so as to be able to select his metals by chemical analysis. The metal for a gear should be as close grained as possible, especially in the teeth, since a skin of fine grained combined carbon, offers the best wearing surface, yet must not be chilled, as in many cases the shrouds must be turned, hub-bored and key-seated in the machine shop, hence must not be too hard for the tool.

A metal mixture containing 2 to 2.5 per cent. of silicon would be suitable for a gear 1-inch pitch, but would be useless for a gear 7-inch pitch; in which the mixture should contain an average of about 1.25 to 1 per cent. of silicon.

The following table may be taken as a good working guide in the selection of suitable metal mixtures for average thicknesses:—

**** Grading of Metal Mixtures According to Thickness.**

	Sil.	Man.	Phos.	Sul.	Remarks.
¼	3.25	.40	1.00	.000	
½	2.75	.40	.80	.025	Note.—A casting
¾	2.50	.50	.75	.030	to machine well
1	2.00	.60	.70	.040	should not con-
1½	1.75	.70	.65	.050	tain more than
2	1.50	.80	.60	.060	0.50 of combined
2½	1.25	.90	.55	.065	carbon.
3	1.00	1.00	.50	.070	

Another condition worth noting is, that if the casting is to be sound and the teeth sharply defined, the metal poured into the mould must be *hot*.

With lively metal the gases generated in the mould can be easily expelled, and owing to its fluidity shoots quickly out of the hub, along the arms, into the rim and teeth around the circle, filling every nook and corner in the mould, and producing teeth with the knife edge appearance which the gear moulder likes to see.

An excellent preparation for clearing the metal from scoria and dirt and increasing the chances of clean castings is Kirk's flux, a composite powder with a dolomite base, which we made into a paste and spread on top of each charge in the cupola, as well as sprinkle (in powder form) over the bottom and sides of ladle before tapping out the hot metal. This composition causes the metal to boil, throwing the scoria—which is of lighter specific gravity than the iron—up to top of bath as a scum, which is raked off prior to pouring the metal into the mould.

Having described the preliminary mould-forming preparations; *modus operandi* of making the teeth by machine; method of building up the internal structure of the mould with green sand arm cores, and dry sand covering in cores, besides giving some practical data on sands, metal mixtures,

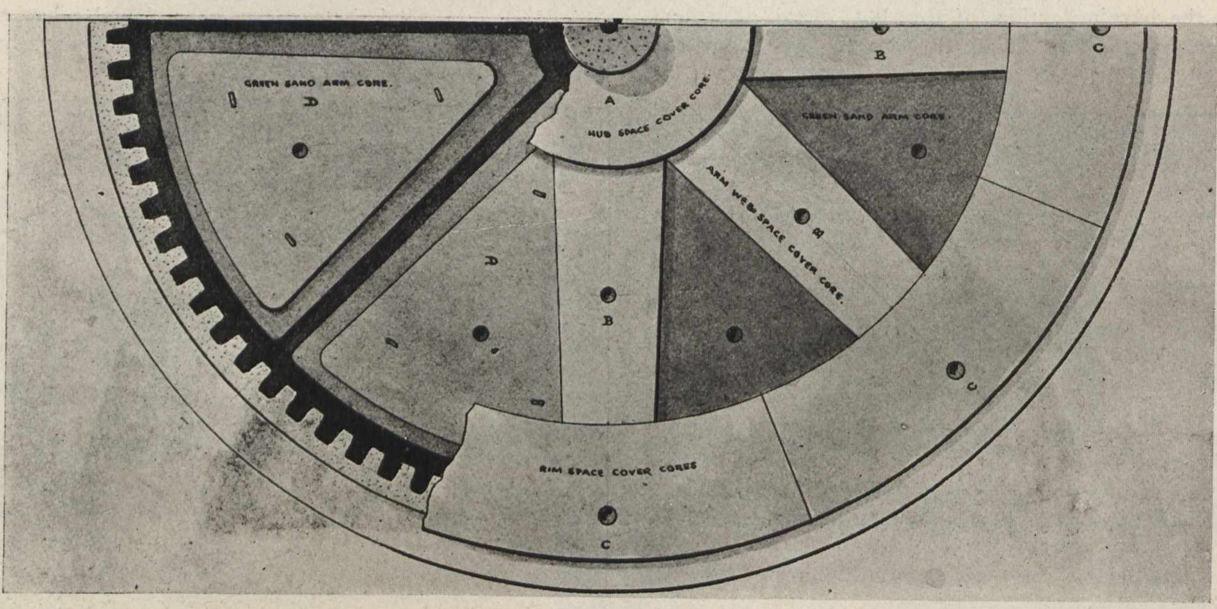

Fig. 6.

Half Plan.
Showing Green Sand Arm Cores.

Half Plan.
Showing Dry Sand Cover Cores.

The metal mixture from which I got the best results was used in casting a short-toothed rolling mill pinion, 40.20-inch pitch diameter, 18 teeth 6.98-inch pitch, 22-inch face, 16-inch bore, and weighing 4¼ tons. Here is what went into the cupola, and chemical analysis after it came out:—

Metals.	%	Weight. lbs.	Chemical analysis Constituents.	%	[Tensile strength per sq. inch.]
* Meurkirk (4) ..	25%	2,250	Silicon . . .	1.250	
* Meurkirk (4¾)	15%	1,350	Sulphur . .	0.058	
Maddison	25%	2,250	Phosphorus	0.930	
Gear scrap	25%	2,250	Manganese	0.320	
Isabella	10%	900	Graphite .	2.850	
Wrought iron . . .	10%	900	Com. carbon	0.400	
Total		9,900 lbs.			lbs. 38,197

** Prepared by W. A. Bole, general superintendent The Westinghouse Machine Company, for the foundry foremen at East Pittsburgh.

* These metals cost $26.00 per ton.

etc.; it only remains to add, that in estimating the amount of metal to be used in pouring the casting, at least a ton extra should be provided to flush through after it has once been filled; to ensure the elimination of occluded gases, or to eject any stray dirt which may have flowed in accidentally. To effect this purpose, capacious overflow gates should be provided, and a suitable pig bed made in the foundry floor in close proximity to the mould. It is not necessary to dwell upon the importance of feeding, both around the centre core and in the rim at junction of each arm; but as a final word we would emphasize the wisdom of determining carefully the time of hoisting out the centre core in order to accelerate the cooling of the heavy mass of metal in the hub, and thus adding uniformity of shrinkage. We had a costly experience by neglecting this precaution. A 15 ton gear was poured in the afternoon, and the removal of the core in the early hours of the next morning was left to a labor gang boss. He took out the 18-inch hub core before the metal skin was set, hence the hub began to bleed, leaving a huge cavity, and the gear had to be thrown on the scrap heap; at a loss of some $700, in addition to causing no end of profanity and financial loss down at the rolling mills where they were waiting for this large gear wheel.