

Having discussed the method of determining the direction between shafts, it is now proposed to give a short description of the method of transferring the lines underground and prolonging them until a junction is effected between the workings from adjoining shafts.

The first business is to lay out the working shafts, which should be upon the centre line if possible, although this is not always feasible. They should be long enough to give about 10 feet in the clear between the plumb-lines. As soon as the shaft has been timbered up and excavation started, a nail is driven into the timbers and a distance marked, showing depth from top of nail to subgrade. As soon as bottom is reached, line will be required by the miners for opening up the sidelengths.

The direction being known from a given point, the instrument is set up and an angle turned that will give the proper direction, or if a point has already been

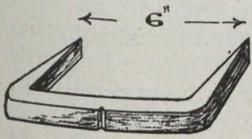


Fig. 2.

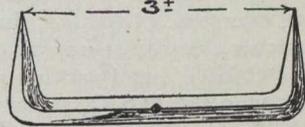


Fig. 3.

established on the centre line this is sighted on very carefully, so as to bisect the arrow or plumb-line. The telescope is then depressed and a point given on a brace on either end of the shaft; six-inch iron dogs, as Fig. 2, are then driven central to these points, care being taken to see that a line dropped from the dog will clear all obstructions below. The dogs being driven fairly tight, a small plumb-bob is dropped over them, and the telescope focused on the cord, which is then moved so as to bisect the line of sight and a pencil mark is drawn on the face of the dog on either side of the cord. A file nick is now made between the lines about 1/16 inch deep and plumb-lines dropped to the bottom of the shaft. The transit cannot be used in the bottom until one or two tunnel lengths have been excavated and completed, but centres can be given with sufficient accuracy, by stretching a cord from the shaft into the tunnel and adjusting it so that it just touches either plumb-line.

Some engineers use a slow-motion screw device for bringing the lines into adjustment but the iron dog will be found to give as good results, and perfect adjustment can be secured by striking the shoulder of the dog with a hammer, so as to draw the line over as required. The usual practice is to use 25 B.W.G. piano wire for the plumb-lines, but the writer prefers to use a strong plaited line, such as is used by sea fishermen. If this is treated in a bath of boiled oil and dried it will remain waterproof and be free from kinks, and will give considerable service. It has the further advantages of being easier to handle and requiring a lesser weight to bring it taut. The piano wire requires at least 20 lbs. to effect this, while about 7 lbs. is sufficient for the cord. This difference in weight will be appreciated by the assistant who is responsible for carrying the weights around.

For use with the cord, the writer designed a plumbing weight as shown in Fig. 4. The body of the weight is in the shape of a shell with three vanes cast on the sides at angles of 120°. A screw top similar to those used on an ordinary plumb-bob is fitted and the line knotted through this. When the lines are dropped down the shaft the plumb-bobs are suspended in a pail of water and the tension on the cord will cause them to rotate. The vanes, however, soon stop this movement and the lines come to perfect steadiness in a very short time. Care must be taken to see that the plumb-bob does not touch the pail anywhere, or that the lines are fouled by any of the braces.

When it is desired to project the line into the tunnel, the transit is set up behind the back line, just near enough to clearly focus it, and the instrument is set on the centre of the line. The focus is now altered to catch the forward line which will probably be found to be off. The transit must now be moved either to the right or left and the operation repeated until both lines are exactly bisected when in focus. When this result has been attained a point may be given in the tunnel as far ahead as can be seen and two intermediate points should also be established on the permanent work. If, on checking the line at some later date, these three points are found to agree they may be adopted as a permanent base and the line extended from them.

For fixing centres in a brick-lined tunnel, a small steel dog, made as Fig. 3, is very useful. This is driven astride the keying course so that a space is left between the inside of the dog and the brick. When giving line a plumb-bob is suspended by a cord, with a lighted screen behind it and the line moved until the transit bisects it. A pencil mark is then made on either side of the line and a nick filed between them. The plumb-bob is now hung in the nick and the line adjusted by tapping the dog with a hammer until the line is truly bisected.

The ordinary tripod will not be found of much service underground as it is difficult to obtain a rigid foundation, on account of tracks, etc.

To overcome this, a platform is sometimes suspended from the roof and rigidly braced and the transit is placed upon this on a small tripod. The observer's seat should be independent of the platform. A sketch of such a tripod made of malleable cast iron suitable for a three-screw instrument is shown in Fig. 5. For an instrument of ordinary design, a screwed ring must be attached to the body of the tripod. The tripod shown in the sketch has V grooves cut in the top at angles of 120°. The ball at the foot of the levelling screws rests in these and the weight of the instrument will retain it in place. A hole about 3 inches in diameter is cast in the top of the tripod so that a small plumb-bob may be dropped from the instrument for centering purposes. This is very useful

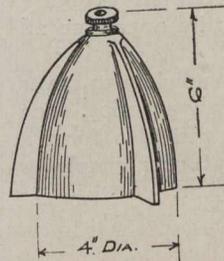


Fig. 4.

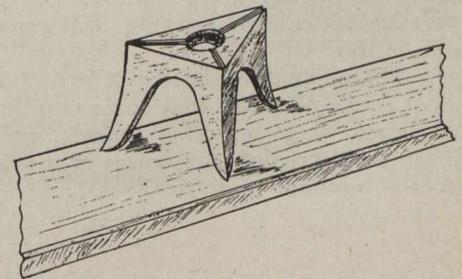


Fig. 5.

when ranging curves, for setting over the B.C. or other points.

For small tunnels up to 12 feet diameter it is best to use a plank wedged across the tunnel at springing for a platform. The top of the plank should be cleaned, so that the tripod can be moved easily upon it when making lateral adjustments.

When a curve occurs in a tunnel, the P.I. must be carefully located by a surface survey and then established in the tunnel from the information obtained, although this cannot always be accomplished owing to the point coming outside the limits of the tunnel section.

In such a case, when the B.C. has been established, the point is plumbed on to the platform and the transit set up over the point, a sight being taken on the back