a short time after patching up and see the patching full of cracks where drying has set in. This allows an escape of heat from the melting zone and should not occur. It is very probable that the mud used for this patching was mixed or made up after first being wetted.

Cupola Dimensions.

The form of lining should be regular and should not have offsets in its contour. It should be kept to as near a standard form as is possible; this form to be determined by careful experimenting with each cupola as no two cupolas work exactly alike. As to the dimensions of a cupola, of course, the work to be done must be considered, but it is better to get a larger cupola and line it down to the size wanted than to try to force a smaller one.

Amount of Air and Coke.

For every pound of coke burned to complete combustion, 150 cubic feet of air is required, and in good practice one pound of coke will melt nine pounds of iron, so that to melt one pound of iron, 16 pounds of air will be necessary, or about 32,000 cubic feet per ton of iron melted. This air is heated by passing through the incandescent coke and carries that heat upward, heating the stack above the melting zone and finally passes out at the top of the stack. If the rate of driving be so fast as to drive more air into the cupola than is required to melt with, a larger loss of heat occurs. This extra amount of heat will be taken from the iron, where it belongs, and thus lower the temperature at which the iron is melted. Additional fuel in this case is of no benefit as the amount of fuel that can be used is limited to the dimensions of the cupola, so that to drive the blast faster than the cupola can take care of it results in a greater loss than would at first thought be considered possible.

Pressure of Blast.

The pressure should very seldom be higher than 18 ounces per square inch, and a lower blast is desirable, say 14 ounces or even 12 ounces. In order to determine the proper blast pressure for a given cupola, samples should be taken of the gases, about a foot below the charging doors, and a chemical analysis made. This sampling should be done while the cupola is running normally and should extend over two or three days' time.

When once the proper maximum pressure suitable for a given cupola is obtained, it should be a strict rule of the foundryman never to allow the pressure to exceed that amount. He thus not only secures more uniform iron but a more economical melting, in being able to utilize more heat than he otherwise could.

Economy in Melting.

On a heat of 100 tons per day, 3,200,000 cubic feet of air will be required. Should more than this amount be forced into the cupola it would only carry heat away. Let us say, for argument, that 1,600,000 cubic feet of air was forced into the furnace, over and above the amount actually required. Let us again say that the temperature at which the air leaves the charges at the charging doors is 325 degrees Fahr., and that the temperature of the blast entering cupola was 25 degrees Fahr. Then, reducing the excess air to pounds, multiplying by specific heat and dividing by 12,000 B.t.u. (average available heat units from one pound of foundry coke) we find it takes 760 pounds of dry coke to supply the heat carried away by this excess blast. In other words, forcing an excess of 600,000 cubic feet of air per day carries away the heat liberated by 760 pounds of coke. Extending this for a year of 300 working days, we have an enormous total of 228,000 pounds of wasted fuel, enough to melt 1,026 tons of iron. This is perhaps more than actually occurs in practice, but has purposely been made large in order to show how big an item of waste heat might result.

To avoid this useless expenditure a careful comparison of working conditions, day by day, should be kept, and it is a most excellent plan to plot these different conditions on cross-section paper. In that way a very ready observation may be made and ofttimes shows the furnacemen conditions existing that would have gone by unnoticed.

Making Up Mixtures.

One of the most, if not the most, important question that bothers a cupola manager is that of the mixture. It is necessary to obtain a mixture that will produce the castings desired, and in the attempt to meet competition as to quality foundrymen generally use a large percentage of pig iron in their mixture. Some managers go so far as not to allow the use of their own scrap, while others may be more lenient and permit a small percentage of their own scrap in the charge. As to the use of pig iron there can be no question, but it is not necessary to confine oneself to pig iron exclusively. In fact some mixtures are much better without a large amount of pig iron present. At one of the largest foundries in the country, making a high-class article, it is seldom that the pig iron is allowed to reach as high as 25 per cent. of the total charge, yet their product withstands shocks and strains that few castings are called upon to endure. The balance of that mixture is made up of scrap.

Saving by Chemical Analysis.

When once the theory of mixing irons is understood it is not hard to obtain a casting fully representative of the estimated analysis. Permit me to say here that by the use of chemical analysis many seemingly impossible things are brought about. So great is the standing of the chemical laboratory among the foremost foundries that it would be useless to try to dissuade them from its benefits. In no other way can so uniform a quality of iron be produced, and when once the foundryman decides to employ the information unfolded by a careful analysis he seldom goes back to the old way of "hit and miss."

At one foundry, making car-wheels, a saving of $80,000 per year was made. This was effected by carefully watching the market prices of material and employing a chemist to calculate the mixtures according to these market prices. If one kind of scrap increased in price, the amount used per charge was decreased and the kind of scrap which was less in price substituted. This substitution was immediately followed by a chemical analysis of the castings, and any variations noted in the mixture could be quickly corrected.

Composition of Mixture.

Now as to the composition of the mixture and how obtained. First it will be well to review the elements commonly occurring in cast iron. These are the carbons (hardening and graphitic), silicon, sulphur, manganese and phosphorus. The carbons are controlled largely by the silicon; sulphur effects the silicon by neutralizing its effect on the carbons; manganese is antagonistic to the action of sulphur and may even go so far as to eliminate a large portion of it; phosphorous is there by right of way and resists all efforts at elimination. As to the desirable amount of each of these elements only individual castings will determine, yet there is a limit, both maximum and minimum, which should be regarded. For instance, silicon should be present to some extent in order that the carbons may become separated. In chilled castings, for frictional wear, sulphur should be fairly high in order to produce a very hard wearing surface. For car-wheel work, sulphur may be as high as 180 per cent. and not be detrimental, but for soft work the sulphur should be kept below 100 per cent. This low sulphur permits the silicon to separate the carbons, or strictly speaking allows more hardening carbon to change to graphitic form, which might as well be called softening carbon. Each of these elements has an effect on the shrinkage of the castings.

The Elements and Shrinkage.

I have prepared a chart which shows the effect on shrinkage of the different elements. One striking peculiarity revealed by this chart is the fact of the great influence of combined carbon on shrinkage. In no other element do we find so great a power over shrinkage. Increasing this combined carbon increases shrinkage; manganese reduces it, as does silicon. Sulphur also increases it, but may be controlled somewhat by manganese. Without going any farther into the effects of the elements on the physical qualities of the metal I would say that to be able to produce good castings an understanding of these effects should be obtained. It is by this means that the status of gray iron may reach the high standard that its brother, cast steel, has attained. There are no less possibilities for gray iron than for steel, but it will require the united efforts of intelligent men to raise the standard of cast-iron castings to a point approaching the quality of steel castings.

Careful operations of detail work in and around the cupola will very greatly tend to a more uniform product, and the time will not be far distant when the cupola will force the steel castings to find new pastures, and the thanks of it all will be to those foundry men whose hearts have been in the work and who are not satisfied with less than the best.

Building News

Alberta.

DIDSBURY.—A by-law will be prepared calling for a debenture of $2,000 or $2,500 to erect a suitable building to contain a small fire hall, council chamber, lock-up, reading room and library.

CALGARY.—A permit has been issued to H. Thompkins for the erection of a three story business block.

New Brunswick.

ANDOVER.—The general store of J. E. Porter & Sons here, together with the adjoining store, have been completely destroyed by fire.