eminently required. The scraping takes off only a dust. If too strong depressions may be made deeper than before, and requiring the reduction of the entire surface. The superiority of the modern tool is now especially shown. By lowering the angle of the tool, the workman presents the slightly curved edge to the surface in a position as nearly parallel with it as he desires. Interchanges similar to the former ones are now repeated, until

the bright points are brought as close together as is desired, with uniform distribution and distinctness. The tedious operation is now finished, and these bright points remain as witnesses.

The three plates were necessary to the production of one. They have also a permanent use. They are indispensable to the preservation of the true plane, which it has cost so much patient labor to produce. The date of their completion is stamped on their edges. Then plates 1 and 2 are put away in the store-room, their surfaces carefully protected from rust or injury, which last is best avoided by inverting one on the other, and No. 3 is put into use. A prominent use is for the production of smaller plates or straight-edges adapted to special purposes. After a while, perhaps in a little while, this plate loses its truth by unequal wear. Indeed, speaking with absolute truth, it may be said that the first time this plate is used it is ruined. But by taking pains to use different parts of its surface as equally as possible, it may be kept in fair condition for some time. It can at any time be restored to its original condition by scraping it to No. 2, taking the same pains to turn it one quarter way around at every rub. In the course of time No. 2 will itself become worn unequally, when its truth can be restored by rubbing it on No. 1. Finally the three plates can all be restored to their original condition by rubbing them together interchangeably as at first. Thus the true plane can be absolutely perpetuated.

The importance of this work can only be realized when we consider that the true plane affords the only means by which true cylindrical work also can be either produced or verified. It is thus seen to be fundamental to all mechanical truth.