the sort ever took place, and enormous areas of floors have been constructed without any provision in this respect, and no expansion has been noticeable. Thus manufacturers have been engaged in pursuing a shadow in trying to eliminate expansion, for the results in practice are not so harmful as they have been supposed. They have now gone too far, and we have lately heard of instances where overlaid cement was used for the construction of concrete floors, of contraction taking place in the setting, which drew the floor slabs away from the supports and caused cracks; obviously this is very detrimental. Many minor troubles that have occurred in connection with the cracking of concrete floors might be traced to this over-laying, if we may so call it of the cement, and the

elimination of expansion. There are other aspects, also, of the results of contraction in concrete which may here be set forth, to be borne in mind by manufacturers.

In reinforced concrete work, steel is, as a rule, introduced for the purpose of taking tension, but it is also often introduced to reinforce the concrete in the resisting of compressive stresses—as, for instance, in columns, posts or pillars. The vertical rods in such structural members are imbedded sufficiently far within the concrete to feel the full effects of any contraction that may occur. This will put an internal compressive stress in the steel that may be considerable, so that in building a column under such conditions on ordinary theory, we may have the steel over-

stressed, to counteract which we ought in designing it to resist any specific load to increase its amount, which, of course, is not in the direction of economy. The same thing applies to the construction of reinforced concrete arches. In some few tests that have been conducted upon reinforced concrete beams it has been surprising to note that practically no deflection has taken place in the first stages of loading. An explanation of this, it has been suggested, may be found in the contraction of the concrete, which would introduce compression into the steel that would have to be neutralized by the application of loads before deflection under the tensile stresses thereby induced would become evident.—The Builders' Journal and Architectural Engineer.

APPLICATIONS OF OIL-BURNING APPARATUS.

A REVIEW OF PRESENT METHODS.

BY C. M. RIPLEY, E.E.

PERHAPS the most unique and unexpected application of oil-burning apparatus is in the heating of railway coaches on the electric divisions of steam railroads. The New York Central and New York, New Haven & Hartford railroads have both installed vertical steam boilers in the electric locomotives of their new equipment, and equipped them with oil burners, pressure tanks for oil and water, and utilized the compressed-air system of the train for atomizing the oil. Thus, as soon as the steam locomotive is detached from the passenger train, the electric motor can be coupled on, and the existing piping system of the train used to heat the cars. The expense of installing electric heaters in each car, the expense of power for these heaters, and the danger that would have resulted from coal stoves, are all dispensed with.

At the plant of the Pennsylvania Bridge Company, Beaver Falls, Pa., advantage has been taken of many of the latest devices to bring about economical production and fabrication. Among these is the installation of oil-burning furnaces for rivet heating, etc.

This equipment consists of a 10,000-gallon supply tank buried in the ground outside the building and near the railroad switch to facilitate the unloading of the oil cars. An oil pumping, heating, and pressure regulating system, located in the shop, draws the oil from the supply tank, strains it, and after raising the temperature to the proper point for complete combustion, pumps it to the burners under 20 pounds pressure. Compressed air for atomizing the oil is taken from the regular shop air line, and reduced by a regulating valve to 15 pounds before being piped to the burners. As only 150 cubic feet of free air compressed to 15 pounds are required under the system in question for each gallon of oil burned, the air taken for atomizing is hardly felt.

There are five double-door stationary rivet forges, with hearths 16 x 24 inches, and four similar in design but 12 x 18 inches, with the tank containing the oil supply located underneath, and connected with the air supply by a flexible hose. This last furnace is designed to allow of its being moved from place to place in the shop. All these furnaces are equipped with a burner so designed that there will always be perfect atomization of the oil, and also that the one lever regulates both oil and air supply.

The relative merits of oil, coal, and coke as fuel for the forge shop are ever open for discussion and experiment. The writer was recently allowed the favor of taking a trip through the factory of a well-known manufacturer of railroad cars, and was much interested in the operation of the oil-burning furnaces in the blacksmith shop.

There were seven furnaces, ranging in size from 36 x 48 inches up to practically twice that size. These were used for heating up king-pins, bar iron, etc., some to a bending temperature and others to white or welding heats. All were designed so that only enough compressed air was supplied to the burner to atomize the oil thoroughly, while the air for combustion was supplied by forced draft by a separate piping system. Thus the air for combustion is not drawn in from the surrounding air, which always makes a noisy burner, but is forced in under a few ounces pressure, at the rate of approximately 1,440 cubic feet of free air per gallon of oil.

The writer was privileged to view some work on a lot of kingpins. These were made from 2-inch billets about 20 inches long, and were heated for a distance of 12 inches from the end, at the rate of 21 pins in seven minutes, at the end of which time each was white hot and a $\frac{3}{8}$ x 2-inch slot was punched through in one operation.

It has been the writer's experience that where hard

coal or coke was used in the forge, the time in tending fires and cleaning out the slag and cinders can be easily an item consuming more time than is usually believed. After witnessing the speed with which the bars, billets, and plates were heated, and the wide range of sizes taken care of, the conclusion was irresistible that for the same floor space the oil furnace could approximately double the output where high heats are required on work about 2 inches in diameter. Where only bending or swaging heats are required, I should conclude that there is easily a 50 per cent increase for equal floor space.

STEAM GENERATION BY OIL FUEL.

Starting the Fire.—Since the oil must be atomized, the initial starting of the fire requires either a supply of compressed air to turn into the atomizing nozzle until steam pressure has been attained (when it is switched off to steam by a three-way cock) or else a small boiler must be kept as an auxiliary. This disadvantage is made up in the fact that by starting the oil and throwing some oil-soaked waste into the fire-box, the fire is instantly in full blast; this has been found to be a great time saver in the long run, for plants that close down entirely.

Kind of Oil to Use.—Oil with a fire test of 180 to 200 deg. F. is considered as safe as coal, which latter has been known to ignite spontaneously. If oil with a test of 250 or 300 deg. is stirred with a red-hot poker, it will not ignite, and even a shovelful of hot coals thrown on its surface will immediately sink and be extinguished. Crude petroleum or fuel oil is the commercial name.

Storage and Temperature of Oil.—The oil is best stored, when convenience and safety are both considered, in an underground tank between the railroad track and the boiler room. The most successful result is obtained when the oil fed to the burners under constant pressure is strained and heated before fed to the furnace. It might be mentioned here, however, that the piping into the breeching of the boilers is frequently so arranged that a considerable rise of temperature is obtained by the time the oil reaches the nozzle—sometimes as high as 200 deg. F.

Importance of Atomization.—As is the case with any fuel, oil must be thoroughly mixed with air in order to secure complete combustion and no smoke from the stack. If the spray of oil contains some small and some large particles of oil, the larger particles, being supplied no more air than the small ones, will not be burned, and the result will be a coating on the boiler tubes which is more difficult to remove than the soot deposited from a coal fire. This difficulty, however, has finally been entirely overcome by the latest design of nozzles, which give a steady fire and no smoke. In the Texas oil fields, where oil is especially cheap, and in California, where coal is especially dear, the results of a tour of inspection will convince anyone of the fact that burners have been obtained which are most efficient and satisfactory. The old-time explosions which occurred now and then were due to the fact that the oil dripped, and later evaporated till the mixture with air became explosive. This danger has been proved a dead issue, since many of the insurance companies are giving the same rate for boilers using oil as a fuel as for those using coal. Frequent tests with open flame, of boiler pits, and many months of successful operation have convinced the most skeptical that oil burners for steam boilers are practical, safe, and convenient attachments, even as auxiliary equipment. The best comparison to be made between oil burners of the present and of the past is the comparison between the Welsbach gas lamps of the present, that thoroughly mix the gas with the air, and the obsolete open tip, which is both inefficient and filthy.

TRIPLE USE OF OIL BURNERS IN STEEL MILLS.

Oil burners can be and are being employed in some of the greatest and most progressive steel mills in the country, in three capacities:

1. To heat the open hearth furnaces regularly.
2. To serve as auxiliary where gas is used.
3. To heat the ladles and prevent explosions and consequent loss.

For Continuous Use.—In the open-hearth process there has been proved a saving by the introduction of oil burners. This saving is made up by the following items, as gathered from talks with users:

a. A lower grade of scrap or a greater per cent of scrap can be used, since oil is comparatively free from phosphorus and sulphur.

b. Since the highest temperature of the oil flame is at the bottom, it follows that it is directly applied to the "bath" and not to the walls, arches, and doors of the furnace. It is the enthusiastic opinion of users that shutdowns for repairs to doors and brickwork are much less frequent; so much so that a run of 840 heats was made at the General Electric Company. The Midvale Steel Company and others report extremely satisfactory results also.

c. Owing to accurate control, the furnace can be banked for two or three days and then heated full blast in 12 to 16 hours, a thing impossible to do with a gas furnace.

d. Small first cost as compared with producer-gas systems.

e. Large saving in labor, since furnace attendants can take care of oil burner, while large corps of men are needed to operate producer-gas plants of any considerable size.

f. Efficiency has been as high as 38 gallons oil per net ton of charge.

As Auxiliary Equipment.—The oil burner is made hinged, so that it can be swung out of action until such time as the regular fuel supply might happen to fail. Thus it is ready at a moment's notice, and the heat of the bath and walls instantly brings the flame to an efficient state.

To Heat Metal Ladles.—The swinging stand or hinged idea is used here as in the open hearth auxiliary arrangement. Thus it can be lowered into the ladle, the long nozzle reaching clear to the bottom and thoroughly heating and drying the entire ladle.

OIL BURNERS IN THE BRASS FOUNDRY.

One of the largest electrical manufacturing companies in the country states that No. 70 Dixon crucibles, which lasted only 17 or 18 heats when coke was used as fuel, now last from 30 to 32 heats since the oil burners were installed in the foundry.

The same company states that the cost of fuel has been cut in half and that the annoyance, dirt, and expense of handling ashes has been entirely eliminated. It is interesting to note that although a brass foundry was originally built for coke, it can be easily piped for oil burners. One of the manufacturers of oil-burning apparatus offers the free service of their engineering department in designing the complete layout for any foundry, showing the application of the oil burners, if the owner will but submit a sketch of the present equipment.

The writer has been much interested in chatting with the various manufacturers who have adopted oil for a fuel, and was pleased to note the general satisfaction which follows its adoption. The quiet and unostentatious development of any line of enterprise often gains a far greater lead than is generally supposed. The author is glad to be able to present the various applications of this particular line of thought to the engineering public, i. e., the readers of this publication.