IMPROVEMENTS which have been effected in the metallurgy of gray iron have raised the standards of the entire industry and caused a changed conception of that material for structural applications. Gray iron has become an important engineering material because of its vastly improved physical properties and because it is possible to control and reproduce these properties at will, thus enabling this new material to fill economically an important place in engineering design and service.

Therefore, the modern gray iron foundry must be prepared to meet definite physical specifications. Facilities must be available for accurately producing cast iron of any required composition, controlling the physical properties and thus meeting the increasingly rigid requirements being specified for many types of important iron castings.

Keep Abreast of Demands

To keep abreast of those advancing demands constant research and installation of modern equipment in the foundry are essential for the economical production of castings of highest quality for the variety of service requirements which must be met. And it is by following those principles that the Eaton-Erb Foundry Co., Vassar, Mich., a pioneer in the manufacture of electric furnace iron, has been able to accomplish some remarkable developments in the production of superior quality gray iron castings with high physical specifications.

The firm operates a production foundry specializing principally on automotive work and also engaged extensively in making refrigerator castings, glass molds and production machine parts as shown in Fig. 6. The foundry is advantageously located at Vassar. It is served by both the Pere Marquette and Michigan Central railroads and is within easy trucking distance of Detroit, Saginaw and Flint, to which points

Fig. 1—Molds are poured from a small hand shank which in turn is filled from a bull ladle shown at the left

Fig. 2—Rough and finished tappets for various motor cars made from electric iron
complete shipping and service facilities are maintained.

In addition to sand casting facilities, the foundry contains a completely equipped permanent mold department. That department includes eight 12-head rotary casting machines, as well as a number of smaller casting machines. The permanent mold process is ideally adaptable to a large class of castings permitting substantial economies in comparison with the cost of producing castings possessing similar properties in sand. At the same time a high quality product is obtained with the dense fine-grained iron produced by this method.

Equipment also includes annealing ovens, as all permanent mold castings are annealed to provide definite machineability. The annealing operation is conducted in such a manner as to break down the massive cementite without sacrificing the high strength of the casting. The annealing cycle occupies about 3 hours from the time the castings enter the furnace until they are removed.

**Have High Machining Speed**

Through improved machineability of the casting, a higher machining speed is made possible, and in many cases machining operations are eliminated because the castings may be made to closer dimensions. Machining of permanent mold castings may be performed within narrower tolerances, especially where holes are held to close size. This is made possible because of the unusual density of grain structure and uniform hardness.

To meet present-day specifications the Eaton-Erb Co. has installed electric furnace equipment consisting of one 6000-pound and one 400-pound capacity furnaces of the Indirect-arc, rocking type manufactured by the Detroit Electric Furnace Co., Detroit. These furnaces shown in Fig. 3, are used both for cold melting operations and for duplexing molten cupola iron. Decision as to melting from the cold or duplexing is dictated primarily by consideration of the tonnage required. Since it is possible to obtain three to four times the hourly productive capacity from the furnace when duplexing as compared with cold-melting, duplexing is followed at all times when production requirements permit.

Both plain and alloyed irons are made and, depending upon the nature of the castings to be made and the physical properties which they must possess, various types of materials are charged into the electric furnaces. Close melting control is maintained and the various ingredients of the charge are apportioned so as to secure, within extremely close limits, the composition required for maximum physical properties. This facility also enables the firm to produce the exact iron best suited to the casting in question and to reproduce that material dependably.

The first unit to be installed was the 6000-pound furnace for continuous production. Later the 400-pound unit was installed for development work. The latter furnace has been used profitably for a great many experimental heats, producing special compositions and has been used extensively for making tappets when production schedules have been limited. The small furnace also has proved of great value in melting complex alloys in the manufacture of valve seat inserts.

High temperature and mixing action in the furnace are of special importance with those materials, whose combined carbon must be in a
stable form at high temperatures to retain red hardness. Excellent work has been done with the small furnace in the development of cam shafts, manifolds, gear blanks, glass molds and a variety of special permanent mold work.

An important part of the firm's work is the manufacture of automotive tappets and piston rings. Due to the increasing speed and more drastic service requirements of the modern automobile and airplane engine, it became necessary to produce a stronger tappet. In connection with this work and particularly when pouring the iron into permanent mold castings, the Eaton-Erb company has found its electric furnaces of distinct value.

Fig. 5 illustrates the type of tappet used for mushroom valve operation. The head is cast against a chill giving a completely white iron face, while the stem is kept machineable. It is necessary to maintain high shock resistance in the head and neck while the face must have excellent wear-resisting qualities. The depth of chill is of great importance and is kept within narrow limits. A standard tappet test which simulates extremely adverse service conditions in a motor is conducted on a machine developed by the tappet manufacturer as a standard test method.

Through close control over composition and temperature, the firm has developed an electric iron tappet, both permanent mold and sand cast, which has gained an enviable reputation for strength and wear-resistance.

Fig. 2 shows a group of electric iron tappets as made for various motor cars, and includes both the rough castings and finished products. As may be surmised, the variety of weight and design necessitates precise control over the metal composition and the casting temperature to insure maximum physical properties.

**Piston Rings Are Strong**

To meet the demands of the automotive industry the Eaton-Erb Foundry Co. produces a high quality piston ring. The production of piston rings in electric furnace iron has resulted in increased strength and tension and other improvements. These improvements, which are obtained either by duplexing or cold melting, are: Higher strength, better tension, elimination of hard spots, improved machineability, and uniformity.

The properties attained on the electric furnace iron produced by the Eaton-Erb Foundry Co. are as follows:

**Rough Castings After Splitting at the Gate**

Load required to break in pounds...18.4
Stretch in inches ....................... 0.979 inches

**Finished Rings**

Load required to break in pounds.....11.4
Stretch in inches ....................... 0.781 inches

The result of tests for strength and stretch covering an average of ten tests on 35/8-inch x 5/32-inch finished oil control rings shows the load required to break to be 19.1 pounds and the stretch 1.472 inches.

Elimination of hard spots and the uniformly better machineability result in savings of great importance in the machine shop.

In modern automotive design a great many castings must be made of special types of iron to meet the more difficult service conditions be-
ing imposed. Most of these castings call for iron of low carbon content or a special composition to produce high strength, wear resistance or other specific improvements in physical properties.

An important development is the replacement of the forged steel cam shaft with electric furnace iron. The firm has made many cam shafts, one of which is shown in Fig. 4, cast in permanent molds of electric furnace metal. Higher strength shafts of great rigidity are produced, having excellent wear-resistance properties and which are giving thoroughly satisfactory performance in service.

While extremely high tensile strength is not necessary for cam shaft service, tests show values well over 50,000 pounds per square inch. Of great importance, in addition to wear-resistance, is the fatigue endurance limit and in this respect the cam shafts made by the Eaton-Erb company have shown superior characteristics in service.

High strength gear blanks of excellent machineability also are made. These gears have a tensile strength in excess of 50,000 pounds per square inch and show exceptional wear-resistance. Tests on a recent shipment of these gear blanks for automotive work gave the following physical properties: Transverse strength (18-inch centers)—3300 pounds, deflection—0.30-inch, and tensile strength—52,500 pounds per square inch.

Special manifold castings are being made of carbon controlled electric furnace iron containing a small percentage of alloy. Much trouble previously was encountered by the customer due to cracking in service. Control of the carbon content and superheating in the electric furnace has resulted in a strong, fine-grained iron with complete elimination of the cracking tendency.

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