THE MANUFACTURE OF DYNAMITE.

Our illustrations show the apparatus commonly used for the preparation of nitroglycerin, the dangerous substance to the peculiar properties of which the fearful slaughter at Bremerhaven is due. A contemporary states that Nobel, the inventor of dynamite, tried many experiments "in order to bring nitroglycerin within the range of articles of transport, and finally hit by accident upon the one which resulted in the production of the powder known as dynamite." This description is a severe criticism on the inventor and his discovery, for every change of temperature produces free nitroglycerin from dynamite, and the latter substance is thus far more dangerous than the former; and an attempt to send dynamite over land or sea will soon show how it is regarded

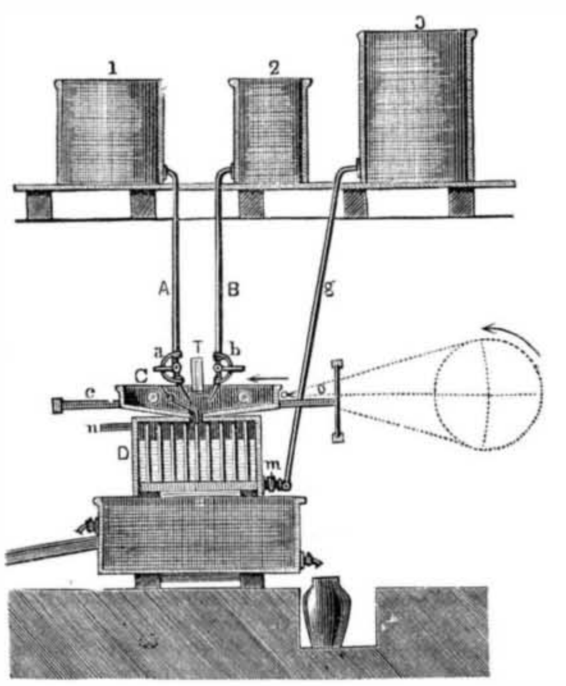


Fig. 1,—PREPARATION OF NITROGLYCERIN.

as an article of article of freight by railroad and ship authorities.

Nitroglycerin is usually commenced by mixing 2 parts nitric acid with 4 parts sulphuric acid. This mixture heats spontaneously, and is left for 24 hours to cool. Then 1 part glycerin is added to the combination of the two acids by the method shown in Fig. 1, the acids being in the vat marked 1, and the glycerin in vat 2, the vat 3 being a reservoir of water. The vats 1 and 2 communicate with a box, C, which is lined with lead, and divided into compartments which open into the trough, D. This box is provided with machinery to give it an oscillating motion, indicated by the dotted lines; it also has a thermometer to show the temperature. A constant stream of cold water is made to flow around the vat, D, and out at N. As soon as everything is ready, the acid is allowed to flow through A into C, and the glycerin through B into the same vessel. At the same time an oscillating motion is imparted to C by workmen who are stationed at a distance of thirty or forty feet, protected by a strong wall. As soon as all the glycerin has flowed in, the operation may be considered as ended, for the nitration takes place instantly. The oil from D is drawn into the vat below, which is half filled with water. The nitroglycerin sinks to the bottom and can be decanted from the dilute acids.

The nitroglycerin being now ready for use, the next step is to mix the oil with inert silica. The infusorial earth has three constituents which must be removed —water, organic salts, and coarse gravel. The first two are removed by calcining at a red heat in an oven with four shelves, one above the other, on which the earth is placed and slowly pushed from the upper to the lower. The organic matter which is considered dangerous to the stability of the dynamite, but which is less dangerous than the nitroglycerin, is thus burnt out. It is then pressed with hard rollers

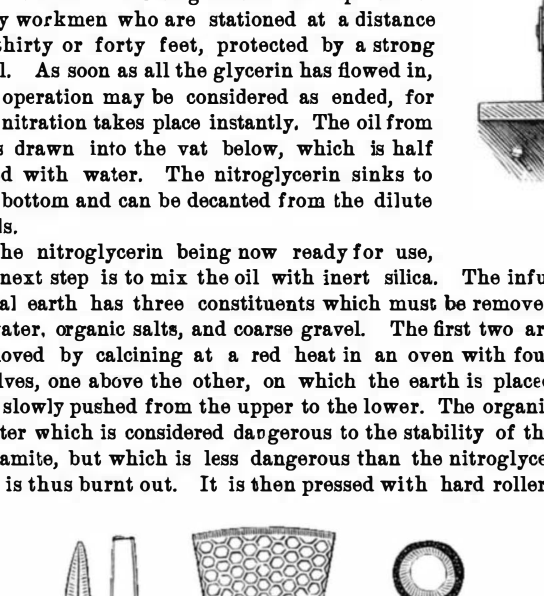


Fig. 3.—MICROSCOPIC ENLARGEMENT OF INFUSORIAL EARTH.

and sifted, which separates it from the larger grains. It is now ready for use.

Fifty lbs. of the infusorial sand are put into flat wooden tanks and covered with 150 lbs. nitroglycerin, when the workmen mix them with the naked hand. Gloves of india rubber were at first provided, but the workmen preferred to knead the mixture with the free hands. In half an hour the incorporation of the oil with the sand is complete, and the dynamite is ready for filling in the cartridge molds. The cartridges are simple cylinders, protected by parchment paper. If ordinary paper is used the oil soaks into it, and there is great danger of premature explosion. Dynamite is a brownish gray, sometimes reddish, inodorous, pasty, greasy mass, having the specific gravity of 1·6. When ignited by an ordinary flame it burns up quickly without detonation, and must therefore be fired with a patent exploder containing fulminate of silver inclosed in a copper capsule. When in its normal state, it requires a heavy blow of a hammer on an anvil to explode it, and even then only the portions struck are fired. Nitroglycerin, however, is easily exploded by percussion, and it exudes from dynamite on the slightest change of the temperature; and the wood of the boxes in which dynamite is packed becomes, by slow degrees, impregnated with nitroglycerin, and forms a most dangerously explosive material, which may give rise to serious accidents in warehouses where it is stored.

The sulphuric acid used in this dangerous manufacture is the oil of vitriol of commerce, an acid too well known to need description here. The nitric acid is usually made from native saltpeter, imported from Chili or elsewhere; and as it is required to be highly concentrated, the preparation of it is a peculiar process, which is shown in our Fig. 2. In a cast iron vessel, A, is placed the nitrate to be operated upon, to which is added, by means of a funnel, strong sulphuric acid. The lid is replaced, and the vessel connected, by means of the clay-lined tube, B, with the glass tube, C, dipping into the large stoneware flask, D, which serves the purpose of a receiver. This flask is connected by means of a tube, *a*, to a similar vessel, D', and that to a third vessel, D'', and so on, in order to completely condense the vapors which might have escaped through the first, second, and third vessels. The iron vessel, A, is heated by means of the fire placed in the hearth, F, the smoke and hot gases being carried off by G, H. At the outset of the operation, the damper, *d*, is so regulated as to shut off the lower channel and cause the smoke and hot gases to pass through E, heating the vessels, D, D', and D'', this precaution being required to prevent their cracking by the hot acid vapors entering from A. As soon, however, as the distillation has fairly commenced, the damper is altered to shut off E, and pass the hot air and gases through G. The product from each retort is so mixed that the average specific gravity shall be equal to 47° or 48° B. A weaker acid than this does not work well.

The acids being mixed as above described, the next step is the mixture of them with the infusorial earth, called by the Germans *kieselguhr*, which is found in most countries. The polishing powders known as tripoli and electro-silicon are specimens of it; and it is composed of the skeletons of a vast number of diatoms, which yield a spongy silica, admirably adapted for a polishing powder, or as an absorbent for oils and liquids. It is also used in the preparation of soluble

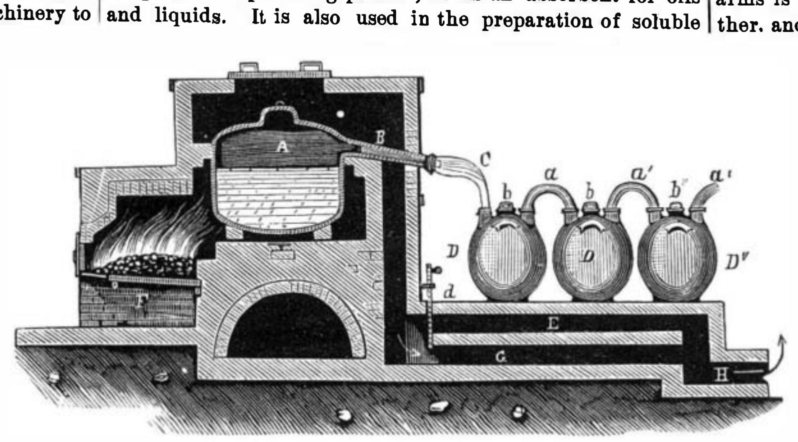


Fig. 2.—PREPARATION OF NITRIC ACID.

glass for pigments, and fireproof packing and numerous other purposes. A microscopic view of a portion of this substance is shown in Fig. 3, which fully exhibits the remarkable porosity which makes it adaptable for absorbing the perilous fluid which gives it its efficiency as an explosive.

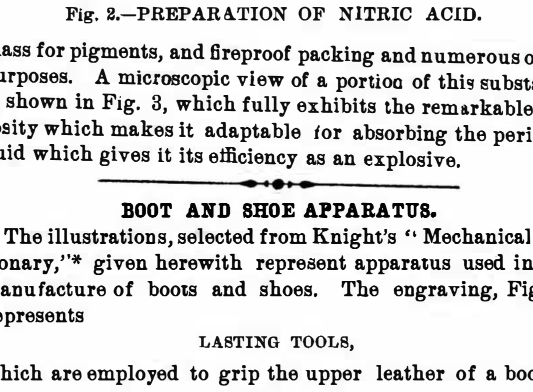
BOOT AND SHOE APPARATUS.

The illustrations, selected from Knight's "Mechanical Dictionary,"* given herewith represent apparatus used in the manufacture of boots and shoes. The engraving, Fig. 1, represents

LASTING TOOLS,

which are employed to grip the upper leather of a boot or shoe, and draw it over the last. In the tool on the left, the two jaws act simultaneously upon the leather through the motion of the nut, C, upon the screw. The same movement brings the jaws toward each other and stretches the leather around the last. The two pairs of jaws in the second tool engage the sides of the leather, and are then drawn thereupon and also inwardly by the action of the cam lever. Lasts are usually made upon the ordinary type of lathe employed for turning irregular forms. For this purpose, however, special machinery has been devised, to which class belongs the

Fig. 1.



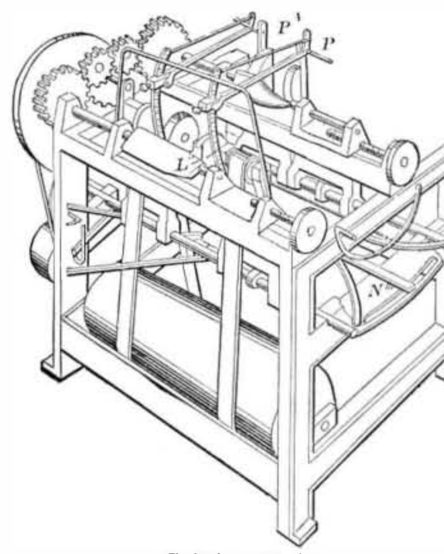
Lasting-Pinchers. *Tool for lasting Boots and Shoes.*

*Published in numbers by Messrs. Hurd & Houghton, New York city.

LAST LATHE,

represented in Fig. 2. In this machine, the block, L^5, from which the last is to be cut, is, by a train of gearing, made to present a face to the cutters precisely corresponding to the face of the model against the guides, P P^4. By moving links on these rods, up or down on their graduated scales, the last

Fig. 2.



Frohock Last-Lathe.

may be enlarged or reduced in its relative proportions to the model. A similar variation of the bar, N''', on the sector at the end of the machine, will vary the work in relation to its length as compared with that of the model.

In Fig. 3 is a

BOOT SHANK MACHINE,

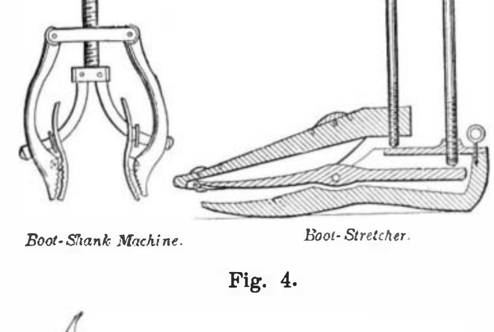
used for drawing the leather of the upper or boot leg over the last into the hollow of the shank. The leather being placed over the last is inserted between the jaws, which are pivoted to the plate. The screw connecting the jaws by arms is thus turned, causing the jaws to be brought together, and thus stretching the leather. The same figure also shows a boot stretcher, for stretching the uppers. The last is divided into an upper and an under section which are connected by a lever. The fore end of the upper section is pivoted to the fore end of the lever, and the middle end of the lever has its fulcrum at the mid-length of the lower section. The screws operate to raise the rear end of the upper section directly, and its fore end through the medium of the lever. The upper surface of the last has changeable knobs to stretch the leather in particular places.

Fig. 4 represents a

BOOT HOLDER

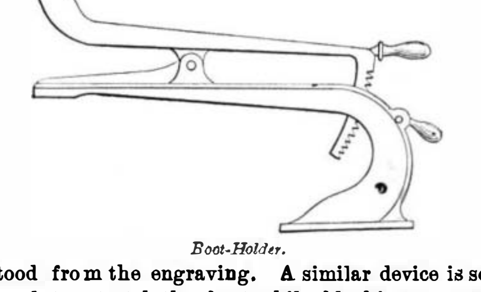
or jack, for holding the boot during the process of manufacture. The base piece is attached to the bench and has a stationary prong. The movable prong containing the foot piece is attached to the other, and is held at its adjustment by a rack and pawl. The operation may be clearly

Fig. 3.



Boot-Shank Machine. *Boot-Stretcher.*

Fig. 4.

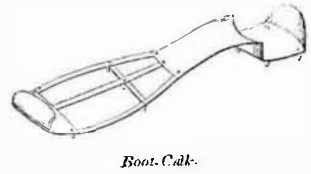


Boot-Holder.

understood from the engraving. A similar device is some times used to stretch the boot while blacking or varnishing it.

Fig. 5 shows a boot sole with steel calks attached, for the use of pedestrians in winter weather or when scaling the snowy tops of mountains or crossing glaciers. These calks are readily arranged to screw into plates fastened to the sole and heel of the boot, and are then removable at will. In walking over ice, these or similar appliances are indispensable; and many bruises, and sometimes limbs and even lives, have been saved by their use.

Fig. 5.



Boot-Calk.

Correspondence.

Employers and Trade Unions in England.

To the Editor of the Scientific American:

Intelligence having been received from England that the Amalgamated Society of Engineers is in dispute with the employers, on the question of the re-introduction of the system of piecework, which dispute has culminated in one strike, with the probability of the occurrence of others, I take the opportunity of ventilating this question a little, premising my remarks by stating that they are based upon personal knowledge of the actual facts. As a rule the editors of newspapers have very little mercy upon trades' unions, and this has been often said to be because the interests of newspapers lie with the employers of labor. This I believe to be a mistake, for even a mechanical newpaper has as large a circulation among workmen as it has among employers. The truth is rather that employers are more apt to avail themselves of the press, to present their side of the question to the public, and workmen are not usually skillful as writers or as special pleaders. Furthermore, editors, having no knowledge of the real evils of piecework (for piecework has its evils), and not being enlightened thereon by the workmen themselves, whose interest it is to ventilate that side of the question only, cannot be expected to form an equitable judgment upon the issues involved.

All the real causes of the opposition of trades' unions to the introduction of piecework will be found to be elucidated in the following recital of facts, in which it will be made apparent that, between employers and employed, there is, so far as abstract justice between them is concerned, but little to choose, and that the balance, if any there be, is decidedly in favor of the workmen, excepting in so far as acts of violence are concerned; and the occurrence of these acts is due only to the fact that a strike or lockout renders the condition of the workman a positively desperate one, whereas to the employer it is a mere question of his capital lying idle.

Public opinion is largely influenced by the publications of such works of fiction as Charles Reade's "Put Yourself in his Place," in which injustice is done to the workman, not in describing the terrible deeds which have been wrought by one workman on another, but by gathering together isolated cases of extreme violence, and attributing them all to the hero. This was perhaps a necessity for the author, in order to give this book the flavor of sensation necessary to the success of such works. But the excuse for the author by no means debars the artisan or trades' unionist from protesting against the injustice he sustains at the hands of the writer, whose impression on the public mind, by the description of such outrages, is grossly partial.

Towards the end of the year 1860, a young man who had been in business in South America and had returned to England, was re-engaged in the workshop in which he had served his apprenticeship; and having himself been an employer, he resolved to so perform his duties as a workman that he would prove to others that a good workman had only to study the interest of his employers to secure promotion. He wished to demonstrate that employers were watchful of those who were capable and who studied their interests, that the interests of the two were bound up together, and that the success of the one involved the success of the other; but alas! his employers were a railroad company, and that companies have no souls was amply "proven in the sequel." Labor was, in the estimation of this workman, a commodity whose value, like that of any other article, was just what it would fetch, its price being regulated by the quantity and quality delivered, and varying with the same. It was, therefore, not very encouraging to him to be told that it did not matter how much work he did, nor how well he did it, and that his wages at starting could not in any event exceed £1.12s per week, for that was the highest price paid to a new hand. That labor was not, therefore, the same as an article of merchandise, became to him at once painfully apparent; as it is not a rule of trade to pay less for an article because it is the first time you have purchased such a thing. There was nothing for it, however, but to accept the situation, and trust to time to obtain a higher rate of pay in the future. However, time passed, on, and the workman found no improvement in his condition until at last it was decided to have much of the work done by piecework. Accordingly a set of engine connecting rods were set aside to be fitted up by piecework, and some dozen workmen were selected and invited to give an estimate of what they would do the job for; and the young man in question, whom we will call Tom, gave the lowest bid and took the work, the price being sufficiently below the ordinary cost to be satisfactory to the managers. A set of axle boxes, other sets of rods, and several other jobs were done by Tom under similar conditions, he earning as much again as his day's work wages. This caused a sharp competition, as other workmen, anxious to better their condition, gave in lower prices; Tom, however, kept the lead, always managing by shrewdness, luck, or whatever else it may be termed, to take every job he bid for. Nothing daunted, however, his fellow workmen continued to compete, thus compelling Tom to either reduce his prices or lose the work. Some of the competitors bid because they would be satisfied if, by working piecework, they could increase their pay only twenty-five per cent; others competed upon general principles, saying that, if Tom could do it, they could. At length, however, Tom's repeated success discouraged competition, not, however, without raising some little feeling among the men, on account of his having, as was charged, cut the prices of the work down. This charge was scarcely fair, since it was in consequence of the competition of others that the prices had been reduced. It cannot, however, be denied that, since Tom was always the lowest, he was the most instrumental in the reduction of prices, notwithstanding the fact that his price was as a rule remarkably close to the next lower one. But the feeling among the men did not amount to positive estrangement, and it only found vent in upbraiding Tom by statements that he was ruining the trade and injuring the other workmen. At length, however, Tom began to make from 60 to 70 per cent more than his day's wages would have been: and this notwithstanding that the prices of his work had been very materially reduced since the piecework began. He innocently believed that the unusually low cost of his work, and the unusually large amount of his earnings, would open the eyes of his employers to his expertness, to the methods by which he saved time and work, or to whatever other cause may have enabled him to do so well. How far this was the case, he learned by an intimation that the prices of his work must be redueed because *no piecework man was allowed in that shop to earn more than 50 per cent more than his ordinary daily wages.* He pleaded that the cost of his work was at least 50 per cent less than the large quantity of the same kind of work being done in the same shop by men who had had from 7 to 15 years' experience on it. He was told it didn't matter what time the day's work men had taken, nor what their work had cost, or was now costing; he was making *too much money*, and must reduce his prices. He urged that, since no one else would take the work at so low a price as his, he could not perceive why he should be called upon to still further reduce the price; and he was informed that he must either reduce the prices of all those kinds of work on which he earned more than 50 per cent above ordinary day's wages, or else he would be put back to day's work on his old day wages; and as an alternative he had to reduce the prices.

Now, this was not a new shop, or one in which a constant change of work was had; but, on the contrary, there had probably never been, at any one time during the then preceding 15 years, less than 70 workmen in that shop who were employed on the same kind of work, many of whom had been engaged for years on precisely the same jobs from the selfsame drawings. Tom learned from the old hands that similar rules with regard to the amount of earnings of piecework men existed throughout England, that the rules were a sort of tacit understanding, and that as a consequence piecework men who had any wisdom in them gaged it so as to never exceed the allotted amount of "time and a half," as it is called.

At this time Tom's reflections were anything but rose-colored, as he had commenced with the idea of being an example to other men and a student of his employers' interest; but although he had practically demonstrated the identity of interests of the employer and the employed, he had advanced sufficiently far in his programme to be on questionable terms with many of his fellow workmen, and at loggerheads with his employers. His situation, so far as his personal relations with his business acquaintances were concerned, threatened ostracism; he felt almost like a criminal, and was only consoled by the consciousness that, in his own mind, he could not believe that doing a large amount of labor for an unusually small price, which is perhaps the most severe language in which his struggle to better his condition can be termed, deserved the meted punishment. "So much work for so much money,'' and "the more the work, the more the money," sounded exceedingly well as aphorisms; but when the workmen shouted: "No extra work, and no extra pay," and the employer added: "No more pay, however much more work you may do," and (in the same breath) "*less pay for more work for you only,*" it became exceedingly difficult for Tom to put his theory of identity of interests into any sort of practice. Tom found himself, according to the ordinary rules of commerce, the very worst paid man in the shop. In every article (as his work may be termed) he sold, he obtained a less price than any one else, and was at the same time grumbled at and virtually punished by the purchaser (his employer), because he had so many articles to sell; while that same purchaser was buying the same quality and kind of articles from others on the same spot at a much higher price. He, however, resolved to persevere in his course, and let the future take care of itself, with such results as I will describe in another letter. PIECEWORK.

New York city.

A SIMPLE mode of roughing horses, practised in Russia, consists in punching a square hole in each heel of the shoe, which, in ordinary weather, may be kept closed by a piece of cork. When the ground is slippery, the cork is removed, and a steel spike inserted. If this steel rough be made to fit the hole exactly, it remains firm in its place, and is not liable to break off short at the neck, like some of the screwed spikes.

PRACTICAL MECHANISM.

BY JOSHUA ROSE.

NUMBER XLI

TO DIVIDE A CIRCLE INTO ANY NUMBER OF EQUAL PARTS.

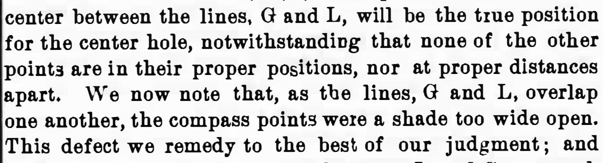
When a circle requires to be marked with a number of holes equidistant from each other, it is a very difficult matter to set the compasses so that, commencing at any one point and marking off the centers of the holes continuously in one direction, the last center marked will come true with the one first marked: because, if the points of the compasses are only one half the thickness of a line out, the error becomes, supposing the circle to require 60 holes around it, 60 times as great in the distance between the center last marked and the starting point.

The consequence is that it is almost impracticable to mark off any large number of holes in such a manner, not only on account of the frequent trials necessary to obtain so fine an adjustment of the compass points, but because the frequent trials will leave upon the surface of the work so many compass marks that those last made become almost indistinguishable from the other and incorrect ones. By the following method, however, such holes may be marked off, sufficiently correctly for all practical purposes, and more expeditiously than by any other means:

Let us suppose that it is required to mark off 60 equidistant holes upon a circle 30 inches in diameter. Our first procedure will be to ascertain at about what distance to set the compasses, so as to be nearly correct at the first trial. The most natural way would be to find the circumference of the circle, which is 94·248, and divide it by the number of holes, 60, which will give us 1 5708 as the distance between the centers of neighboring holes. The difficulty, however, of setting the compasses to the distance represented by the decimal fraction becomes apparent; and though this plan gives as near a result as any that can be arrived at, even in those cases in which the diameter of the circle may contain fractions of an inch and the number of holes required may be an odd one, still, in the matter of our example and, in fact, in all circles of whatever diameter, if the required number of holes is even, we may adopt a much better plan as follows:

We know that the radius of any circle will divide its circumference into six equidistant points; and since we require ten times as many of such points, we have only to divide the radius of our circle into 10 equal parts to get the required distance, between the compass points, more correctly than by any other method. In many cases a simple mental calculation will give us the required distance. If, for example, our 30 inch circle requires to be divided into 18 equidistant points, we would say: If the radius (15 inches) of the circle gives us 6 points, one third of it, 5 inches, will give us 18 holes. Such instances are, however, the exceptions; and it is therefore necessary, in all cases where the required number of holes or points is an odd one, to divide the circumference by their number; and if an even number be required, to divide it into the radius of the circle, which may be done readily enough if the number of holes is small, but if they are many, the following method is the most expeditious: In Fig. 200, let A B represent the radius, 15 inches, of

Fig. 200.



our circle, and therefore the distance between any two points when the circle is marked off into 6 equal divisions. It is apparent, then, that each of such divisions will require to contain ten equidistant points, which we mark off as follows: Setting the compasses as near as practicable to $\frac{1}{10}$ of the radius of our circle, we commence at A, and mark on one side of the line only the line, C. and from that the line, D, and so on up to G. Then recommencing at B, we mark off in like manner the lines, H, I, etc., up to L, and the exact center between the lines, G and L, will be the true position for the center hole, notwithstanding that none of the other points are in their proper positions, nor at proper distances apart. We now note that, as the lines, G and L, overlap one another, the compass points were a shade too wide open. This defect we remedy to the best of our judgment; and starting from the center point, between L and G, we mark off the lines, M, N, and O, on one side, and P, Q, and R, on the other. Then commencing again at A, we mark off the lines, S and T, and then from B, the lines, U and V: the junction of the lines, T and R, forming another true point, and that of O and U forming another, the fifth practically true division. It will be readily observed that, by marking the lines, from C to L, on one side only of the line representing the radius of our circle, and then subsequently marking the lines, from O to V, on the other side only of the said radius line, we keep them distinct, and are enabled readily to perceive the difference between them. For all ordinary purposes our compasses will now be set sufficiently exactly; but if a greater number of holes be required, we make a light centerpunch mark at the points, A and B, and at the junction, in the center of the nearest approach of the lines, T, R, O, and U; and rubbing out or chalking over all the lines save the one representing the radius, we proceed as above to mark out other holes to justify the compass points' distance. The centerpunch marks, however, should be made very lightly, and all of about one depth. If this second adjustment is necessary, it may be concluded by commencing at A and continuing on to B, so as to have the longest possible distance for the justification.