block. When this space has been filled the laborer takes hold of the drawback handle, makes a complete revolution, and the tooth-space pattern is withdrawn clear of the moulds. This done, he lifts out the index pin, pushes the extension arm forward, drops the pin into the next hole in the index plate, takes hold of the drawback eccentric handle again, thrusts the tooth block up against the black sand backing once more, and the moulder commences to rain another tooth-space, and so on, until the whole circumference of teeth mould spaces are completed. Simple though

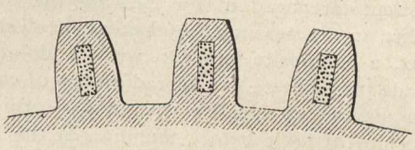

Fig. 4.—Mode of Venting Gear Teeth.

this work seems, it demands all the skill and resource of an experienced moulder, for, in selecting his facings, several important conditions have to be observed. The fine grained sands which he used for 1-inch pitch will not do for teeth 4½-inch pitch, the particles of silica in the sands must be coarser in order to render the facings porous, and thus allow for the free exit of the gases; it must be sufficiently cohesive to mould well and resist pressure, and sufficiently refractory to prevent the burning action of the hot metal. Further, the moulder, in ramming the teeth, must be able to judge exactly the necessary degree of force to impart to his rammer; the force applied in forming the tooth spaces for 1-inch pitch will not do for the larger sizes; and besides, the ramming must be uniform, since a hard spot here and a soft spot there, will tell its miserable tale when the gear is lifted out of the sand, either in unsightly scabs or ugly swellings, necessitating the use of hammer and chisel. And I may remark here that in moulding the teeth of large gears of 3-inch pitch and upwards, it has been found necessary to vent the mould of each tooth space, by leaving an oblong hole in the middle (Fig. 4), which is connected to the coke bed below by a vent wire and filled with fine particles of coke. Teeth moulds formed in this manner afterwards coated with a refractory solution, and thoroughly skin dried, not by the erratic heat of a coal or coke fire, but by a steady, regulated gas flame delivered through a 1¼-inch pipe, about 12 inches less in diameter than the mould and perforated with holes a few inches apart; so arranged, that the flame does not play on the face of the mould. With the mould made and dried thus, teeth can be produced with sharply defined edges and flanks bright, smooth and clean.

Another important improvement in manufacture is the substitution of green sand for dry sand arm cores. This is one more instance of necessity being the mother of invention. It a large gear is to be true in diameter, there must be no resistance to general shrinkage. The shrinkage which takes place in the arms towards the hub must be followed by the rim between the arms also; anything which hinders this onward movement is detrimental to the diametral perfection of the gear. Hard-earned experience has proved that this is just what dry sand cores are found to do: hinder normal shrinkage. I well remember a deplorable instance of this. It was a large gear, 7-inch pitch 30-inch face, and when cast, a number of teeth were cracked transversely across the face, midway between the shrouds. The use of dry sand cores was manifestly the main cause of this mishap, for the arms were of I section, and as the metal in the top and bottom flanges shrank in towards the hub, it naturally drew the rim and whole face of the gear with it; but the hard dry sand cores resisted this, hence the metal in the teeth opened out in the middle. From that time forth I discarded dry sand cores, using only hollow, coke-filled green sand cores, made of coarse gravel or gum sand; and in no instance was the old trouble repeated, for they adjusted themselves to the shrinkage of the environing metal.

Having described and illustrated the method of forming the teeth moulds, selecting facings, and making the green sand arm cores, we now pass on to the question of covering in. In casting a heavy gear it is important that there should be no strain; the slightest uplift of the cope would cause the width of the face to vary and the gear to run untrue. With this danger in mind the modern gear founder has entirely discarded flexible wooden copes, as they are always liable to twist in lifting and bulge under pressure. Ponderous iron copes have also been abandoned, both on the score of expense and difficulty in handling. The best makers now use strong, dry sand covering cores exclusively—used after the manner indicated in Figs. 5 and 6. This system of cover cores represents a manifest advance in the art of moulding large gears; it is safe, economical and expeditious.

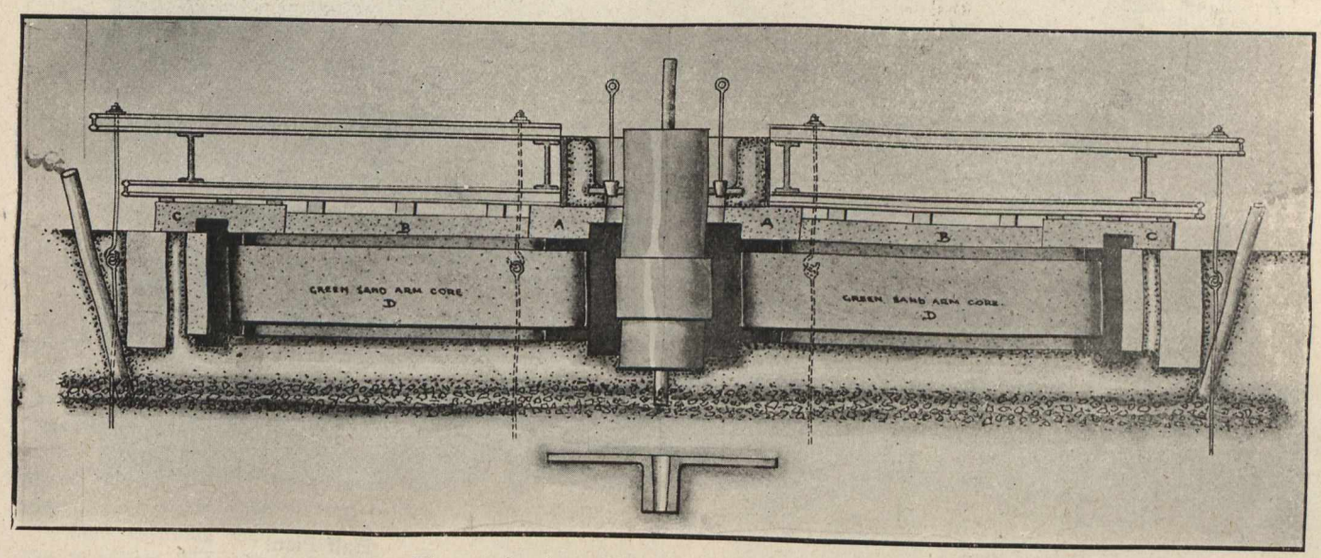

Fig. 5.—Section of Mould: Ready for Casting.

Again, not only is it important that the gear founder should have an accurate analytical knowledge of the properties of available moulding sands, in order to formularize suitable mixtures to suit the varying magnitude of the castings to be made; but should be acquainted with the refractory qualities of the various facings on the market; and, if need be, should have a few old-fashioned wrinkles up his sleeve, to bring out when occasion demands. Well do I remember such an occasion. A heavy casting had been made, with a skin the sight of which was enough to turn one grey with fright. A moulder of the "old school" suggested that a certain proportion of fire clay should be mixed with the facing. It was done and the skin on the next heavy dynamo field produced, was a joy to any moulder who takes a delight in his work.

For a like reason to the foregoing, the maker of machine-moulded gears should have a sound knowledge of metallurgy,