timber piling, they will more than make up for this in permanence. Where piling is the suitable type of foundation to adopt and there is danger from decay so common in timber, concrete piles have already, supplanted the wooden pile in many localities and will likely do the same in this district.

Wherever piling is used in or around Winnipeg it should be driven to refusal. It should never be stopped in the blue clay, depending entirely on its skin friction for its supporting power. While there is doubtless some frictional supporting power in this clay, it is safer to disregard it except as a means of lateral support, depending on the underlying stratas and the rock to carry the downward thrust.

The next type of foundations are those which are installed directly on the rock or in the rock by means of caissons or wells. This type presents the only dependable kind of foundation which can be installed, for two reasons:—

First: Because the foundation gets its support from rock, the only strata in this district which should be used for founding an important or heavy structure, and

Second: Because the method of construction affords a visible means of inspection of the class of material passed through, the bottom on which the foundation rests, and the placing of the concrete.

The pneumatic caisson is seldom used in this district, except for constructing deep bridge piers or foundations of heavy structures where it is not practical or economical to control the water volume with ordinary pumping units. Consequently this paper will not go into a detailed description of it.

The cast-iron-cylinder method of sinking wells is occasionally used in underpinning operations when working under conditions of an exceedingly heavy superimposed load, and where a very small loss of ground might prove disastrous to the building which is being underpinned or to adjoining property. The system of sinking wells by this method differs from the Chicago well method only in the manner of placing the well lining. After the excavation has been started a section of a cast-iron cylinder is set into the top of the excavation and jacked down. As the excavating proceeds, additional sections are placed, one at a time on top of the last one to be jacked down, and the jacking process repeated. The sections are provided with flanged ends (turned in) so that they can be bolted together. If necessary, the joints may be made water-tight with gaskets. By this process it is possible at all stages to keep the sides of the excavation protected against a cave-in.

Small diameter cylinders for shoring or underpinning purposes are sometimes installed by driving an open-ended pipe in the same way a pile is driven. The material is then excavated from the pipe by means of special tools and buckets made for the purpose, and the pipe filled with concrete. The two foregoing types are only used in exceptional cases where the construction conditions are peculiarly hazardous.

For ordinary conditions of underpinning existing structures or constructing foundations from the rock for new structures the Chicago well method is by far the cheapest and most satisfactory for this district. It has almost entirely supplanted rectangular wells from the standpoint of speed, economy and safety of construction.

This method obtained its name from the city where it originated and has been used very extensively.

The manner of constructing Chicago wells is briefly as follows: Excavate the well to the required diameter for a depth which will take the first set of lagging. Set the lagging and brace it firmly back against the clay with iron rings. Continue this sinking till there is depth for the second set of lagging. Place this in position so that the ends of the lagging pieces will butt up against the bottoms of the first set. Brace as before with iron rings. Continue this process until the well is finished.

The length of lagging used in each set is determined by the class and condition of material being passed through, the amount of pressure transmitted by it, and the length of time the excavation can be left unprotected against cave-ins or movement in the material. Care should be used in keeping the well plumb as the excavation proceeds. This can be done by placing the first set of lagging vertically and then plumbing each piece in the second set from the first set. Continue this rotation, plumbing each set from the one immediately above. A better method by far is to establish permanently your well centre overhead before starting the sinking. From this centre hang a plumb-bob which can be lengthened out as the sinking progresses. Always do the finished trimming by measurements taken from the central plumb string.

The trimming of the clay to receive the lagging should receive the greatest care, and none but experienced diggers should be permitted on this work, for considerable skill is required to do it properly. If the trimming is not carried far enough, difficulty will be found in placing the rings. If it is carried too far the joints between the ring flanges will have to be filled out with wedges to make the rings bear against the lagging. At the best, results from shovel trimming are uncertain, because of the voids left behind the lagging, and a loss of ground is probable from a movement in the clay to fill these voids. This difficulty may be overcome imperfectly by pouring grout behind each set of lagging as it is placed, but the remedy is slow and not entirely satisfactory. The writer devised and used on recent work a very simple little machine, operated by hand, that gives most positive results, leaving a face to the clay absolutely circular and without any unevenness.

In this connection the writer anticipates that a power-driven machine with a device for elevating the muck to the surface will before long take the place of the present method of digging by hand with shovels and elevating the muck to the surface in buckets operated by winches on the surface. About four-fifths of the sinking is through an even textured clay with no boulders or large gravel to interfere and this part of the excavation should be handled with a machine digger more economically and quickly than the present method.

The last eight to twelve feet of sinking through the conglomerate stratification overlying the rock is by no means so simple as sinking through the overlying clay. Under normal conditions this material is water-bearing, and extreme care must be used in lagging it to prevent cave-ins. Where water, however, has been drained out and the material has been permitted to consolidate and harden under pressure, much of the exposed face can be left safely without lagging. With the hardpan in this condition, sinking through it frequently is almost as expensive as going through rock. Picks make little or no impression on it. Bull points driven with sledges are effective but the progress is slow. We have had the best results from drills operated by compressed air. Wherever compressed air is available without a heavy installation charge, its use is advisable.

When water is encountered in sinking, pumps must be used. The available space for hanging pumps in a