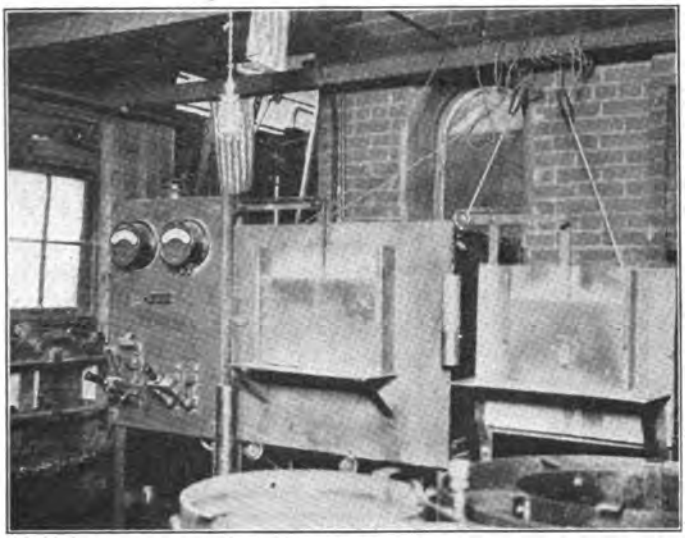
A Modern Tool Room Heat Treating Plant

Electric Furnaces and Pyrometers Installed at Ft. Wayne Shops of the Pennsylvania System

ACCURATE temperature control in heat treatment is one of the most important considerations in insuring good tool service. This is a fact which is coming to be generally recognized in railroad shops, and the use of special equipment has for several years been replacing the old hand forge method of hardening and drawing these tools.

A new heat treating plant has recently been installed in the tool room at the Ft. Wayne, Ind., shop of the Pennsylvania System in which complete provision has been made to insure uniformity of results with the expenditure of a minimum amount of labor. The plant is adequately equipped for handling all classes of tool work and is of particular interest from the fact that electric furnaces and pyrometers are used for the hardening operations.

The plant is called on to handle a wide variety of work, some of it in considerable quantities. The largest output is beading tools and flue expanders. About 300 beading tools are treated a week, for use at Ft. Wayne and a number of other points on the system. The output of flue expanders is considerably less, but in putting them through the plant they are handled in lots of about 200 at a time. The remainder of the output is made up of special tools of various kinds, such as taps, reamers, special milling cutters, inserted cutter blades, shear blades and punch and die work. Several examples of the variety of special tools turned out are shown in one of the photographs. In the manufacture of many of these tools, axle steel, case hardened, has been used.



Electric Furnaces and Switchboard at the Ft. Wayne Heat Treating Plant

The Electric Furnaces and Equipment

All hardening and annealing operations are carried out in two electric furnaces. These furnaces are of different types and provide different temperature ranges. The two are used together on hardening operations. The low temperature furnace, shown at the right in the illustration, has a maximum temperature limit of about 2,000 deg. F. and is used for annealing and hardening carbon steel tools, heating case-hardened carbon steel tools for quenching and pre-heating tool steel to a temperature of about 1,800 deg. F. The high temperature furnace has a maximum temperature limit of 2,500 deg. F. In this furnace the pre-heated tool steel pieces are finished to the proper hardening temperature, ranging from 2,250 deg. to 2,300 deg. F.

Both furnaces are of the muffle type but differ materially in the type of heating elements used. The elements in the smaller furnace are of the so-called hairpin type. Surrounding the refractory muffle are four slabs of refractory material provided with longitudinal slots in which fit the hairpin heating elements. These elements are inserted by removing the furnace front, which exposes their closed ends, and are placed entirely around the top, sides and bottom of the muffle lining. At the rear of the furnace, the ends of adjacent elements are joined by a series of connector blocks, with the exception of one pair to which the lead terminals are attached. This furnace operates on a maximum of 55 volts which is obtained by means of a regulating transformer. The secondary winding is divided into sections, each of which corresponds to a different voltage and the terminals of these sections are connected to a bank of single knife switches by means of which any section, or combination of sections, may be connected to the heating elements of the furnace. There are five of these sections, which afford a wide range of voltage and temperature regulation.

This furnace has a heating chamber 26 in. long by 8 in. high by 12 in. wide and has a full load rating of about 15 kilowatts. At full load about one hour and thirty minutes is required to bring the furnace up to its maximum temperature limit of 2,000 deg., after which this temperature may be maintained on about two-thirds of the full load rating.

The high temperature furnace has a heating chamber 18 in. long, 8 in. high and 12 in. wide. In this furnace the heating elements are carbon plate resistance piles which are placed inside the muffle on both sides. These plates are about ¼-in. thick and rest on heavy graphite blocks at the bottom. At the top the two piles are connected by a set of heavy transverse carbon plates. Graphite electrodes extend vertically through the bottom of the furnace and bear against the bottom of the graphite blocks, one on either side of the furnace. Hand wheels located conveniently in front of the furnace, through beveled gears, operate elevating screws which in turn bear against the lower terminals of the electrodes. The current thus passes from one electrode up through the carbon resistance pile on one side of the furnace, across the top to the carbon slabs, down through the carbon resistance pile on the other side of the furnace and out through the other electrode. Temperature control is obtained by varying the upward pressure against the carbon piles and hence varying the resistance.

Like the lower temperature furnace, current is obtained from the secondary of an air-cooler transformer which is wound in one section. The maximum voltage for this furnace is kept down to about 30.

This furnace has a full load rating of 30 kilowatts, at which about one hour and thirty minutes is required to bring it up to its maximum working temperature. Considerably less power is required to maintain a uniform working temperature after the furnace has become thoroughly heated.

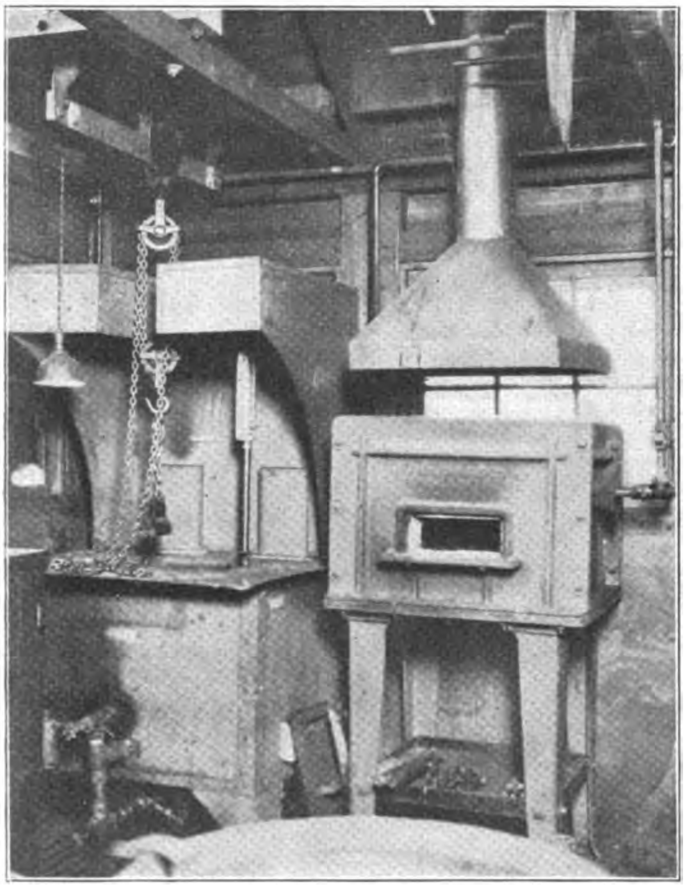
The switchboard, shown at the left in the illustration of the furnaces, contains a switch, circuit breaker and an ammeter in the primary circuit of the high temperature furnace transformer. The pyrometer is connected to a double-throw switch by means of which it may be connected to the thermocouple in either of the two furnaces. The switchboard for the low temperature furnace is attached to the side of the furnace frame.

Other Equipment

For low temperature drawing work an oil burning furnace of the oil bath type has been installed. Above this furnace has been placed a short monorail from which is suspended a chain hoist for handling the basket container into and out of the oil bath. As will be seen in the illustration, the temperature of the oil bath is indicated on a thermometer which forms part of the equipment.

A small oil burning muffle furnace has been installed to take care of various odd jobs for which the other equipment is not adapted. This furnace is useful for small forging jobs which it is desired to perform in the tool room and it is also used for short heats in hardening lathe centers and other pieces which it is not desired to heat all over.

The equipment of the plant also includes three quenching tanks containing water, salt water and oil, respectively. The



The Oil Bath Tempering Furnace and Small Oil Burning Muffle Furnace

oil and salt water tanks are jacketed and cooled with flowing water. These tanks are conveniently located to the electric furnaces. In hardening carbon steel tools they are first quenched in water till the vibration ceases and are then transferred to the oil. High speed steel tools are quenched in oil.

Classes of Work Handled

When a run of high speed steel tools is to be treated both electric furnaces are used. This reduces the time required for the complete heating operation to that required to preheat the tools to about 1,800 deg. in the low temperature furnace. Work of this kind is handled in lots in order that as long a run as possible may be obtained without the necessity of cooling down and reheating the furnaces.

When annealing is to be done, the parts to be annealed are placed in the furnace at the end of the day's work, brought to the required temperature and allowed to cool down in the furnace during the night. This work is thus a by-product of the regular operation of the plant and costs practically nothing for power or labor.

Reference has already been made to the variety of special tools which are handled in the heat treating plant and to the fact that some of these tools are made from axle steel and case-hardened. The use of this material offers a number of advantages where occasional jobs come into the shop requir-

A Number of Special Tools Representative of Work Turned Out of the Heat Treating Plant

ing special tool equipment and also for tools which are regularly but infrequently used. This material is not used for cutting tools which are expected to operate at high speed.

In the illustration showing a number of these special tools, the first one at the right is a hob which was made for use in replacing a broken worm gear from a coaling station on the line. This cutter was machined out of axle steel, sent to the blacksmith shop for case-hardening and reheated in the tool room for quenching. By its use the new gear was cut and the plant returned to service with only a few day's delay at an expense from which the cost of tool material was practically eliminated. Such tools manufactured from tool steel are difficult to harden without serious risk of fracture and loss both of the material and time expended in their manufacture. The case-hardening process is comparatively easy to handle and where the quenching heat is under control, as it is in the heat treating plant, perfect results are assured. Other tools of the same material shown in the photograph are a large 45 deg. reamer, a special reamer for finishing the piston rod pits of crossheads and a large special tap.

Among the other tools which have been developed and manufactured in the tool room are shown two sets of punches and dies for cutting piston rod and valve stem swab rings and a special three-fluted cutter for machining the crosshead key slots in piston rods. This work is done by first drilling a hole of the proper size at one end of the slot, setting the rod up on a milling machine table with the cutter inserted through the hole and finishing the slot with the cutter.

At the left in the illustration is shown a set of punches and dies for perforating driving box grease cellar plates. The punches are mounted in short sections of hardened steel which in turn are secured to a soft steel bar. The die blocks are also formed in short sections and similarly mounted on a bar of soft steel. The punch on which the work is done operates at the rate of 80 strokes per minute. Each stroke perforates two rows of holes and the work is complete in 19 strokes at a total time of about a quarter of a minute per plate. The finished plate is clean and smooth with no distortion or fins at the edges of the holes whatever.

The equipment of the plant includes a Sclerscope, which instrument has proved of value in checking up the work of the plant and determining the temperatures to be used on various steels.

Results

The plant has justified expectations as to providing better and more uniform service from the tools turned out. Before this plant was installed, in making up a lot of flue expanders it was the regular practice to include a number of extra sections in each lot. These were always needed to replace sections broken in hardening. Since the electric furnaces have been in use, no breakages of this kind occur and the physical qualities of all of the hardened sections are exactly alike. When beading tools were hardened in the blacksmith shop they frequently broke in the shank, it being impossible to harden them all over alike. Now these tools are heated to a uniform quenching temperature all over and so far no trouble has been reported from failures in service. The same conditions apply with respect to special rivet sets and air hammer chisels. These tools are annealed, hardened and drawn at a uniform temperature all over.

Not the least of the benefits which have resulted from the operation of this plant is the saving in labor as compared with the old methods of heat treating tools in the blacksmith shop. To take care of this work it formerly required two men on blacksmith fires. Now, one man is easily able to take care of the work, which from the tool hardeners' standpoint is performed under conditions far less exacting. The operation and maintenance of the electric furnaces requires no knowledge of electricity, and skill in regulating furnace temperatures within narrow limits is readily acquired with a small amount of practice.

THE DRIFTING VALVE

BY S. H. LEWIS

When a locomotive drifts the fire box gases, at high temperature, smoke and the atmosphere are forced into the cylinders and destroy the oil which is supplied for lubricating them. These elements leave abrasive deposits and cause the cylinder packing to break or wear out in a small percentage of the time that it would otherwise be useful. This in turn decreases the power of the locomotive and in point of economy and service the exclusion of the gases, smoke and atmosphere is desirable and important.

To prevent the creation of vacuum within the cylinders, numerous valves have been invented for supplying steam to the cylinders while the locomotive is drifting, and the best known of these may be considered as being of three types, viz., hand-operated, semi-automatic and automatic.

Owing to human fallibility the hand-operated valves are unreliable and dangerous. As they are not opened regularly they do not prevent the creation of vacuum at all times when the locomotive is moving and damage results. As they are not closed with regularity they have caused locomotives to move or slip when unattended, and have increased the liability of personal injury and damage to property.

The semi-automatic valve employs a pressure operated valve in conjunction with a hand operated control valve which is supposed to be opened at the beginning of a trip and closed at the end of the trip. This type is open to the same criticism as the hand operated type with respect to human fallibility.

The automatic valve is either pressure operated or mechanically operated and will give the desired results only where such valves prevent the pressure within the cylinders from falling below atmospheric pressure *at all times* when the locomotive is moving.

From the foregoing it may be reasonably concluded that a drifting valve should be automatic, and as expense is increased and service impaired by the creation of vacuum in locomotive cylinders, it is obvious that a drifting valve should not depend for its operation upon vacuum created in the cylinders. It is equally true that a drifting valve should not depend for its operation upon compression created in the cylinders as compression and vacuum occur simultaneously in opposite ends of the cylinders.

Classification of Drifting Valves

The steam supply pipe should be arranged to prevent condensation and the delivery pipe from the drifting valve may be so arranged that *superheated* steam may be supplied to the cylinders through the valve chests and steam distribution valves or *saturated* steam may be supplied through the same channel, or *saturated* steam may be supplied direct to opposite ends of the cylinders. These methods are subsequently referred to respectively as arrangement *A*, arrangement *B*, and arrangement *C*.

In arrangement *A*, the steam is delivered to the *saturated* steam compartment of the superheater header or the dry pipe, and passes through the superheater units before reaching the steam chests and cylinders; in arrangement *B*, the steam is delivered to the *superheated* steam compartment of the header or piped direct to the steam pipes or steam chests, and in arrangement *C*, the steam is delivered to the cylinder clearance spaces through non-return check valves. The check valves serve to prevent the passage of steam from one end of the cylinder to the other when the throttle is open.

With arrangement *A*, the drifting valve may remain open at the time that the locomotive is moving as the steam from the drifting valve passes through the superheater units when the throttle is open and when the locomotive drifts.

With arrangements *B* and *C* it is necessary, in addition to the drifting valve closing automatically with the stopping of the locomotive, that it close automatically with the opening of the throttle when the locomotive is moving in order to prevent delivering saturated steam to the cylinders with the *superheated* steam when the throttle is open. It is also necessary for the prevention of vacuum, for the drifting valve in the arrangements *B* and *C* to open automatically with the closing of the throttle and in time to maintain steam within the cylinders until the locomotive stops or the throttle is again opened.

The volume of steam necessary to prevent the creation of vacuum in the cylinders varies according to the diameter of the cylinders, the speed of the locomotive and the position of the reverse lever or point of steam cut-off, and will require approximately the use of a 1¼-in. pipe for 22-in. and smaller engines, a 1½-in. pipe for 23-in to 26-in. engines, and a 2-in. pipe for 27-in. to 30-in. engines.

Advantages of Drifting Valves

It has long been recognized that manifold advantages, including the prevention of vacuum, are derived from the presence of steam in suitable quantity in the cylinders of a locomotive at all times when the locomotive is running above a very low speed, and that these advantages can be fully derived only through means to supply and cut off the steam automatically. A drifting valve which functions properly distributes and preserves the valve and cylinder oil, provides a steam cushion for the machinery, prolongs the life of the cylinders, pistons and rod and cylinder packings, protects the superheater units and prevents the loss of high cylinder temperature when drifting and results in increased locomotive mileage, decreased maintenance cost, higher average power, and increased mileage per unit of lubricant.