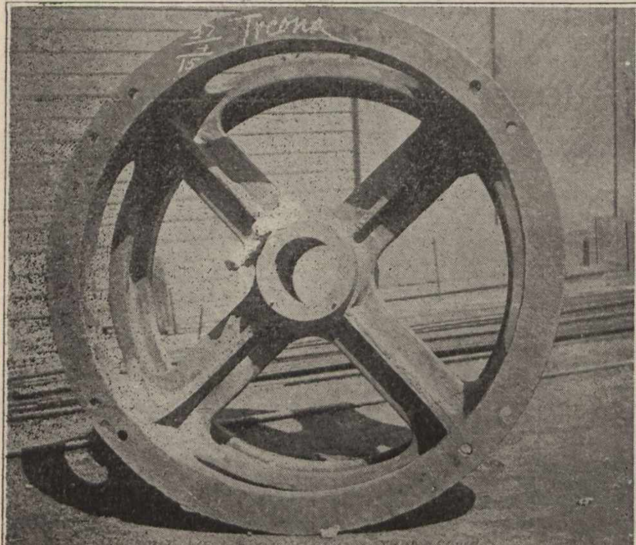
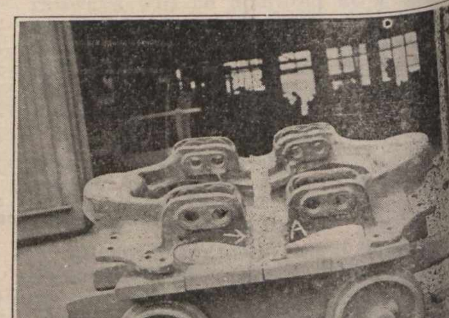
perature of the thermit steel, it being 5400 deg. Fahr., it will cut the moulding material if the ingredients are of poor quality, or if they are not carefully selected and properly mixed together. Even in cases where the moulding material, while poor in quality is yet sufficiently refractory to prevent the thermit from running out, the resulting weld will be anything but satisfactory. Upon close inspection it will be found that the moulding material has been carried into the metal, impairing its value and possibly spoiling the weld. Sand containing from 96 to 98½ silica, such as used by the steel foundries, when available, should be mixed, two parts of sand and one part of good fire clay.

Although great importance is attached to the moulding material, no less attention should be given to the preheating system. From personal observation sometimes I have found, upon machining thermit welds, that the metal is not perfectly solid, containing blowholes, impairing the strength of the weld greatly. Now from experience I have found this can be avoided. Do not assume for one moment that this fact is peculiar to the thermit process and cannot be avoided. Welding with thermit is essentially the same as making a steel casting, the process of reasoning will apply to both cases in so far as the conditions are the same. The chief cause of blowholes in steel castings is the presence of ferrous oxide in the metal, this is removed by adding some very active deoxidizer such as aluminum manganese or silica. Thermit itself is a mixture of iron oxide and aluminum, in such relative proportions as to reduce the oxide, and the manganese added to the thermit is to reduce all oxides which may be present in or on the parts to be welded, so it is evident that blowholes which may occur in thermit welds cannot arise from this cause. I am satisfied from past experience that if the parts that are to be welded are not heated or brought to a high temperature before the thermit steel is poured, the small portion of thermit steel coming in contact with the larger amount of comparatively cold metal, which at once conducts away the heat of the former so rapidly at the junction of the two metals, it becomes so thick and the shrinkage so severe that it results in blowholes. These precautions I make mention of, as the tendency by a great number of men doing this class of work is to overlook the fact that unless all the work done be in accordance with standard thermit practice they cannot expect to obtain satisfactory results. It should be remembered also that the same precautions should be taken in thermit welding as are observed in the best regulated steel foundries, especially in regard to the construction of venting, gating, providing the proper number of risers and the mould properly arranged, so that the parts may be preheated evenly and thoroughly and the crucible properly tapped. Let me point out that this is a decided advantage that does not hold for any other class of autogenous welding, as results are always dependent on the skill of the operator, as there are no fixed rules laid down, such as there are in thermit welding.



Let us consider the reinforcement provided around the welded section. I have heard a great deal of comment about this reinforcement, as if it was something to help the welded part, which was not satisfactory and could not be depended upon without it. If I understand thermit at all, this reinforcement is simply put on in order that sufficient heat may be concentrated around the part to be adhered or welded with thermit steel. This may be cut away providing it is necessary, without affecting or impairing the strength of the welded parts. This is not an assumption on my part.

The accompanying fig. 1 is a cast iron boring bar of a 6 ft. vertical boring mill which was repaired in 1913, under my own care, and fig. 2 is a quadrant belonging to the same, which had to be machined and cleaned before assembling. This mill has been doing heavy work, such as boring steel tires and cylinder rings since repaired. A recent test on a riser that was cut off, which is considered the poorest part of any resulting thermit steel weld, showed a fine granular structure and a tensile strength of about 60,000 lb. per sq. in., with elongation of from 11 to 15%, which is considered very good for cast steel.



The question of expansion and contraction, not only on locomotive frames but on all other sections where the contraction is affected by thermit welding, is one of great importance. A great many men regard the words "expansion and contraction" purely as relative, and they do not give the matter the consideration it should have. There is no fixed law regarding the exact amount of expansion on any piece of work, be it iron, steel, or cast iron, but practical knowledge and experience is just as safe a guide as will ever be needed along this line.

We will take the following locomotives which have recently been welded at Transcona shops: On locomotive 427 four welds were made. See fig. 3. Following are particulars of the locations of the fractures and of the methods adopted:—

Top zone A. When the 3rd weld was made the zone at E was heated after crucible had been tapped.

Bottom zone C. First weld was made at zone C, zone B was cut open 1 in. wide, front end was jacked up, expanding from 3/16 in. After 3 hours jack was lowered to normal condition.

Zone at D. In welding D heat was applied at C.

Top zone B. Second weld was made at zone B, jacks were lowered at front of locomotive and secured an expansion of 3/32.

Following are particulars of work on locomotives 405 and 634. See fig. 4. On locomotive 405 zone B was heated. On locomotive 634 zone A was heated.

Experience has already shown the advantage of the thermit process over other