the obstructions which will be experienced from snows on any of the other proposed routes north of the latitude of 35° will be much greater than upon the one under consideration, while upon the latter they will not be of so formidable a character as not to be readily surmounted by a resort to the proper means, without involving any very great or unusual expense for the purpose, provided the road is judiciously located and constructed.

To be continued.

The Liverpool Docks.

The docks now in course of construction, as we learn from the *Liverpool Mercury*, at the extreme north end of the port of Liverpool, (the New York of Great Britain,) are rapidly approaching completion. The Huskisson dock, which is one of the largest in the world, is constructed for the accommodation of ocean steamships. The locks at the south end are finished. The dock itself is ready to receive vessels, water having been let in at the last spring tides; and workmen are busy paving the pier and parts of the quay, and constructing the locks at the north end. Large as the Bramly-Moor, Nelson, and other of the northern docks, finished in 1848, are, they are outrivalled by this new evidence of what the genius and enterprise of Liverpool can effect. The width of the east lock-gates is 80 feet, 10 feet wider than the lock-gates of any dock hitherto constructed at this port; the west lock-gates, 45 feet. The water area of the dock, 14 acres 3,451 yards, with quay-space to the extent of 1,122 yards. The water area of the east lock is 4,682 yards, with quay-space of 242 yards; the water area of the west lock, 3,650 yards, with quay-space of 330 yards. No sheds have at present been erected on the dock-quay, which is still in an unfinished state; but sheds have been constructed on the lock-quay, where arrangements have been made for unloading vessels and for the reception of cargoes. A large space of the west end of the lock quay is set apart for a timber-yard, and the remaining portion by the side of the locks, will be used as the sites for sheds in which to stow away dry goods. The total water area of the wet-docks along the margin of the Mersey, belonging to the corporation of Liverpool, is now 177 acres 3,684 yards, with a quay-space of 12 miles and 1,412 yards; and of dry-basins, an area of 20 acres 892 yards, with quay-space of 1 mile 712 yards; making a total of 197 acres 4,576 yards of water area, and 14 miles 712 yards of quay-space; with a length of 5 miles and 20 yards of river wall. Independently of this large extent of dock space, other docks are yet to be formed, and excavations in reference to this object are going forward.—The walls surrounding the Huskisson dock, as well as the north docks which have recently been constructed, and the Normanlige towers, to serve as offices to the gate-keepers, are built of granite, and combine considerable beauty and neatness with extraordinary durability and strength.

Red River Raft.

The removal of this obstruction has been again advertised for contract by the United States Government, the former contractor having failed to complete the work, and abandoned the enterprise. By a communication which appears in the National Intelligencer, it seems that the raft is so formidable that its removal is thought impracticable. According to this writer, the great raft was originally one hundred miles in length, and not ten miles of it has ever been removed. Through this whole extent the river is obstructed by an immense aggregation of logs and trees, which have to be dug up and sawed out. The attempt to remove this raft was abandoned many years ago, and a new route adopted for navigation, by way of Bayou Pierre, Shreveport, Lake Caddo, and a canal from thence into Red River above the raft, which is used to this day. This, however, is also annually obstructed by a raft at the upper end formed by every freshet.

On Hollow Railroad Axles.

By J. E. McConnell, of Wolverton.

[*Paper read at the Institution of Mechanical Engineers.*]

The selection of the tubular form of axle originated from the knowledge, that with a considerably less weight of material in the form of the tube, a much greater strength can be obtained to resist torsion, deflection by pressure or weight, or concussion from blows. The resistance of a solid system to deflection and torsion, increasing in proportion to the fourth power of the diameter (or the square of the square), but the weight increasing only as the square of the diameter, two solid cylinders, having the respective diameters of 4 and 5 inches, or 1 to $1\frac{1}{4}$, will have a proportionate weight of 16 to 25, or 1 to $1\frac{1}{2}$, but a resistance of 256 to 625, or 1 to $2\frac{1}{2}$. Then, if a hollow of two-thirds the diameter be made in the larger axle, its weight will be diminished $\frac{1}{2}$ ($\frac{2}{3} \times \frac{2}{3}$ = 4-9 or $\frac{1}{2}$ nearly), and its resistance only one fifth ($\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3}$ = sixteen-eighty-firsts, or one-fifth nearly), and the comparison with the smaller solid axle will then be 1 to $1\frac{1}{4}$ in diameter, 1 to $\frac{7}{8}$ in weight, and 1 to 2 in resistance, being double the resistance, with $\frac{1}{8}$ less weight.

The use of hollow axles was tried some years ago, but was not continued, the main objection being, that there appeared a great difficulty of insuring, by the particular mode of manufacture adopted at that time, a sufficient uniformity of thickness of the sides of the tube throughout, and also of the soundness of material. The mode adopted consisted of rolling two or three bars of a semicircular cross section, which were welded together with butt-joints, but with no internal pressure, and with solid ends where the bearings came. These axles, having no mandril or internal pressure during the process of welding, were found to be of a very uncertain strength throughout the axle, and the weakest point might be close to that part where the greatest force or strain would be exerted.

To overcome these objections, a mode of manufacturing railway axles has been introduced by the writer, which, it is believed, effectually accomplishes the object in view, securing the utmost strength with the least possible amount of material, uniformity of structure of the iron, perfect equality of thickness of material, and soundness of manufacture.

The plan adopted is as follows:—A number of segmental bars of the best quality of iron are rolled to a section, so as to form, when put together ready for welding, a complete cylinder, fig. 1, about $1\frac{1}{2}$ times the diameter of the axle when finished, the bars fitting correctly together, so as to have no interstices, and overlapping in such a manner as to insure a perfect and sound weld when completed, as shown in fig. 1.

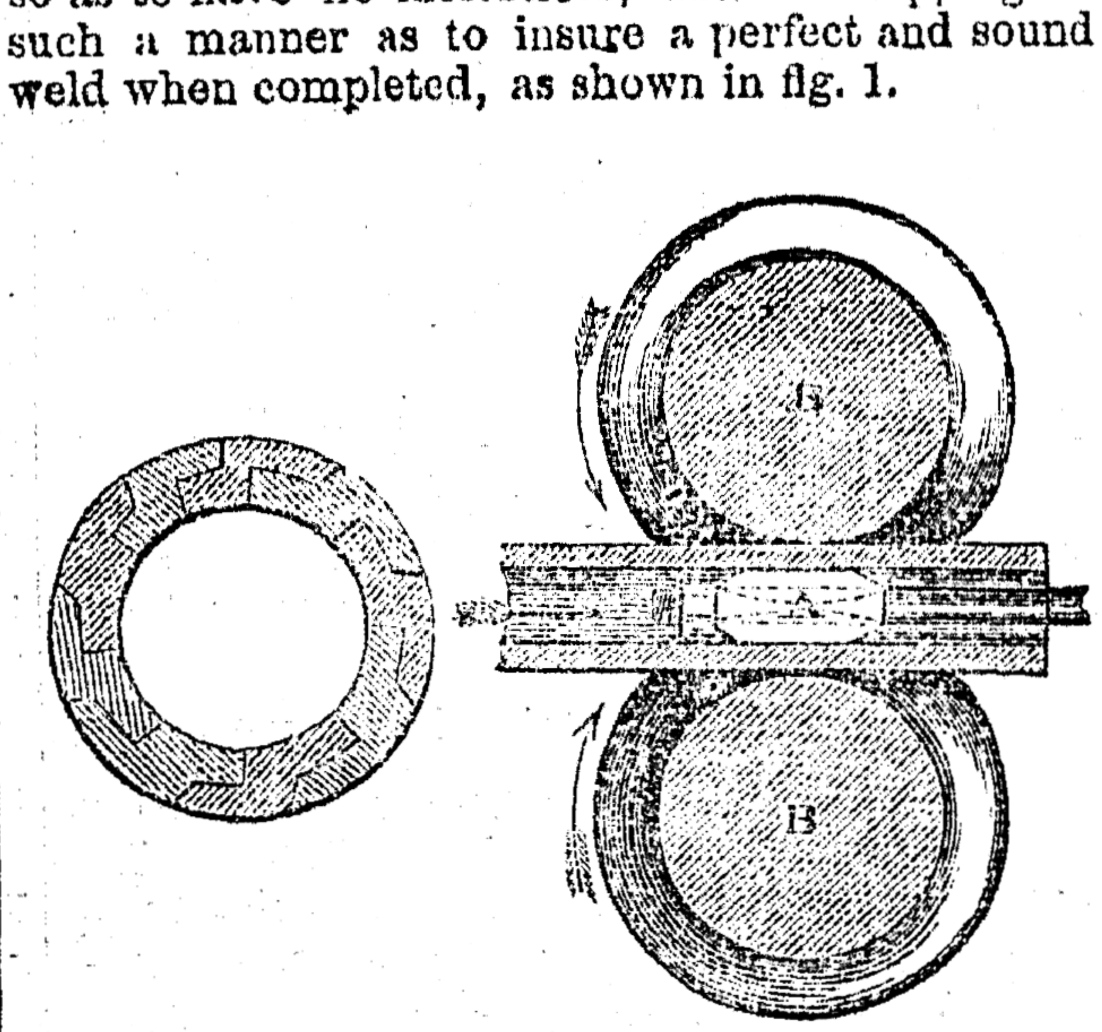

Fig. 1. *Fig. 2.*

This cylinder of loose segmental bars is temporarily held together by a screw-clip, and each end being put into the furnace until a welding heat is produced, the bars are then partially welded together, and the clip removed. The whole cylinder is then placed in the furnace, and brought to a proper welding heat; it is then passed through a series of rollers B, B, fig. 2, which have each a mandril of an egg form A, in the centre of the circular opening, which are attached and supported on the end of a fixed bar, the bar being firmly secured at the opposite end, to resist the end pressure or strain during the process of rolling. The mandrils are made of cast-iron, chilled, fitting on like a socket on the end of the bar to a shoulder, and they are secured by a screw-nut, so that they are easily removed when required.

The motion of the rolls is so arranged, by a reversing-clutch on the shaft, that as soon as the axle-cylinder has been drawn clear through, the motion is reversed, and the axle which has been drawn on the mandril-rod, is again drawn back through the same openings in the rolls; it is immediately passed through the next smaller groove of the roll, with a decreased size of mandril, and again reversed back through the same groove in a similar manner, and so on through a series of grooves in quick succession, each decreasing in size, and consequently increasing the compression and strength of the iron of which the axle is formed, and by the last groove it is passed through it is reduced to the proper diameter. At each time it is changed from one groove to another, the axle-cylinder is turned by the workmen a quarter round, so as to equalise the pressure on every part of its surface, to insure uniformity of the compression of the iron, and thoroughly complete a sound welding throughout every part of the axle.

The specimens before the meeting showed the soundness and perfection of the manufacture, as a proof of which, in every test applied, either by blows on the outer surface or by an immense splitting pressure, by driving a mandril in the interior, there has never been found in any one instance a failure of the weld, although the test has been applied to pieces cut off the extreme end, where it might be supposed the welding of the cylinder of the axle, from various causes, would not have so good a chance o: being perfect.

The axle at this stage, after being welded and drawn down in the rolls to the proper size, is taken at once to a hammer, where it is planished between semicircular swages over its entire surface. A small jet of water plays upon it during this process, which enables the workman to detect at once, by the inequality of colour, any unsoundness in the welding. From the hammer it is taken to the circular saws, where it is cut accurately to the length required, and ready to have the bearings formed upon it.

On coming from the hammer, the axle is found to be perfectly clean both inside and outside, the scale being entirely removed. The ends are then re-heated, and gradually drawn down by a hammer to the proper dimensions and form of the journals, a mandril being inserted in the end of the tube during the process of hammering.

The formation of the journals can also be produced by a rolling-machine, constructed of tables the entire length of the axle, rolling transversely, each table being a duplicate of the other, and matrixes of the axle when finished. Or in another way, by two sets of rollers, each set consisting of three rollers running vertically, being of the same diameter, and driven at the same velocity, formed exactly to the shape of the bearing, and set the proper distance apart from shoulder to shoulder of the journals.

The manufacture of these axles has been intrusted to the Patent Shaft Company, and a great amount of credit is due to Mr. Walker, the managing partner of that firm, for the very excellent system he has adopted and carried out in the process of manufacture.

As an illustration of the saving in dead weight, take, for instance, a railway employing 15,000 wagons and carriages, and assume each of these vehicles to run on an average 10,000 miles per annum. The weight of two axles of the solid description finished, is say 5 cwt., and if replaced with hollow axles of equal strength, the weight per vehicle may be reduced $1\frac{1}{2}$ cwt.; this taken over