sition. The following examples have variously shaped heads and modes of securing the contents. The lower figure has a clasp, with a pair of hinged jaws with pronged bars.

Correspondence.

On Ponderable Matter and the Ether.

To the Editor of the Scientific American:

No intelligent student of Science can help being struck with the violations of the first principles of mechanical philosophy in the current conceptions of ether and dense matter, and which the highest authorities do not know how to avoid. To blind ourselves to them must necessarily vitiate all our conclusions in regard to the constitution of Nature. I therefore wish to draw attention to the most prominent objections, in reply to which there has been nothing at all satisfactory.

Let us assume the ether to be continuous, which, consistently with the principles of thermodynamics, we must; for were it particled, heat would be taken up by it, and an equilibrium of temperature with the bodies it surrounds attained, instead of being, as it evidently is, a cold medium of radiation. Then solid atoms moving through it must displace their own bulk, and lose force of motion according to the resistance; and equably, whether a body be rare or dense, unless the body as a whole displaces the ether bulk for bulk, which is negatived by aberration. Besides, according to the laws of fluid resistance, all bodies removing within the ether would be resisted according to the squares of their velocities; and the ether within the interiors of bodies should offer resistance as the velocities (squared) of the molecules. The nearer that planets are to the sun, a greater resistance to their motion should therefore be manifested, their motive forces being proportionally greater. Indeed, many have argued with great force (see Bayma's "Molecular Mechanics," pp. 27 to 31) that motion is impossible if matter be continuous. Bayma himself, however, has to make the ether virtually continuous, or self-attractive, in order to attempt to explain the unresisted motions of the heavenly bodies. Another objection to the continuity of the ether has been the proof that, in a continuous fluid medium, all transversal waves must become changed to longitudinal at a great distance from the point of propagation, which the phenomena of light shows us to be not the case.

The matter is not mended by supposing the ether particled, and ascribing definite intervals between the particles; while to suit the phenomena of light, the ether must be understood to possess the properties of an elastic solid. Although the difficulties attending the explanation of dispersion, and transversal vibrations to any distance, are not so formidable, others as great are made, while the objections already indicated in regard to resistance to bodily motion still remain. No matter to what extent the distances of the ethereal particles may be conceived, proportional forces of repulsion must be assumed to hold them in their respective places, and proportional pressure against gross matter in motion. We need not dwell upon the metaphysical difficulties involved in making space both a plenum and a vacuum for the swinging of ethereal particles, the mathematical quantities of nothingness being vastly greater than those of substance.

"Astronomy says aberration cannot be explained unless the ether be at rest; Optics replies that refraction cannot be explained unless the ether moves," are Professor Lovering's words. Tyndall is self-contradictory. The ether "fills space; it surrounds the atoms of bodies; it extends without solution of continuity through the humors of the eye." "The intensity of the light depends on the distance to which the ether particles move to and fro." ("Notes on Light," pp. 218—220.) He does not say whether the ether particles which do *not* fill space strike against each other or not. If they do, they have only a certain amount of space to swing in. If they do not, we are thrown back again upon the generally repudiated theory of action at a distance. Herschel seemed to favor the idea of making the ether self-attractive, but attached beyond the known limits of space, so that it would be virtually in a state of tension, and all wave motion be consequently transversal to the direction of propagation. Others make it self-repellent as well as of great tenuity, to allow the heavenly bodies to pass through it free from the resistance of aggregated particles.

In the ether has also been sought the cause of cosmical motion. Professor Challis supposes a force of impulsion from outside the limits of the stellar universe, and all radiant waves the result of material reaction in a continuous ether. The gravity waves are constant, and proportional to mass; and yet, at the same time, other ever-changing, uninterfering waves are produced from the same bodies, with the alteration of material constitution and conditions! Besides, the difficulty of constant tangential motion is untouched, and the change from waves of attraction to waves of repulsion is assumed in interstellar regions where there is no evidence of such, in order to explain the stability of the Universe. Dr. Guyot, a predecessor of Challis in this line of investigation, opined that the ether became rarefied in dense bodies, the outside ether pressing thereto, like atmospheric pressure upon an exhausted receiver. But this opinion is shown by optical phenomena to be the converse of the truth. Maxwell sought in the ether the mechanical cause of gravitation, but was obliged to confess that he could not conceive of a medium, of which a diminution of intrinsic energy would be so far produced, by the presence of dense bodies, as to result in their mutual attraction, and at the same time be consistent with manifested radiant action. The theory of gravitation by impact, proposed by Le Sage, even as improved by Sir William Thomson, is altogether too artificial to be seriously held for a moment as being the reality, although it attempts to dispense with the ether as the cause of gravity.

Now is it possible to rescue Science from all this serious entanglement—to have a point of view whence a physical cause of the motion of cosmical bodies can be shown upon strict mechanical principles, and the ether producing such motion consistent with all other phenomena, collateral or otherwise? Whatever is true as a matter of fact may certainly be known, if we get upon the right track. In another communication, I will endeavor to point out the direction.

Philadelphia, Pa. WILLIAM DENOVAN.

PRACTICAL MECHANISM.

BY JOSHUA ROSE.

NUMBER XXVIII.

DRILLING HARD METALS.

Very hard metal, such as steel tempered to a blue, may be drilled by a drill tempered to a deep straw color, the drill being used at a comparatively slow speed, and forced against the work as hard as possible without breaking the point of the drill. Sufficient oil may be applied, after the point of the drill has entered the metal, to keep the cutting edges barely moist, the drill being again allowed to run dry and again moistened, thus using as small an amount of oil as is consistent with keeping the drill cool. In this way the drill will cut hard steel the best. For cast iron, however, the drill should be kept as dry as possible. In drilling cast iron that is very hard, and also wrought iron that has been casehardened, the operation may be greatly assisted by taking a hammer and a chisel and jagging the surface of the metal, thus enabling the edges of the drill to bite it. If necessary, the chisel may be made very hard for this especial purpose.

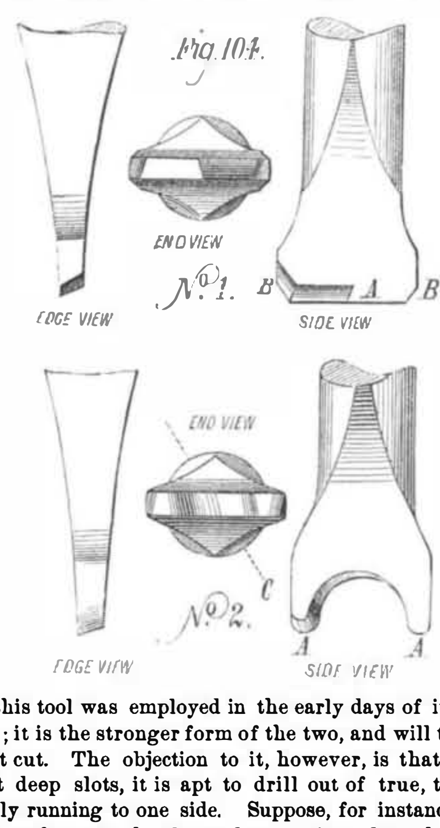
To make a drill exceedingly hard to suit some especial case, it may be heated in a charcoal fire to a dull red heat, and quenched in mercury instead of water. Another method is to heat the drill to a red heat in molten lead, and then to drive it into a block of cold lead, striking successive blows lightly and quickly until the drill is sufficiently cool to permit of its being held in the hand. The cases, however, in which a drill is required to be so hard are exceedingly rare.

If a drill squeaks while being operated, it arises from one of two causes: Either the cutting edges are dull, and require grinding, or else the cuttings are binding in the holes. In the first case, immediate grinding is necessary; in the second, the drill should be withdrawn and the cuttings extracted. Twist drills will bring out most of the cuttings of themselves, but a piece of wire, spoonshaped at the end, is necessary when plain drills are used.

SLOTTING OR KEYWAY DRILLS.

For drilling out oblong holes, such as keyways, or for cutting out recesses such as are required to receive short feathers in shafts, the drill known as a slotting drill, shown in Fig. 104, is brought into requisition. No. 1 is the form in

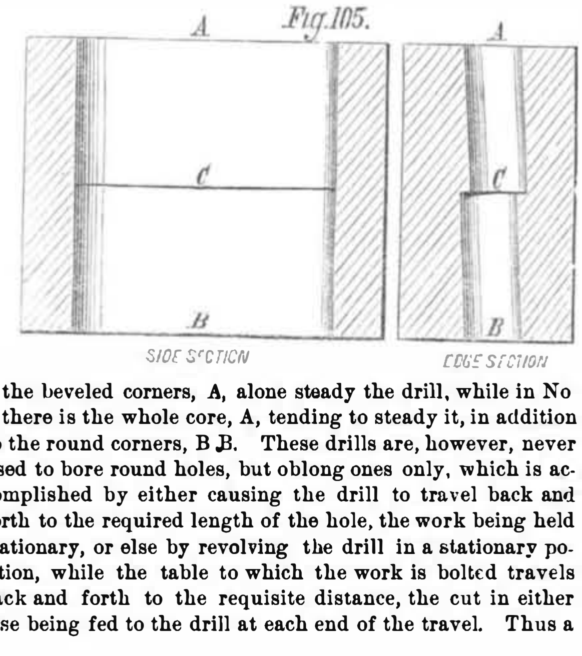
Fig. 104.



which this tool was employed in the early days of its introduction; it is the stronger form of the two, and will take the heaviest cut. The objection to it, however, is that, in cutting out deep slots, it is apt to drill out of true, the hole gradually running to one side. Suppose, for instance, as is sometimes the case, the slot or keyway is so deep that it becomes desirable to avoid having an extra long drill, which would be liable to bend and spring from the pressure of the cut, and hence that a shorter drill is used, drilling the keyway half way from each side: the tendency of such a drill would be to cut the slot as shown in Fig. 105.

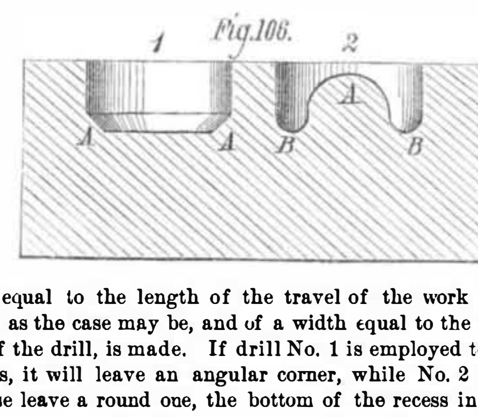
The drill having entered at A on one side, and at B on the other side, and having cut down until it arrived at C, and hence cut the keyway clear through the metal, and the junction of the two not being even at C, it is evident that the keyway will require considerable filing to make the faces so true level, and parallel that the key will fit all the way through. To remedy this defect, the form of drill shown in No. 2 has been brought into use. It will be observed that it enters the metal at the points, A A, first, and therefore cuts a ring of metal out, leaving a projecting piece in the center which serves as a guide to steady it; whereas form No. 1 cuts a flat-bottomed hole. So that, if both drills were simply rotated and fed as a common drill, the holes made by them would appear as in Fig. 106. It will be observed that in No.

Fig. 105.



1 the beveled corners, A, alone steady the drill, while in No 2 there is the whole core, A, tending to steady it, in addition to the round corners, B B. These drills are, however, never used to bore round holes, but oblong ones only, which is accomplished by either causing the drill to travel back and forth to the required length of the hole, the work being held stationary, or else by revolving the drill in a stationary position, while the table to which the work is bolted travels back and forth to the requisite distance, the cut in either case being fed to the drill at each end of the travel. Thus a

Fig. 106.

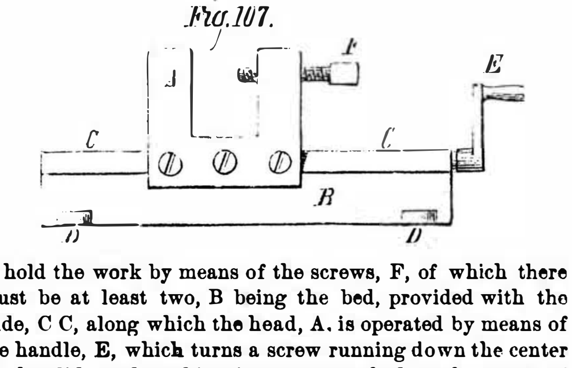


slot, equal to the length of the travel of the work or the drill, as the case may be, and of a width equal to the diameter of the drill, is made. If drill No. 1 is employed to cut a recess, it will leave an angular corner, while No. 2 will of course leave a round one, the bottom of the recess in either case being left quite flat, since the bottom of No. 1 is flat of itself, while the rounded corner of No. 2 cuts away, as it travels along, the cone, A, which, as shown in Fig. 106, is made when neither the drill nor the work travels.

Slot drill No. 1 is made by filing the cutting end square, level, and true to the requisite diameter and shape, and then backing off, that is, filing away on one side, the edges from the center of the drill, outwards and across the beveled corner, as shown in Fig. 104; while No. 2 is made by filing up the cutting end true, level, and square, and then filing out the curved hollow centrally in the end face, with a round file held at an angle with the center line of the width of the drill, as shown by the dotted line, C, in the end view of No 2 in Fig. 104, after which the corners, A A, should be rounded and backed off. The thickness at the cutting end of drill No. 1 should be the same as that given for common drills, while No. 2 may be left somewhat thicker, to give it extra strength, since its form renders it comparatively weak. The reason for keeping the end of No. 1 as thin as a common drill is that it has, at the junction of its two cutting edges, centrally on the end face and between the beveled corners, a cutting edge across the thickness of the drill, as shown in end view, Fig. 104, and is in that respect subject to the defect before mentioned as inherent in common drills. This defect does not, however, exist in slotting drill No. 2, in which the cutting edges on the outside faces extend clear to the center of the diameter of the drill.

Slotting drills should be tempered to a deep brown, and should be supplied freely with oil when employed to cut wrought iron or steel, but must be kept perfectly dry when used upon cast iron or brass. They are revolved at a higher rate of speed than common drills. To employ them in a common drilling machine, whose table has no horizontal sliding motion, it is necessary to make a chuck which will bolt to the machine table; the chuck is to be provided with a pair of jaws to clamp the work, and to make the upper part of the chuck movable upon a slide in the lower part. Such a chuck is shown in Fig. 107, A being the jaws, wherein

Fig. 107.



to hold the work by means of the screws, F, of which there must be at least two, B being the bed, provided with the slide, C C, along which the head, A, is operated by means of the handle, E, which turns a screw running down the center of the slide and working in a nut attached to the center of the head, A. The lugs, D D, are provided with holes through which to bolt the bed to the drilling machine table.

In using such a chuck, the operator will be very apt to vary the distance to which he moves the slide at each cut, the effect of such variation being to cause the edge of the slot or keyway to be very uneven. To remedy this, it is best, after having drilled to the proper depth, to wind the slide and set the drill so that it takes a slight cut out of one