805 American Rolling Mill Co.

The Making of

ARMCO IRON

Purity, Evenness and Solidity—
the Basis of Rust-Resistance

The Making of
ARMCO IRON

Qualities other than High Purity which have an Important Bearing on Rust-Resistance.

B. G. MARSHALL

The trade-mark **ARMCO** carries the assurance that iron bearing that mark is manufactured by The American Rolling Mill Company with the skill, intelligence and fidelity associated with its products, and hence can be depended upon to possess in the highest degree the merit claimed for it.

The Making of Armco Iron

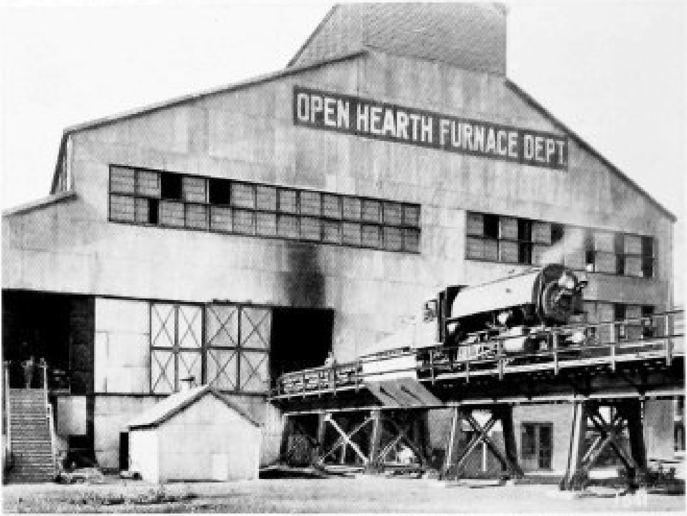
Qualities other than High Purity which have an Important Bearing on Rust-Resistance.

The manufacture of Armco Iron begins with the selection of the raw materials. Pig Iron is specified which must not contain more than a certain maximum of sulphur, copper, and certain other impurities. A great deal of pig iron which would be unhesitatingly accepted for the making of ordinary open hearth steel is wholly unfit for the manufacture of pure iron. The same thing applies to the iron ore, although this is used in but small quantities. The selection of heavy melting scrap for this purpose is one which entails considerable added difficulty and expense, since one impurity at least, copper, is not eliminated by the purifying processes through which the raw material passes and must be kept down to a very low point by careful selection of the materials of the charge. The American Rolling Mill Co., habitually pays a substantial bonus for scrap iron which is free from bronze bushings, copper rivets, and other fragments of this metal, and also exercises a constant supervision to see that any pieces of copper which do find their way into the scrap are thrown out.

In addition to the supervision and inspection of material coming into the plant to make sure that it is as free as possible from copper, an extra and effective precaution is taken. The men loading the furnaces have an arrangement with the Mill by which the Mill will buy from them any copper, brass, or bronze, which they find in the scrap while loading the furnaces. This frequently nets these stockers a neat little sum, and the Mill derives the benefit by keeping that material out of the furnaces.

The Open Hearth

The open hearth furnace is rectangular in shape, and a 65 ton furnace is about 70 feet long by 15 feet broad. It is constructed of highly refractory brick in order to withstand the extremely high temperature involved in the process of manufacture. The hearth of the furnace occupies a space of about 14 x 35 feet in the center of the furnace. This space is hollowed out to a depth of about 2½ feet and is constructed



"Locomotive drawing train of charging pans through the Open Hearth Department."

of magnesite brick and lined with burned magnesite and dolomite. Magnesite and dolomite are basic materials similar to lime in their chemical properties and they are used as linings for the furnace bottom in the basic process, not only because they are highly refractory but also because they are not attacked at high temperatures by the lime which is charged into the furnace for the purpose of uniting with the phosphorus and sulphur of the charge and thus eliminating them. The limestone, pig iron and scrap are charged into this hearth and are there melted by the flame which passes over them.

The Sulphur and Phosphorus are eliminated by means of extra limestone upon them after the material has become fluid, and working to the low limits necessary in Armco Iron, requires that a heavier charge of lime be used than in the manufacture of steel. Limestone is not costly, and hence the additional material does not increase cost materially, but it requires more heat to put this limestone in a fluid condition and that of course must be charged up against the heat of iron.

The fuel used may be either fuel oil, natural gas, producer gas, or occasionally tar. Producer gas is the fuel used at the East Side Plant of the American Rolling Mill Co. the fuel and air are introduced into the ends of the furnace through openings known as ports and in order to obtain the extremely high temperature requisite for the process, the furnace is constructed on the regenerative principle whereby both the gas and air are preheated to a temperature of approximately 1500 degrees F. before entering the furnace. This preheating is accomplished in the following manner. Before entering the furnace the gas and air pass through separate chambers which are filled with loose brick work and are located under the charging floor. From these checker chambers, as they are called, the gas and air pass through separate passages to the ports which end a few feet from the end of the hearth. At this point the gas and air mix and burn, the flame passing over the length of the hearth and melting the charge. The hot products of combustion pass out of the opposite end of the furnace to the stack through a set of ports, passages and checker chambers, which are precisely similar to those on the intake end of the furnace. In passing through the loose brick work of the checker chambers on the exit end of the furnace, the hot gases give up a large amount of their heat to the brick work and thus heat it to a bright yellow color. At the end of a certain period (which in ordinary furnace practice is about 15–20 minutes) the course of the gases through the furnace is reversed. The exit end now becomes the intake end and what in the preceding 15 minute period has been the intake end, is connected with the stack and becomes the exit end. The gas and air now pass through the brick work in the checker chambers which has been heated by the products of combustion during the preceding 15 minute period. The gas and air are thus preheated before they enter the furnace. In this manner an extremely high temperature can be obtained and most of the heat in the waste gases is conserved.

In operating the process, limestone, pig iron, and scrap are charged on the hearth. As the charge melts, the silicon, most of the phosphorus and some of the manganese burn out and unite with the lime to form a slag. Some of the carbon is also lost during this period and escapes up the stack in the form of gas. After the charge is melted which usually takes about 6 or 7 hours, iron ore is added to burn out the carbon and manganese to the desired amount.

Some of the heat necessary to raise the bath to the desired temperature is supplied by the burning out of the impurities in the charge. The tapping temperature for soft steel is about 2800 degrees Fahrenheit. A considerably higher temperature (which not infrequently exceeds 3000 degrees Fahrenheit) is necessary in the latter part of the process for making Armco (American Ingot) Iron and this must be sustained for a long period.

From 8 to 10 hours' time is usually required to make a heat of dead soft steel while a heat of Armco (American Ingot) Iron requires from 11–13 hours. The higher temperature employed in making Armco (American Ingot) Iron is necessary for two reasons: First a high temperature is necessary to burn out the last traces of impurities which are usually disregarded in the manufacture of soft steel. Second, the melting point of pure iron is considerably higher than that of soft steel and a higher temperature is necessary to keep it in a molten condition. This higher temperature causes the brick work to deteriorate more rapidly thereby necessitating more frequent and extensive furnace repairs.

> "When the charge is entirely melted and at intervals thereafter, the melter takes a ladle full of metal and pours it into an iron mold. As soon as this is set hard, it is cooled in water and broken. From the appearance of its fracture, the melter can estimate very closely the amount of carbon and phosphorus it contains."—*Stoughton.*

The description of the open hearth process given in the preceding paragraphs applies to the manufacture of soft open hearth steel as well as to pure iron. Many of the processes that can be seen at the Middletown Works look the same to a hasty observer as what would be seen at open hearth steel plants. There are, however, very material differences, as will be noted in the following paragraphs.

No heat of Armco Iron is released as such until chemical analysis in the laboratory connected with the open hearth department shows that the impurities have been reduced to the required standard. It is also of importance to note that the chemist in the Open Hearth laboratory is checked by the chemist in the Research Department, this constituting an extra precaution against any material leaving the plant which is not above the guarantee of 99.84% pure iron.

Getting Rid of Oxygen

In steel production it is customary to "catch the carbon on the way down;" that is to say, when the carbon is reduced to about the proportions desired and the manganese perhaps a little lower than is wanted in the finished product, the heat is tapped. Then, either in the furnace or in the ladle, manganese is added. The object of this is to eliminate the oxygen which has united with some of the iron in the open hearth furnace. Right here is a very important point in relation to Ingot Iron practice. You will recall that silicon, phosphorus, manganese carbon and sulphur are eliminated largely by allowing them to combine with oxygen, this being facilitated, of course, by the tremendously high temperatures of the furnace. Now iron also has an affinity for oxygen which is an active one at high temperatures. The higher the temperature the more is iron inclined to combine with the oxygen of the air forming ferrous-oxide or burnt iron. This is practically the same as the scale which forms on the outside of white hot and red hot iron or steel. Remember that iron will not combine directly with oxygen at ordinary temperatures but that it will at very high temperatures. Now as long as there remain in the bath considerable quantities of carbon, silicon, sulphur, etc., for all of which oxygen has a higher affinity than it has for iron, it will combine with these substances and form slag, which floats to the top and is eliminated. As long as considerable quantities of silicon, manganese, or carbon remain in the bath the iron is protected from oxidation, but when these impurities are nearly all gone and when also the temperature of the furnace is at or near the maximum, the combination of oxygen with iron goes on to some extent, and if the process were not in the hands of skilled and experienced men, it would go on to such an extent as to ruin the product. This burning of the iron is the great

"Ingot Molds in yard ready for transportation to Open Hearth Department."

difficulty of the pure iron process, and it was the overcoming of this difficulty that constituted one of the points of the invention.

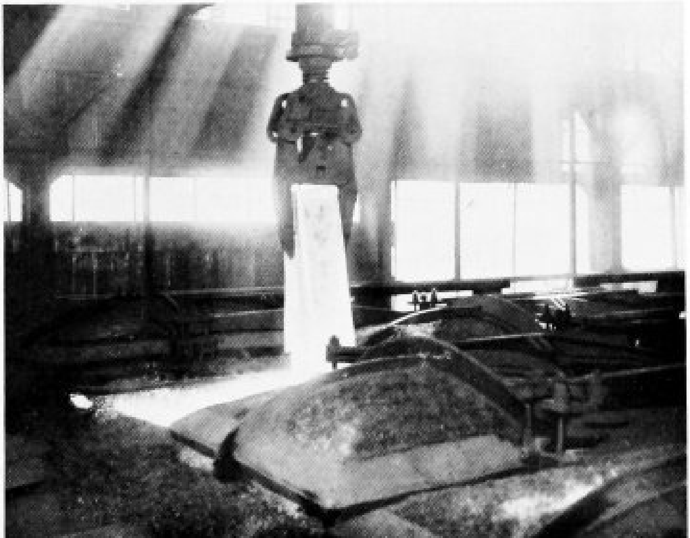
To return to open hearth *steel*, it was stated that when this was poured into the ladle, manganese was added in order that it might unite with the oxygen which had gone into combination with iron and thus free the bath of oxygen or "deoxidize" it. It performs its function quite successfully, but unluckily not without leaving certain amounts of metallic manganese and occasionally manganese oxide and manganese sulphide in the molten iron. Therefore, it is always the case that the finished open hearth steel is higher in manganese than was the molten metal before pouring. Manganese is a very desirable ingredient in steel for some purposes, but it is perhaps the worst of the solid impurities in respect to corrosion. It is evident, therefore, that some other method than the use of manganese had to be devised in order to make possible the production of pure iron.

In the manufacture of Armco (American Ingot) Iron no manganese is necessary. The oxide of iron and gases are removed by adding the correct amount of some powerful deoxidizing and degasifying agent which will eliminate the oxides and gases without contaminating the product. Aluminum is the most important deoxidizing agent used by the American Rolling Mill Co. Aluminum is probably the most expensive deoxidizer which could be used, but it is the one which does the most thorough and satisfactory work, and therefore it is used exclusively in this work. Analysis shows that it is very successful in eliminating the iron-oxide and also in eliminating itself as slag.

The Ladle

The ladle containing fifty to seventy tons of molten metal is lifted by the great traveling crane and carried over the train of ingot molds which are filled one after the other by the operation of a very ingenious mechanism.

The ingot train is run out into the yard where the ingots cool for a certain period. During the time the metal is still liquid in the ingot mold, an important part of the purifica-



"View showing method of handling an Ingot from the hot Soaking Pit, ready for rolling."

tion is going forward and can be observed in the fire-work like display at the tops of the molds. Gases are being eliminated and some further traces of carbon.

The Soaking Pits

When the ingots are solidified, though not by any means cold, the ingot molds are stripped, i. e., lifted off them, and the ingots are placed in the soaking pits. These are furnaces wherein the ingot is raised to a white hot temperature. The ingot does not have to be heated all through, as it is probably the case that the interior is still white hot with the heat it retains from its condition in the open hearth furnace. Care and judgment are very necessary in reference to the operations in the soaking pit. It is quite possible to heat the ingots too hot or keep them in the pits too long.

The Blooming Mill

They are next lifted out of the soaking pit by a crane and sent through the blooming rolls. This is one of the most spectacular of the operations of an open hearth plant, and has certain elements of danger to bystanders, since sparks or fragments fly to a considerable distance when the white hot ingot receives its first tremendous blow from the blooming rolls. It is interesting to note that one very decided improvement on the score of safety, the hanging of rows of chains on both sides of the blooming rolls to catch these sparks and fragments, is the result of the suggestion of one of the workmen.

The ingot is rolled into a bar about 120 feet long in the blooming mill and is run to the blooming shear. The operation of this shear is a very interesting and important part of the process. It will be noted that the extreme front end of the red hot bar has a rough appearance sometimes for a distance of several feet from the end. This arises from the fact that all ingots are somewhat more impure at the top than anywhere else, since this is the last portion to solidify and impurities both solid and gaseous tend to find their way to this portion. In the production of pure iron this fact is a decided advantage, for this portion of the red hot bar is simply sheared off at the blooming shears and the scrap sent back to the furnace. Of course, blooming mill shears are operated in all open hearth plants and for the same purpose. The difference with Armco

Iron is that the inspection is more severe and the cropping is farther back from the end in proportion to the amount of imperfection shown.

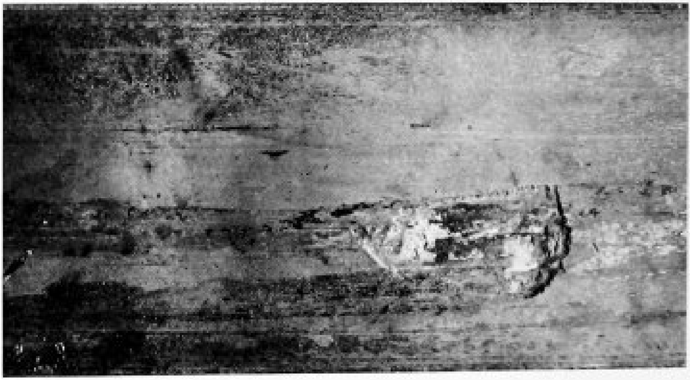
The Sheet Bars

The bars are next rolled into long strips about 8 inches wide and something less than an inch in thickness. These are sheared up into what are called sheet bars, which are in the neighborhood of 2 feet long (the length varying according to the size of the sheet which it is intended shall be made from each bar). These bars are subjected to the most rigid inspection. All open hearth practice involves the rejection of some sheet bars on account of certain defects which are familiar to every steel worker. Bars may be "seamed," "scabby," "piped," "clay-spotted," or may have any of several other imperfections.

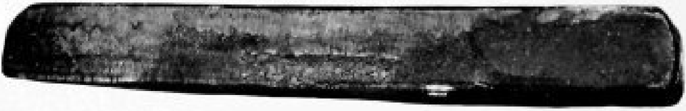
The radical difference between Armco Iron practice and open hearth steel practice at this point is that bars are rejected for defects, which to the open hearth steel worker, would seem so trivial as to be ridiculous. These defects, however, have a very important bearing on the rust-resistance of the finished material, since if the bars are rolled into sheets even though they are successfully galvanized, the imperfect spots remain as

"Eight inch defective Sheet Bar showing how the surface has been burned."

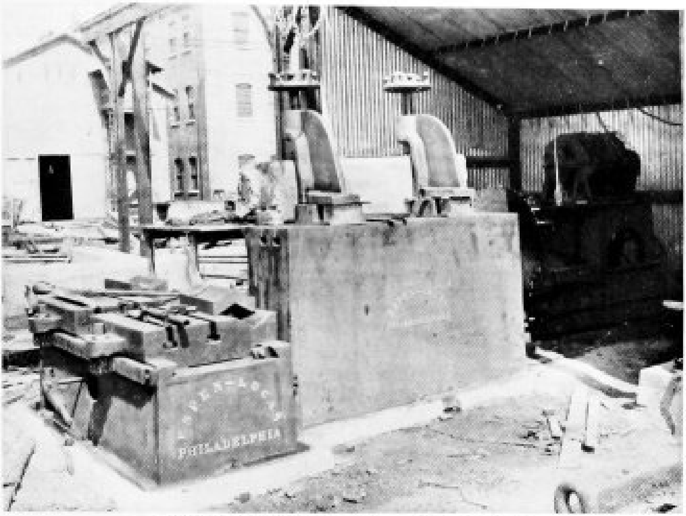
an opportunity for the rust working elements, exactly as the slums of a great city are the points at which contagious diseases find their entrance. In spite of all precautions in the open hearth and in the blooming mill, it is necessary to reject and send back to the furnace a large number of defective sheet bars.



"Eight inch defective Sheet Bar showing scabs on surface."



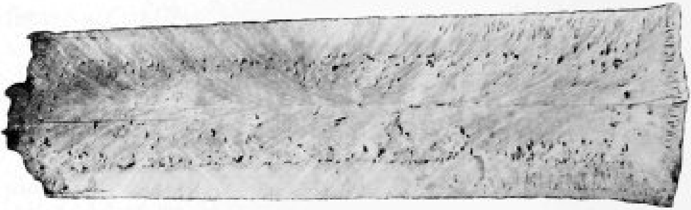
"Eight inch defective Sheet Bar showing pipe in end of bar."



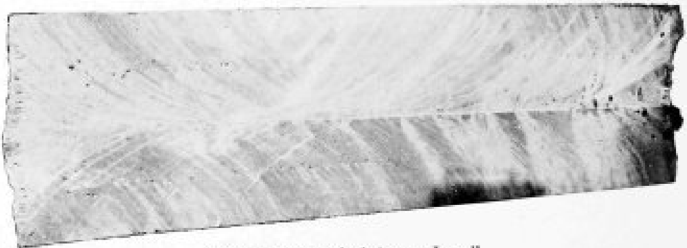
"Showing Cold Saw used for splitting ingots."

The ingot splitting saw is a very important feature of Armco practice. The importance of the gas bubbles or blow-holes, which are contained in iron and steel ingots has been thoroughly appreciated only in recent years, and the American Rolling Mill Co., takes measures to guard against this condition more effectively than any other producer.

Whenever a heat of Armco Iron comes through about which there is the least suspicion of its being "gassy," one of the ingots is sawed in two on the splitting saw. It is then usually very easy to note its condition by a visual examination, and this, of course, can be supplemented by the use of the microscope and by the taking of samples from various parts of the split ingot for chemical analysis. Heats which show this condition are not allowed to go into Armco Iron.



"Split Ingot, showing blow holes."



"Split Ingot, typical Armco Iron."

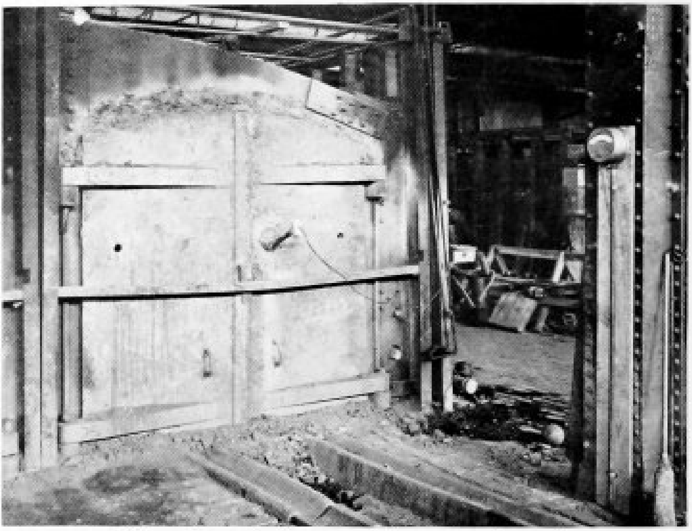
Reheating and Rolling

The sheet bars are next sent to the sheet mill where they are reheated in small furnaces near the sheet mill rolls. The exact manner and degree of this heating is also very important. It is quite possible to do damage here by careless practice. The red hot sheet bars are taken from the furnaces by the workmen with the aid of tongs and are passed back and forth through the rolls until the proper dimensions of the sheet have been attained. Many of the lighter gauge sheets are rolled in packs of several at one time and care is necessary here lest too high a temperature result in sticking them hopelessly together.

In the processes of the bar mill and sheet mill, the iron has acquired a quantity of internal stresses and strains and a condition of uneven crystallization;—that is to say, it is *physically uneven.* Here is a point which should be thoroughly understood: iron which is in this condition would rust much more rapidly than we expect Armco Iron to, no matter how high a degree of purity its analysis showed. In fact the rust-resistance of Armco Iron rests upon physical evenness almost as much as chemical evenness. The real basis of rust-resistance is "homogeneity;" and this means that a substance is the same in all its parts, both as to chemical analysis and as to physical condition. The nearer we can approach this ideal the nearer we shall come to a rust-proof iron.

Annealing

These stresses and strains and these physical unevennesses are removed by means of the annealing furnace. The sheets are piled up on huge iron trays and are covered with what is called the annealing box, and the whole is run into the annealing furnace. Here the object is to raise the temperature of the iron to a point somewhat short of the melting point. Then a curious and interesting thing takes place. The particles of the iron which had arranged themselves roughly in crystals of varying size, do not let go their hold of one another completely as is the case when the iron is melted, but they do relax their hold to such an extent that if the iron is then cooled down very slowly, they rearrange themselves in new crystalline forms which are regular and even and in which the crystals are of small size. This brings about the condition known as fine and even crystallization, which is ideal for corrosion-resistance and for working quality. Here again is one of the radical differences between Armco Iron and steel practice. Open hearth steel is often annealed in from 24 to 36 hours; Armco Iron requires 5 days, since the idea is that this process shall be as perfectly carried out as is humanly possible. It is to be remembered that this annealing does not change the chemical composition, but does change and make uniform the physical structure. It would be possible to absolutely eliminate this annealing process and still keep the material 99.84% pure iron, but tests have shown that in addition to the purity, it must be properly annealed if a material of the greatest rust-resisting quality is to be secured.



"View of Annealing Furnace and Pyrometer equipment."

Pickling and Cleansing

The sheets coming from the annealing furnaces are taken to the pickling baths. These are of dilute acid, and the sheets are raised and lowered within these tanks until the action of the acid and the washings of the liquid have removed all traces of scale (iron-oxide) and any grease and dirt accumulated in its passage through the mill. This is strictly necessary in order that the galvanizing may be successfully carried out. When this pickling is completed, however, other processes are necessary to surely get rid of the acid, for if any trace of the acid were left on the sheets, it would be fully as bad in corrosive effects as the scale. The iron is washed in clear water and just before it passes into the spelter or galvanizing bath, it is passed through a dilute solution which certainly eliminates the last traces of acid. The idea is for the iron to go into the molten spelter in a physically and chemically clean condition, and this process, like others, is far more carefully guarded in the making of Armco Iron than in that of substitute materials.

Galvanizing and Inspecting

The galvanizing is accomplished by passing the sheets between rolls which are immersed in molten zinc. The iron takes from the spelter bath a coating of zinc, and this is made even by the action of the rolls. The sheets on passing from the spelter bath are received on assorting wheels and are subjected to very close scrutiny by an expert in galvanizing. All those imperfectly galvanized are rejected. The galvanizing on Armco Iron is far purer than that upon steel, since pure iron dissolves in molten spelter only about one-fifth or one-fourth as much as steel. The purity of the zinc coating and the purity of the base metal are the reasons for the superior durability of Armco galvanizing.

After this inspection the galvanized sheets are branded and, if they are to be used flat, constitute a finished product. Sheets which are to be corrugated are sent to the great corrugating rolls at the Central Works. Recent improvements have rendered the corrugating much more accurate. After the corrugating the sheets receive a final inspection and are placed on the cars for shipment.

Briefly summing up the manufacture of Armco Iron, there are a great many points embodied in it besides purity. Armco Iron is a material which represents the best that skilled and experienced workmen with the best possible equipment can turn out. The inspection at every step is thorough and searching, and only that material is passed, which besides having the guaranteed purity, has the correct physical structure—which approaches, as nearly as is humanly possible, *perfect* evenness and solidity.

OFFICE OF

W. B. HARRIS,

RENO COUNTY ENGINEER

HUTCHINSON, KANSAS March 5th, 1915.

The Road Supply & Metal Co.,
H. S. Putney, President,
Topeka, Kansas.

Gentlemen:-

Replying to your inquiry as to our experience with Armco American Ingot Iron Culverts, will say:

This county has used American Ingot Iron Corrugated Pipe for culverts for five years, and for four years exclusively. During this time we have not had a failure, and I know of none in the county at this time that show any indication of decay.

We have taken out a number of steel pipe and replaced them with ingot iron, but since the steel was placed by other parties in a great many instances I am not able to give you the length of time they were in service. I can give you the life history of a number, however, and mention the following three cases, which are about the average.

One 36 inch pipe on what is known as the Monroe Street Road, just outside the city limits of Hutchinson; has been in six years, and is so badly rusted out that it could not be moved, and must soon be replaced.

One 16 inch, on the Plum Street Road, approximately one mile from the city limits of Hutchinson; was in 18 months and was taken out to put in a larger opening. This was rusted through in so many places it could not be used again.

One 24 inch pipe on the 4th Avenue Road, five miles west of Hutchinson was in three years and eight months and was rusted out entirely.

We have put in Ingot Iron pipe temporarily, that is, where the proper completion of the road work would do away with the necessity for the opening, and in some instances these have been in longer than some of the steel pipe that were found so badly decayed they were out of commission. Wherever these have been taken up they were found in perfect condition.

This, briefly, has been our experience with Armco American Ingot Iron.

Very truly yours,

W B Harris

County Engineer

W. DEWOODY DICKINSON
ASSOC. MEMBER AMERICAN SOCIETY CIVIL ENGINEERS

GUY A. WATKINS
ASSOC. MEMBER AMERICAN SOCIETY CIVIL ENGINEERS

TELEPHONE 1280

DICKINSON & WATKINS
CIVIL MUNICIPAL ENGINEERS
STATE BANK BLDG
LITTLE ROCK, ARK.

March 16th, 1915.

The Dixie Culvert & Metal Co.,
Little Rock, Arkansas

Gentlemen:-

In response to your enquiry asking our opinion of the comparative qualities of pure iron culverts and those made of steel, we would state that after a fairly long experience with culverts of various materials, we have adopted as our standard metal culverts only those manufactured from the purest iron we can secure.

Our experience with steel culverts has convinced us that they are notoriously unsatisfactory, that the galvanizing is not to be depended upon, and that their life, instead of being years, may, in some cases, be only weeks. As an illustration of this, we had a garbage can made from a section of steel culvert pipe which was entirely eaten away and worthless in two months time. This can was replaced with one made from a similar section of American Ingot Iron pipe which has now been in use nearly a year and is as perfect as when first made.

We have about fifty miles of levee under our supervision which has under drains of American Ingot Iron pipe. These drains were placed under the levee in 1909 and have never shown the least trace of rust or deterioration.

In every way we have used it, pure iron pipe has been so satisfactory that we have no hesitancy in incorporating it in our permanent construction.

Very truly yours,

DICKINSON & WATKINS.
W. D. Dickinson

WDD/T.

GEORGE ELEAZER Chairman
W. H. NEBLETT Secretary
I. H. HOSKINS Chief Engineer

J. R. BAKER
T. W. CROW
L. B. ADAMS

HIGHWAY COMMISSION

OF DICKSON COUNTY

DICKSON, TENNESSEE

March 6th, 1915.

Tennessee Metal Culvert Co.,

Nashville, Tenn.

Gentlemen:-

Your favor of March 4th, inquiring for my experience with metal culverts to hand today, and in reply will say that during the past twelve years I have been trying out the various culvert metals now on the market, and have decided that culverts made of American Ingot Iron are far superior to any others that I have used.

I was employed as Chief Engineer of the Robertson County Tennessee Pike Commission and under my direction this Commission expended over $500,000 for highways and bridges Immediately before they employed me as Chief Engineer they made a contract with a culvert manufacturer to furnish them with metal culverts for the entire contract These culverts were guaranteed to be as good as American Ingot Iron, and were priced 15% cheaper The first shipment of two car loads was used before the analysis was received from the testing laboratory This analysis showed that the samples cut from the end-sheets were 99 87 and 99.858 pure iron, and the samples cut from the centers of the culverts were 99.39 and 99 31 pure iron These samples were sent on September 3rd 1913

After this analysis was received the Commission refused to use culverts made of this material as it was not up to specifications and they immediately made a contract with manufacturers of American Ingot Iron culverts The four samples, cut at random from a two car shipment of American Ingot Iron culverts, analyzed 99.88-99.89-99.92 and 99 94.

After some of the culverts made by the .... had been in service for 15 months, I found it necessary to remove a 24" and an 18" culvert to install concrete arches, the culverts being too small. Each of the culverts were 40 feet long, and with the exception of the end sheets, the culverts were entirely rusted through along the bottom, and were unfit for re-installation. This was on the Wessyngton Pike, 1/4 of a mile West of New Chapel Church.

I found it necessary to remove two 24" culverts made of this same material, from the pike between Orlinda and Handleyton. These had been installed 27 months. They were not rusted entirely through, but were badly pitted and unfit for further use.

During the construction of the Robertson County highways we found it necessary to remove numerous culverts that had been installed by the District Commissioners. These culverts were bought from six different manufacturers (according to the County Records) and with one exception, none of them could be used again on account of them being corroded and rusted out.

During the construction of the Beets Road, which runs West from Greenbrier, the weather was unfavorable to concrete construction, and I installed three 24" American Ingot Iron Culverts under one fill, with the expectation of removing them as soon as the weather permitted concrete construction. For several reasons we did not get to do this work for 31 months after installing the culverts, and when they were removed they were in perfect condition and were immediately installed in other places.

The Pike Commission sold to the John Porter Ice Co., 75 feet of 15" American Ingot Iron culvert which he used at the Ice Factory

This culvert was installed in a driveway made of fresh coal cinders, and carried the water from the cooling system and other waste water I have been watching it to see the effect the sulphuric action from the cinders, and ammonia from the waste water would have upon this metal, and on the 28th of Feb., 1915, this culvert was in perfect condition after three years service

These tests under actual working conditions have demonstrated to me that it is much more economical to purchase culverts made of American Ingot Iron, even though they cost a trifle more than the "just-as-good" kind.

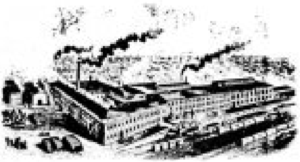
Yours truly,

J. H. Hoskins

JHH/ES. Chief Engineer.

QUOTATIONS SUBJECT TO CHANGE WITHOUT NOTICE
* ALL CONTRACTS AND AGREEMENTS ARE CONTINGENT UPON STRIKES ACCIDENTS AND OTHER OCCURRENCES BEYOND OUR CONTROL

L. O. KOVEN G. H. KOVEN CABLE ADDRESS "KOVENLO"



WORKS
JERSEY CITY N. J.

L. O. KOVEN & BROTHER,

MANUFACTURERS OF

SHEET IRON, SHEET STEEL AND STEEL PLATE WORK OF EVERY DESCRIPTION.

FOR SHIPS, MILLS, MINES, FACTORIES, PLANTATIONS, CHEMICAL WORKS, PAINT WORKS, PAPER MILLS, ABATTOIRS, FERTILIZER PLANTS, WATER WORKS, GOVERNMENT WORK, SEWAGE SYSTEMS ETC.

GALVANIZING

DESIGNERS OF SPECIAL APPARATUS FOR MANUFACTURING INDUSTRIES.

OFFICE 50 CLIFF ST., **New York,** Oct. 31, 14.

American Rolling Mill Co.,

30 Church St., City.

Gentlemen:

It may interest you to know that we used, without a break, one brand of puddled, double refined iron for over thirty-three years. This was high priced material but it was the best we could get and we wanted the best.

We wish to state further that after comparing American Ingot Iron with other new process irons and steels, of which American Ingot Iron is the highest priced, we have adopted the use of the American Ingot Iron and we have been using it with good results in large quantities since April of this year.

Yours very truly,

L. O. Koven & Brother