fire chamber moving with the hearth, while the flue made sliding connection with the stack. These furnaces agitated the bath in a measure and hastened the puddling proper, but they were limited in the angle they could assume by the washing of the bath over the bridge wall and could neither clear the bottom, ball the iron, nor discharge it when balled.

The Gidlow and Abbott furnace* is a good illustration of this type.

Another variety had hearths which rocked either on transverse or longitudinally arranged trunions inside a chamber which had fixed roofs, sidewalks, fire chambers and flues.

Here again the construction limited the angle of oscillation, so that the cinder and iron would not splash or flow over the sides or end of the hearth, since, besides the loss of iron, such splashing would soon prevent the hearth from moving at all by chilling on the walls of the chamber. These furnaces could neither clear the bottom, turn the iron, ball nor discharge it. The Jones† and Daelen‡ furnaces are, perhaps, the best types of this class.

Besides these comparatively simple furnaces there were a number of others which were most complicated in construction, difficult to operate and utterly impossible to maintain in the presence of the active chemical comparatively high temperature. Generally speaking, all of the designs briefly alluded to above, were hampered by too narrow mechanical limitations, some were too complicated, and all of them have failed to prove themselves capable of effecting the whole of the process, that is, puddling, balling and drawing. Those that showed the most knowledge of puddling also showed the overhanging influence of the ordinary puddling furnace, while those that appeared to have been designed by mechanics show an absence of knowledge concerning the details of practical puddling.

The puddling process is really very simple and early appealed to the writer as one that admitted of mechanical solution, provided it was approached broadly as a process and tradition was ignored. Further, it seemed to him necessary that mechanical means should be associated with large units and the use of metal direct from the Blast furnace, that is, that the same broad means that have made possible the low cost in the modern production of steel should be utilised as far as possible. In looking over the field for means of agitation, that of simply flowing by gravitation had strong attractions, due to its simplicity. That is, given an inclined trough properly enclosed and heated, the angle with the horizontal increasing as it descended, lined either with oxide of iron or some neutral material, and then having a charge of molten iron and cinder poured in at the top. Theoretically, a crudely shaped ball should result by the time the metal reached the bottom, provided the trough was long enough. Although attractive, the proposition was an impracticable one, first, because it was ill adapted for experimental purposes on account of expense, since the trough would have had to be about 2,000'-0" long, and elevated about 600'-0" at the top; and, secondly, the cinder would almost always separate itself from the iron and lead in the race for the bottom, it being more fluid at most stages of the process, and the iron being retarded by friction on the bottom. The idea was neither better nor worse than many of the puddling machines proposed, but it contained the germ of what has since been worked out.

The underlying thought was that the long incline, with the wave effect it naturally produced, was good. Following along this line, it became evident that a trough of considerable length, down which the bath could flow, first in one direction and then in the other, would possess all the advantages of the long fixed trough, together with the additional one of a sudden arrest at each end, by which the bath would be forced through itself, and greatly increased thoroughness of mixture would be obtained. This arrangement would also utilise the retardation of the lower stratum of the iron by friction on the bottom, producing the effect of waves running up a beach, at the same time correcting it before it became excessive. It was first determined to make the trough 50'-0" long, but a compromise was finally made with the scrap pile at 28'-0", since that was the extreme length of the old girders on hand. I may say that the scrap pile had great influence upon the design of the first machine, which fact, besides its economical features, pointed out many things to avoid in later construction. The details of the machine can be seen from the longitudinal and cross sections shown in Fig. 1 and 2. It was not inaptly described by a visitor, who saw it in operation, as looking like a steam boat on land, hunting for water. The two long girders formed the substructure, upon which all of the moving parts rested, and were suspended from two hollow trunions placed opposite each other at the middle of the length. The flames from two stationary coal fire chambers passed through the trunions into the furnace and out of the stacks at each end. The trough, forming the bottom, was made of steel plates and was double, water passing through it to preserve the covering.

The question as to the material to be used for the first working bottom was important and complex. There being no definite data on which to base a decision, it was finally decided to lay a course of ordinary fire-brick on the flat, and to tamp upon this a 2" layer of rolled scale and tar. This was selected on account of its easy application rather than because of any supposed special fitness. It was not anticipated that the cooling influence of the water would be sufficiently felt through the brick to preserve them from combining with the oxide of iron of the covering, but it was hoped that it would last long enough to give valuable data.

(To be Continued.)

*Jour. I and S. Inst., 1878, No. I., p. 240.
†Am. Manufacturer, Vol. 49, 1881, p. 282.
‡German Patent, No. 4686, Aug. 4, 1878.

WOODEN WATER PIPES.

In the vicinity of coal mines, where the water is extremely bad and contains a large amount of sulphur, in tanneries, or in fact any place where metal pipes are subject to corrosion, the wooden pipe is fast proving its superiority. Metal pipes do not last long and the expense of frequently replacing same soon becomes a rather large item, particularly in places where long runs of piping are in use.

Metal Wound Wooden Pipe.

The pipe described is manufactured by A. Wyckoff & Son Co., Elmira, N. Y. It is composed of staves made of white pine jointed together with tennon and socket, and banded with steel hoops spirally wound, and over all is a covering of asphaltum cement. Pipes ranging in diameter from 6" up to any size required are constructed of white pine staves with regular tennon and socket, and 1½" steel hooping, which steel hooping is made acid proof by the application of the cement coating. This pipe will withstand a maximum pressure of 160 pounds per square inch.

A cement covered wooden elbow is also manufactured to fit the various sizes of pipe. This elbow is in the shape of a square box and is bolted together, the number of bolts depending upon the pressure that it is required to stand.

Our illustration shows the construction of the metal wound pipe, the spirals of the winding being spaced according to the pressure to be withstood.