THE CONSTRUCTION AND ERECTION OF A 100-TON REINFORCED CONCRETE LOCOMOTIVE COALING STATION

BY

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I recommend that the thesis prepared under my supervision by RAYMOND RUDOLPH LUNDAHL entitled The Construction and Erection of a 100-Ton Reinforced-Concrete Locomotive Coaling Station be approved as fulfilling this part of the requirements for the degree of Bachelor of Science in Civil Engineering.

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The End.
The Locomotive Coaling Station to be described in this paper, was erected for the Chicago Great Western R. R. Company, during the Summer and early Fall of the year 1910. The contract for the construction was let to the Link-Belt Company of Chicago, Illinois. To this company, the author is indebted for all blue prints, drawings, photographs, etc., used in the paper.

The coaling station just mentioned was built at Stockton, Illinois. This is a small station containing at the time the building was started, about 1000 inhabitants, and is about 130 miles due west of the city of Chicago. The reasons for the selection of this particular station are not fully known, but the chief one seemed to be its desirable location, with respect to the larger cities along the line.

For several years the Chicago Great Western Railroad had been considering the establishment of a new division point between Oelwein, Iowa, and Chicago, Illinois. Dubuque, Iowa had been used as a division point up to this time, but the inadequacy of this place was very rapidly becoming apparent and the selection of a new site had to be decided upon. Several locations between Chicago and Oelwein were considered and of these, Stockton was the place finally chosen.

Stockton is about midway between Chicago and Oelwein and was therefore considered a very convenient place for the location of a division point. Land could be bought at a very reasonable price,
and along with this, the town of Stockton gave several other inducements.

The site as selected for the yards, in which the coaling station was to be erected, is situated about two miles southeast of the town. Land much closer to the city, could have been purchased at the same price per acre and why the site was chosen so far out, is a matter of conjecture to all who do not know the actual reasons. The land purchased consisted of a strip of swampy land containing about 100 acres. The purchase price was $200.00 per acre, a very high price considering the condition and quality of the land purchased.

Several guesses were made as to why the yard site was chosen so far away from the present yards at Stockton, but the railway officials did not let the exact reasons be known. The only arguments in favor of such a location, were the reduction in taxes, and the possibilities of starting a new town, as the facilities for the R.R. Company in Stockton were not considered the best.

The disadvantages were of course more apparent and seemingly much more numerous. Chief of these, in the author's opinion is the loss of time in changing engines, at the division point. As usual the change will be made at the depot and this will mean the bringing up of the engines from the yards, two miles distant, and the returning of the exchanged engine, the same distance. If the changes were made at the new yards, it means a delay of several minutes to each train, which of course is not to be desired. This delay is all done away with when engines are changed at regular station stop.

**Layout of Yards**

The general direction of the new yards is east and west, Stockton being to the west. The double track mains are at the ex-
treme north side of the area, and the yard tracks parallel these, covering most of the remaining ground to the south. The round-house, oil house, turntable, etc., are all situated at the west end of the yards. The coaling station is situated about six hundred feet east of the round-house. There are two cinder pits, one just to the north of the coaling station and another very near the round-house. The main tracks are about 300 feet north of the coaling station, and from these, turn-outs are arranged all along the yards.

The land as before mentioned was very low and swampy. The entire yard site of course had to be filled in, and the material for doing this was obtained from cuts at the extreme east end of the area. The greatest depth of fill was about twelve feet. At the coaling station site the calculated fill was about eight feet. The material used for these fills was a stiff yellow clay. The season was very dry and consequently the clay was extremely hard and difficult to handle. It was nearly impossible to excavate with the ordinary pick and shovel.

The general site of the building has been discussed sufficient to give the reader a general idea of the layout of the surroundings. The description of the actual building construction will be taken up, following a short discussion on materials.

MATERIALS

The materials for the construction of the coaling station were delivered by the Railroad Company, in fulfillment of a clause in the contract, calling for the free transportation of all men and materials to the site of the building.

A temporary turn-out from the main track was made and a track with a curve of 180 degrees was installed. This track was to
be used to deliver materials to the round-house and to the coaling station and as a siding for the work trains. The track was very poorly constructed and only the smallest of the engines could go around the curve without being derailed.

As most of the material used in the coaling station came from Chicago, the west-bound local way freight brought it to Stockton. In place of stopping the trains at the new yards, where the work was being done, and switching out the cars, the material was taken into the old yards and the required cars brought back by the east-bound local the following day. This process always caused, seemingly undue delay in the delivery of the material. Since the engines drawing the local freights were not able to go around the curved track, the material had to lie near the main track, until set in place by one of the dinky engines of the construction contractors.

The train crews of the above mentioned contractors were as stubborn as is usual with their type, and this fact often caused a great deal of friction over the switching in of the cars. The crew conductors were ordered by their employers to set cars only when they were not otherwise engaged. This restriction by the employers made it necessary for most of the switching to be done at night, after the construction for the day had stopped. This night switching made it very difficult to get the cars set in the places where they would be of greatest advantage for unloading, because the crews were always in a hurry to get through and were never more accommodating than was absolutely necessary. Often, as the engines attempted to go around the curve the rails would spread and the engines and possibly a car would be derailed. The re-railing was not an easy matter, so that delays from this source were of very serious consequence, lasting for
a week or more at times.

The material track ran along the north side of the building site and the material cars were set and unloaded where it was thought to be most advantageous. The tools and lumber for the building of forms was the first material to arrive. The lumber was all unloaded on the east side of the site, in piles according to the various lengths and sizes of the boards. The tools were taken care of in a shed built for that purpose. The cars of cement came next and were unloaded, and the cement stored in the cement house, built about seventy-five feet from the site of the station.

The plant machinery and hoisting engine was next installed, as the various parts arrived. A description of the plant will be made later. The remaining material was delivered from day to day during all the Summer. The crushed stone was unloaded on the west of the building, about fifty feet distant, and the sand to be used in the concrete was placed on the north side of the material track near the hoisting engine. The reinforcing steel was all unloaded near the cold bender, to the east of the site, near the lumber piles. The rods were sorted according to lengths and sizes, the smaller ones being placed in racks built for that purpose. The unloading and placing of the machinery and other steel material used in the construction of the station will be described when the construction of the building proper is considered.

Not all of the materials used were brought out by the Railroad Company. The supplies for camp and all materials not sent out by freight from Chicago were purchased in Stockton. This all had to be hauled by teams secured in town. The teaming bills thus incurred were considerable items of expense, because a great deal of
hardware and some lumber, lime, and so forth had to be obtained in this manner.

As the description of work of erection progresses, a further description of the method of handling the materials and their storage will be given.
A DESCRIPTION OF THE COALING STATION;
CONSTRUCTION AND ERECTION.

Plant.

Before beginning the description of the building, it may be of interest to have inserted here a description of the lay-out of the concrete mixing plant and its capacity, therefore a brief discussion along that line will be made.

The plant consisted of a thirty H.P. American boiler and hoisting engine, a one-half yard Smith batch mixer, a Smith concrete hoisting tower and self dumping bucket, and a small boiler feed pump, used in pumping water for the boiler and for use in the mixing of the concrete.

The boiler was situated on high, dry, ground and about thirty feet from the mixer. A two inch wrought iron pipe carried the steam from the boiler to the vertical engine of the concrete mixer. This engine was attached to the same platform as the mixer, and was in a hollow, about six to eight feet below the bottom level of the boiler.

The stone pile for the concrete was placed directly back of the boiler and the stone was conveyed to the mixer in wheel-barrows over a plank-way leading along the side of the boiler and engine. The runway sloped from the boiler to the mixer and after being started, the barrow moved by gravity down the incline, thus relieving the laborer of considerable work. The sand pile was situated to one side of the boiler and the sand was brought to the mixer down an inclined runway just as was the stone.

The cement was stored in the shed previously mentioned, about
one hundred fifty feet from the site of the mixer, and just before each mixing of concrete, was wheeled to and stored upon the platform, near the mixer, ready for immediate use. The amount required for a certain pour was estimated and this amount wheeled to the platform. If the mixing was to continue the day following, any cement remaining upon the platform at the close of the days work, was allowed to stay there over night. It was always covered by a large tarpaulin, as a protection against the rain and the moisture in the night air. If the concreting was to last for only the one day, as many of the pours did, the cement left over had to be hauled back and stored again in the cement shed.

The water used in mixing the concrete was, as before stated, pumped by a small boiler feed pump. At the beginning of the work the water was obtained from a small open ditch. A small pot hole was dug down about three feet, in the center of the ditch, and from this hole the water was raised into an elevated tank by means of a steam syphon pump. This method proved very satisfactory for a considerable length of time, but as the building grew in height, the syphon was unable to force the water high enough to keep the forms sprinkled, so the boiler pump was installed in place of the syphon. At this same time water became scarce due to the drying up of the streams. The cause of this was the extremely dry season, and the warm weather. As a last reserve, before attempting to haul water from the town in railway tank cars, a large open well, about eight feet square, was sunk. A very good stream of water, having a flow sufficient to supply all needs, was struck at a depth of about ten feet. The old ditch was then abandoned and all the water was pumped from the new well. This new arrangement made it possible to raise the water, under considerable
pressure, to the top of the building when completed.

One incident of special mention arises from the above discussion. It is one of the best examples of the opportunity for an erection foreman, with some ingenuity, to save his company a large amount of money, on apparently very small items of expense. When the trouble of securing water presented itself, the only alternative offered, after the drying up of the stream, seemed to be, either to pipe the water or haul it from Stockton. Either of these methods would of course entail a considerable cost. The foreman set to work at once to dig the new well. Other companies doing contract work in the same field thought it was folly to attempt to get water in this way, as they had tried to strike water, and were all unsuccessful. Luck seemed to be with the foreman, for at a slight depth a good stream of water, as before stated, was struck. The new well cost about thirty-five dollars, and thus at this slight figure, two or three hundred dollars were saved.

The only remaining part of the plant requiring any special mention is the concrete hoisting tower and self dumping bucket. The tower was of the standard Smith type, made up of four by four inch uprights, two by six inch cross bars and one by six inch diagonal braces. The lower section of the tower, about forty-seven feet in length, was all bolted up on the ground, and raised into position in one piece. The remaining part was built upon this lower section as required as the building grew in height. The uprights were all bolted together, and the braces and cross pieces spiked to the upright posts. The guides for the bucket were four inch channels bolted to the two sides of the tower. The bucket used was of the Smith self dumping type. A complete and thorough description of both the tower and
bucket can be had by consulting any of Smith's catalogues, so no further discussion of them will be given here.
THE BUILDING PROPER.

Following the necessary introductory descriptions and discussions, the description of the method of construction and erection of the building proper will now be taken up. In this description a special sequence of the order of building will be used. This is given here so that the reader may be better able to follow the discussion.

The erection of the building, complete without the machinery, will first be considered, and following this, the installation of the coal handling machinery will be discussed. This order of treating the work is of course not as it was done, during the actual construction, but due to various causes, an ideal method of doing the work was not followed, and it is for this reason that the above way of dividing the description is used. It must not be inferred that this is the practical method of handling the work, but it is discussed in this way, so that some definite system may be followed.
For convenience in discussion and as a natural and practical
order in erection; the concrete work on the building will be divided
into the following parts:

1. Foundation Footings and Floor Slab.
2. Foundation Piers and Walls up to Top of Track Hopper.
3. Columns, Beams, and Walls Under Coal Pocket
   Composing Substructure.
4. Columns, Beams, and Walls Around Coal Pocket
   Composing Superstructure.
5. Columns, Beams, and Walls for Lantern.
7. Scale House.
8. Roofs.
The foundation footings and floor slab is one of the most important parts of the building structure and therefore considerable detail will be of value here. Referring to drawing number one, the general drawing of the coaling station, the footings and slab are found below the line A-A.

Excavation

The amount of excavation required for the footings was estimated at 800 cubic yards, but the actual amount of earth removed fell far below this figure. The ground surrounding the station, as stated in the introduction, was all filled in with clay, obtained from the cuts being made on the main line. The site of the station had been staked out previous to the time of filling in, so that no clay had been dumped here. This of course did away with the excavation of any filled in material. This feature made a very great saving of both time and expense.

The excavation was all done by the use of teams with slips, and by men with picks and shovels. The excavating was carried to a depth, such that a good clay subsoil was reached for a footing. Good yellow clay was struck about three feet below the original surface of the ground, but the earth was removed to a depth of about six feet, so that the proper elevation of the track hopper pit and foundation walls, might be reached.
A plan of the foundation walls and footings, and the floor slab is shown in drawing No. 2. The footings are three feet thick and the floor slab one foot thick. The footings were all reinforced by one inch, round, rods, crossing each other at right angles so as to form one foot squares. The rods were wired together at all crossing points by No. 16 black wire. By referring to drawing No. 2, the exact location of the reinforcing steel is easily seen. The footings that were to carry the large substructure columns, were all tied together by 18" tie beams, reinforced by 4" rods. All rods used in the building were plain, round, soft steel rods, cut to the required length in the shop before shipment. The tie beams caused the footings to act in unison, and any rocking or settling of the building was thus better taken care of, than if the footings had been required to act separately. By this simple method the factor of safety was considerably increased.

The floor slab, as designed, contained no reinforcing whatever, but the erection foreman, to further increase the safety, placed a few 1" rods near the bottom of the slab, to take up any tension that might occur. As may be seen on the drawing, the two footings at the west end of the building, contained no steel, but were made entirely of mass concrete. This was thought to be sufficiently safe construction, since the load they were to carry was very small, compared to that carried by the footings beneath the large columns.

Concreting

No forms were required for this foundation because the earth as excavated held up sufficient to keep the concrete in place, as it was poured.
The concrete used was a 1:3:5 mixture of Portland cement, crushed lime stone, and building sand. It was mixed rather dry, the water just coming to the surface as it was placed and tamped. No hoist was used in handling the concrete, but it was dumped directly from the mixer into two wheeled buggies, and in these it was hauled over a plank runway, to the required destination. Each cart or buggy load, as they were called, contained about 1/5 of a hopper load of \( \frac{1}{2} \) cubic yard.

The footings were all worked first, because they were two feet thicker than the floor slab. All the footings were worked at the same time, so that as the carts dumped their load at one footing the tampers were at work on the preceding one. As the footings rose to the bottom level of the floor slab, the slab was concreted along with the remainder of the footings. This work proceeded from
the east end of the building, back toward the west end, where the mixer was stationed.

As the slab neared completion a large bolt template made of one inch boards was put in place and all the foundation bolts set, concrete being poured all around them. No particular attention was paid to the upper surface of the floor slab, as a finished floor was to be put in after the machinery had all been set, and building completed.

The average distance of hauling the concrete for this part of the work was about twenty feet, the farthest haul being to the east side of the building which was about forty-five feet from the mixer. The force feeding the mixer was usually composed of seven men, four wheeling stone, two sand, and one handling the cement. The boiler foreman took care of the water used in mixing the concrete and the hoisting engineer, ran the mixer, controlled the amount of water to each batch of concrete, and had general supervision of the machinery of the plant. A boy was employed to dump the concrete from the mixer into the carts. Two men wheeled all the material away from the mixer and dumped it in place and here two more were used to do the tamping. The engineer in charge usually supervised the placing of the concrete and the consistency of the mixture. He was relieved of this duty, when required to be at some other place, by the foreman of the work. The pouring of these footings was completed in two days.

Large rods, that were to reinforce the foundation piers, were put in place, extending through to the bottom of the footing. These rods were about 19½ feet long, so they projected above the tops of the footings about 16½ feet. When the foundation walls and piers
were built, these rods extended above them about four feet. This was very near fifty diameters of the rods so they were used as dowels for the large columns. In all, there were eight of these one inch rods, placed in the footings at each place where a pier was to stand. It required a very short time for the concrete to set, so that the forms for the walls of the foundation were set in place within a day or so after the footings and slabs had been completed.
Forms

The foundation piers and walls are shown on the general drawing, between the lines A-A', and B-B. As stated in the discussion of the footings and floor slab, the forms for the foundation were set up as soon as the footings had set for a day. The forms had already been built up by the carpenters, during the time of excavation for the foundation and the pouring of the concrete for the footings and floor slab. They were all built in large sections, so it was only necessary to set them in place, fasten them together and then put up the necessary bracing. They were all made of $\frac{3}{8}$" ship-lap lumber, nailed to 2"x4" uprights spaced every two feet.

The forms were braced inside, in the hopper pit, by 2"x4" and 1"x6" braces, running from the uprights to the floor slab and from the inside of one wall form, to the inside form of the opposite wall. On the outside, the forms were braced by 2"x4" boards nailed to the upright studding and to stakes, driven into the earth embankment. The forms were all very thoroughly braced to line. Spacers, cut in lengths equal to the width of the walls were placed in between the forms which were then drawn together by large No. 10 steel wire. This wire was passed through small holes bored in the forms and was then fastened around a 2"x4" piece run lengthwise on each side of the forms. These wires were then twisted up, inside the forms, until the
latter were at the desired distance apart.

After the forms were all in place and well braced, the next operation was to construct a platform and runway for the carts. Large 6"x6" timbers were laid across the tops of the forms and upon these were laid 2"x12" planking. The planks were nailed lightly to the timbers so as to better hold them in place.

**Reinforcing Steel.**

The steel reinforcement was next placed in the forms. Drawing No. 2 shows it in position. The walls shown in plan were all carried to the elevation of the top of the hopper pit, except the tie wall between the two large columns and the east end of the station. This wall was stopped about four feet below, so as not to interfere with the fill, for the approach to the station.

The reinforcement consisted of one-half inch rods, spaced about two feet apart, and rods of the same size spaced one foot apart running horizontally. This sort of reinforcing was placed on both the out and inside of the wall. The walls at the west end of the building, just as in the footings contained no steel at all. At all the sharp corners, where it was possible that a break or crack might occur, the author ordered made and placed in position, rods bent to the shape shown in the sketch, about one foot apart vertically. These were inserted as the concrete was being poured, one being put in when the concrete had risen a foot above the lower one. These rods were not required by the specifications, but were put in as an extra precaution.

The large rods extending through the footings, were held in place by templates built for that purpose and fastened to the tops of
the forms. All the steel was wired at crossing points with No. 16 black wire. Black wire, as it is called, is considerably better than galvanized wire, for this purpose. This part of the building contains four beam spans. These are shown clearly on the drawing No. 2. Beams had to be used, because the walls could not be made continuous, on account of the conveying machinery that was to be installed. The two smaller beams were reinforced at the bottom by three one inch rods placed as shown and extending through into the walls. The larger beams, those carrying a greater load, were reinforced by seven rods of same size as those used in the small beams. Four of these extended through and were anchored into the foundation walls. The other three were bent up, as shown in the drawing, about two feet from the end of the beams.

Placing the Concrete.

The amount of concrete required for the foundation piers and walls was nearly equal to that used in all the remaining parts of the building combined. The proportions of the aggregate were the same as
used in the footings, 1:3:5, the only difference in the mixture being the increased amount of water used.

The same force, as that described in pouring the floor slab etc., was used to operate the mixer. In addition to his old duties the hoisting engineer now had a new one pressed upon him. Instead of taking the concrete directly away from the mixer, it was first dumped into the hoisting bucket and then raised to the dump hopper by the hoisting tower. The section of the tower previously erected was now being used. The dump hopper was placed slightly above the top of the foundation walls, at a height such that the concrete carts could just be run under it. The self dumping, hoisting bucket, dumped the concrete into this hopper and it was taken from this by the men with the carts.

The foundation walls were carried up all the way around, simultaneously, an attempt being made to keep the walls at the same level, so that the water could not flow off the top, carrying the cement with it. The concrete was carted to all parts of the foundation, except on the west end, where it was spouted into place. As the concrete was put into place it was immediately and thoroughly tamped. The method used in tamping the concrete is of special interest and, it being a very practical and easy method, will be discussed in detail.

View number one inserted here, was taken during the concreting of the foundation walls. By close observation it can be seen how the wall forms are constructed and braced. The section of the hoisting tower mentioned above, is shown, as is also the dump hopper. The view does not show the forms for the entire building, the east end being cut out entirely. The large rods which are to act as dowels for
the large columns described before, are seen projecting above the wall forms. The hoisting bucket cannot be seen, as it is in the pit, at the bottom of the tower. The mixer and feeding platform are also out of view, but the gravity assistance in feeding, mentioned in the description of the plant layout, is shown in the picture.

The stone pile of 1\(\frac{3}{4}\)" stone is shown at B, and the sand pile at C. The type of cart used in handling the concrete is shown. The one at A is in the process of being dumped, the foreman is directing where the load is to be placed. The other cart is at the tower under the dump hopper in the process of being filled. The material track mentioned at the beginning of this paper is shown in the foreground of the view. The guy ropes used to steady the tower are very much in evidence. These ropes were moved up and down, as the tower was added to, and more than one set of guys were required. The arrow points to the mixer, which can be seen on close observation. The men tamping the concrete are inside the forms and cannot be seen.

**Tamping.**

The tamping of the concrete was one of the most important parts of the work. The surface of most of the walls was to be exposed so as good looking a surface as possible, was desired. The concrete was mixed rather wet, so much so that the men tamping it sank, in it, nearly up to their ankles. As it was dumped from the carts into place, the men tamped and churned it thoroughly with tamping spades. These spades were made by fastening a piece of sheet steel about 4"x6"x3/32" to a round wooden handle about six feet long. The concrete near the forms was given special attention. It was spaded so that all entrained air might escape, and the tamper was used in such a manner so as to force the rock away from the forms and allow the mortar to flow in
and take its place, thus forming a grout coating at the surface of
the walls. On removing the forms, this method was proved to have
been very successful, and the surface was excellent except in a few
spots where all the entrained air had not been allowed to escape.

Preparing the Forms for Concrete.

Before any concrete was placed in the forms, the insides
were sprinkled thoroughly, and the bottom cleaned of all wood chips,
saw-dust, and so forth, and was scrubbed clean of all dirt. This
same process was repeated at the beginning of each day's pour. This
cleaning out of chips, saw-dust, etc., is an essential to good con­
struction. The forms were kept wet at all times during concreting so
that they would not absorb the water from the concrete. This sprink­
ling of the forms, also prevented the warping and springing that
usually occurs, and thus gave a much neater wall.

The average daily pour was about 60 cubic yards, and cost
about $0.70 per yard in place, not including the cost of materials. No
keying between the pours of the successive days was resorted to. This
was not deemed necessary in the foundation piers and walls.

All foundation wall bolts were set in templates provided for
that purpose. Triangular strips were nailed to the forms as a gauge
for the top of the walls. These strips were set by a level, and the
concreting was stopped about an inch below the tops of these strips.
A cement mortar coat was then put on top and the wall brought to the
level of the strips. The strips also served the purpose of giving a
beveled edge to the wall top and thus, did away with the sharp corners
and edges, so easily chipped off. Strips were placed at all the form
corners to serve the same purpose.

At each end of the hopper pit walls, were placed two boxes,
which served as form holes to be left in the concrete walls, in which the track girders were to lay. The forms were sprinkled well each day and were not removed for nearly a month. The result showed that a much better surface would have been obtained, had the forms been removed two weeks sooner. The elevation of the surface of the concrete was now about 15'6" above the bottom of the footings.
The substructure is shown in drawing No. 1 between the lines B-B and C-C. It is composed of two 24"x30", two 28"x30", and two 24"x26", columns, each being 20 feet high, from the top of the foundation walls to the foot of the knee-brace. Between the two 24"x30", and the 28"x30" columns, two large 48"x30" beams span the gap. The two 24"x26" columns carry a 24"x48" beam. These beams all run from the north to the south. At right angles to these, between each pair of 28"x30" and 24"x30" columns is a beam 24"x48" in cross section, and between the 28"x30" and 24"x26" columns is a 19½"x48" beam. Besides the beams just described, there are three 10"x12" beams on each side of the building between the 24"x26" and the 28"x30" columns. These smaller beams act as ties, and also carry the guide brackets for the G.D. Elevator, which is described later. The small beams are placed 7'9" apart vertically.

The section shown in figure one refers to the general drawing. The arrangement of all the details, just explained, is shown in these sections, and by referring to them a better idea of the looks of the substructure is obtained, than from the preceding description. Where each of the large beams joins a column a knee brace is placed. This guards against the cracking and breaking that otherwise occurs at a sharp joint of this kind.

Forms.

The column forms were made of two inch material, each side
of the form being a separate section. Pieces of 2"x4" lumber were nailed to these sections, spaced vertically, about two feet apart. The small view No. 2 shown here, gives the reader a better idea of the column form construction. The sections were bolted together by 5/8" rods, so that when ready to be removed, it was only necessary to loosen and remove the nuts on the rods, and then with very little added labor the forms were lowered in sections. These rods are shown clearly in view No. 2 and the way in which they were used is seen here. The corners all contained triangular strips so that the section of the column would contain no sharp angles. Before erection, the forms were well painted with linseed oil, on the inside.

The large beam forms cannot be seen in view No. 2, but these were made up in sections, out of 5/8" ship lap material on 2"x4" uprights spaced 24" apart. The smaller beams are shown in this view. Their forms are made of 2"x12" plank, and are held together by a collar made of pieces of 2"x4" lumber, driven tight by the use of wooden wedges.

The large column forms rested upon collars. These collars were set in a cement mortar, were lined and brought to the required level by means of a transit. The sections were all bolted together on the ground, and the forms for each column hoisted and set in place, by a derrick run by the hoisting engine. The forms were set in the collars, and were plumbed to line with the transit. The forms after being plumbed and lined were braced in this position, by braces running to the forms on the foundation walls.

The beam forms were hoisted in sections with considerable trouble, although the sections were not large. The ship lap lumber is not very rigid, and the sections presenting a great deal of surface,
made it easy for the wind to play havoc with the forms, as they were being set in place. The hoisting cable was wired to the sections, near their centers, in such a way as to hold them in an upright position, as they were being raised. This precaution was of considerable aid. The first sections to be set were the most difficult, because before they were in place, there was nothing to brace to. As more sections were hoisted it became more easy, because then they could be tied and braced to those already in place.

**Shoring.**

After the forms had been set, and partially braced, the shorings for the beams were placed. View No. 2 shows these shores. They were made of 6"x6" timbers, crossed at the top by two, 2"x6" cross pieces, forming a T. These shores rested upon the foundation walls and were driven tight by maple wedges placed under their feet. The longest beams, each required four of these shores, and the smaller ones a proportionate number. These shores were braced together diagonally and the beam forms further braced to the shores.

After the shoring was completed, the bottoms of the beam forms were laid. This kind of construction made it possible to remove the forms from the sides of the beams without removing the shores. **Spacers.**

The spacers used in the beams, were made of 1:3 Portland cement mortar. They were reinforced at the three corners by a No. 10 steel wire. These spacers were made in forms, resembling the ordinary watering trough for the pig. A hole was left through the center of the spacer, and through this hole was placed the tie rods, after the spacers were in position. These concrete "pigs" as they were called, were sort of wedge shaped, being large in the middle and smaller at
either end. Being of this shape they anchored themselves into the beams, as the concrete was poured. There were two rows of these spacers, one near the top and another at the bottom of the forms. The tie rods used were \( \frac{5}{8}'' \) in diameter. These rods carried a nut and a washer placed on either end just outside the forms, and by tightening the nuts, the forms were drawn up against the ends of the spacers. The washers did not bear directly upon the \( \frac{7}{8}'' \) lumber, but two 2''x4'' pieces were placed horizontally, and upon these the washers had their bearing. View No. 3 shows this construction.

The concrete spacers just described have many advantages. The bother of having to remove the wooden spacers is done away with, and the chance of having a piece of wood in the concrete beam or wall is reduced to a minimum. The tie rods are very easily removed and the spacers are placed to a better advantage than are the wooden ones. These spacers also serve the purpose of holding up the reinforcing steel. This could not be done with the wooden spacers because they have to be removed. The only disadvantage apparent seems to be that the concrete spacers break easily.

**Steel Reinforcement.**

As soon as the forms had been set and properly shored, 6''x6'' timbers were laid across their tops, from one form to the other, and upon these was laid a flooring of two inch plank. The reinforcing rods had all been cut, and bent, according to the plan, and these were now hoisted up and placed on the new platform. Drawing No. 3 shows the detail plan of the reinforcing steel, of the substructure so no other description of it will be given, except of the method by which it was put into the forms.
The rods had been cut and bent as before stated, and were ready to be wired in position. The steel of the columns was the first to be put in place. The eight one inch rods were dropped down inside the forms and a man was sent down to wire the bottom of them to the dowel rods projecting from the foundation piers. The beam reinforcement was next put into the forms. The longitudinal rods had been placed in the bottom of the forms before any of the concrete spacers were in, so the spacers did not interfere in any way.

The method used in putting the stirrups around the column rods, was as follows:— A man was sent down inside and the stirrups were then dropped down to him and he wired them to the vertical rods. As they became too high for him to reach, he would stand on the ones already in place and then wire the next ones. This method continued until all the stirrups had been fastened in. The method is very crude and it would have been considerably better to have wired the stirrups to the rods, outside of the forms, and then dropped the whole in, as a unit reinforcement.

The steel rods in the beam forms were wired to the bottom row of concrete spacers, with No. 16 wire. Great care was used in placing and wiring these rods, because the entire bottom was nearly covered, and they had to be placed with a minimum space of two inches between rods. This restriction made it difficult and tedious, to get the steel in place, but it was strictly adhered to. The stirrups, made of $\frac{3}{8}$" round, were not inclined as is usual in concrete construction, but were placed in a vertical position. The rods at the top of the beams were held up by being wired to the stirrups just mentioned. The rods placed in the knee braces were of odd shape, and, with all the other rods interfering, it was a difficult job to get them in place.
As soon as the steel was all in the forms, a careful inspection was made, by the engineer in charge of the entire work. All rods were spaced at least two inches apart and none were allowed to be closer than this to the form surface. No rods were allowed to interfere with each other, as might happen at the connection of the beams to the columns. Each one was made to act separately.

After this inspection the forms were all aligned anew and the column forms carefully plumbed.

**Deposit the Concrete.**

The concrete in the columns was to carry the entire load of 150 tons from above. The steel as designed was to carry 12,000 pounds per square inch, and the concrete 300 pounds per square inch. The proportions in the concrete were changed from the 1:3:5 used in the foundation to a 1:2:4 mixture of the same aggregate.

The mixing force was the same as previously described for the preceding pours. The tower, as is seen in view No. 3, was raised
by adding new sections on top, and the dump hopper was also raised to the level at the top of the superstructure. Each section of the tower as now added is sixteen feet long. View No. 3 was taken when the height of the tower was from 70 to 80 feet high.

A wooden spout was built up, from the tower to the building, carried upon posts extending down to the foundation walls. This spout arrangement required the addition of another man to the ordinary labor force. It was his duty to tend the gate at the dump hopper and keep the spout clean.

Before any concrete was deposited in the forms they were cleansed of all foreign particles, which were washed down the column forms by the water and were here cleaned out thru a hand hole left in the form for that purpose. These holes were all closed up after the shavings, etc. had been taken out, and the concreting started.

One mixer full of 1:2 mortar was deposited, part in the bottom of each column form, before any of the 1:2:4 concrete had been put in. All anchor bolts had been set and wired to place so that no delay from this source, was experienced after the pouring of concrete was once started. Holes had been cut in the outside of the column forms and through these the concrete was tamped. View No. 3 was taken during the pouring of the columns, and in this a man is shown at each column, in the process of tamping the concrete as it is dumped into the form. The columns were all carried up simultaneously, and as the concrete reached the bottom of a hole, the latter was closed up, and the tamping carried on from the hole next above. This method of tamping had to be resorted to, because the depth of the column forms was too great to allow successful tamping from above.

The forms for the columns were completely filled, before
any concrete was deposited in the beam forms, these being then poured. Triangular strips had been nailed to the beam forms, as in the case of the foundation walls, and the surface of the beams was finished just as were the tops of the piers and walls. As the concrete neared the tops of the beams, the dowel rods shown on the rod plan, were put in. Strips of wood, beveled slightly were placed in the tops of the beams to form a groove, to receive the bottom of the metal lath, which was to cover the entire superstructure.

It required one day to pour the forms of the substructure, the total yardage being about 64 cubic yards. The concrete cost at an average about 80¢ per cubic yard, in the forms, neglecting the cost of material and plant depreciation and interest. The forms and shores were allowed to remain for three weeks. The beam forms, as before mentioned, were so constructed that they could be removed without removing the shores, but this fact was not taken advantage of, since both the forms and shores were removed at the same time. The forms were sprinkled thoroughly, several times each day, for the first week after the concrete had been put in them.

The forms were removed by passing a rope around one of the large beams, one end being attached to the form and the other held by two men. In this way the beam acted as a pulley. The column forms were the first to be removed. As the forms were taken down they were all carried to one side of the dump and stacked neatly in piles, ready for immediate shipment to next job. The forms were all designed, with the intention of using them on four other stations just like this one, so they were constructed much more substantially than is customary with the ordinary building forms.

All defects in the surface were plastered over and scales,
etc., brushed off. While all this work was being done, the carpenters had been kept busy building the forms for the remaining part of the building. These were all ready to be set up as soon as the substructure concrete had set sufficiently.

THE SUPERSTRUCTURE.

The superstructure of the coaling station is that part of the building shown, between the lines C-C and D-D on drawing No. 1. It is composed of two stories, and each story was constructed separately. The columns and beams up to the first eave were first constructed, and then the rafters, and the beams and columns of the second story were erected.

First Story.

Figure two shows cross sections through the superstructure. The letters E-E and D-D refer to the general drawing. The first
Fig. 4.
story of the superstructure is made of seventeen columns, four of them 10"x12", and all the other thirteen 12"x12" in section. These columns are a little over sixteen feet long. A horizontal section, through this story is shown in figure four.

The beams carried by these columns were of various sizes, the largest being a 12"x36" girder directly over the center of the coal pocket. The remaining beams on the east side of the building were all 10"x10" in section, whereas all the beams at the west end, coming directly under the lantern, were 12"x12".

**Forms.**

All the beam and column forms were made of two inch lumber, except those for the larger girder, which were made of 7/8" ship lap. The corners of the column forms were all spiked together, and as an extra precaution against spreading, collars made of pieces of 2"x4" lumber, and held together by means of 5/8" rods, were placed around the column forms. Like collars were placed around the beam forms, but in place of being bolted up, were driven tight by use of wedges.

The column forms were all set up to line and were plumbed by using an ordinary heavy plumb bob, the beam forms were then nailed to the tops of the columns. The forms for the large 12"x36" beams and for four of the 12"x12" beams, had to be shored up. The shores used were made of 4"x4" timbers carrying a 2"x4" crosshead braced to the upright timber. Wedges were placed under their feet and driven up as described in the shoring up of the substructure beam forms.

View No. 4 shows the first story of column forms in place ready to receive the reinforcement. The derrick used in handling the forms and the steel can also be seen here. In the foreground of the view and lying between the large columns, inside the station, may be
seen, steel for the track hopper, shoveling boards, etc., which had now begun to arrive. On top of the hoisting tower may be seen two men outlined very dimly. These men are at work adding sections to the tower. The various pieces of the tower are hoisted from the ground by a hand rope and then bolted in place. The forms for the large columns are shown, removed, but the beam forms are still in place. The dump hopper is set at the superstructure level, and the spout frame partly constructed, ready to start pouring the concrete.

Reinforcing Steel.

The plan for the steel reinforcement of the entire superstructure is shown in drawing No. 4. The rods for the beams were wired in the forms in the usual manner, but the column reinforcement was unusual. The error discovered in placing the steel in the forms for the large columns, was taken advantage of here. The steel for each column consisted of four \( \frac{5}{8} \) rods, one placed in each corner, and stirrups of No. 10 wire, placed around the rods, about six inches apart vertically.

The four rods were placed on a template and the steel wires
then fastened to them. This method of wiring the rods, together, gave a very rigid unit reinforcement. These "bird cages", as they were called, were hoisted from the ground, two at a time and placed upon the platform, previously constructed on top of the forms. From here they were raised and dropped by hand into their respective forms. The dowel rods that were mentioned as being placed in the beams of the substructure, were all bent in slightly, so that the cages slipped over them with very little trouble. The rods of six of the cages were long enough to project about 30 inches above the tops of the beam forms. These were placed at the west end of the story, directly under, where the columns of the top story were to come. The rods projecting up acted as dowels for the next story columns.

**Concreting.**

It is unnecessary to state, that before any concrete was deposited in the forms, they were thoroughly cleaned, and the position of the steel inspected, both of these operations are very essential to good construction and should be performed at all times.

The proportions of the concrete remained 1:2:4, but \( \frac{3}{8} \)" stone was substituted for the \( 1\frac{1}{4} \)". No change was made in the labor force and the forms were filled and the beams finished off by troweling, in the usual manner.

Special tampers were made with which to tamp the concrete as it was dumped. These tamps were about sixteen feet long made of \( 1\frac{1}{2} \)" \( \times \frac{1}{4} \)" flat rolled steel, widened at the bottom to \( 2\frac{1}{2} \)". The concrete was tamped from the top of the forms and a very good surface was secured.

In the upper right hand corner of drawing No. 4 is a sketch showing the manner in which wires were placed in the forms. These
wires were to be used later, in fastening the metal lath to the structure. The sketch is self explanatory.

The forms were sprinkled each day, and were not removed, until the second story of the superstructure, and the lantern had been concreted.

Second Story.

The second story of the superstructure is composed of six 8"x8" columns supporting three 10"x12" rafters; three 12"x20" and two 8"x8" beams, two 10"x12" and six 12"x12" columns.

The forms and the reinforcing steel were the same as just described for the first story. The rafter forms carried 3/4" steel rods and the channel roof purlins were also placed in position before any concrete was poured.

View No. 5 shows the station after the substructure concrete had all been completed. None of the forms have yet been removed. To the left side of the view is shown the cement storage shed, office, and a part of the living camp. The hoisting tower was at its full height when this view was taken. It is 110 feet above the original ground level. The tower guy wires are shown plainly. This gives an idea of how well the tower was braced.

No special description will be made as to the method of handling the concrete, the same general method as used in the other parts of the building, being resorted to.
The fifth and last division of the building proper, is called the lantern. It is shown on the general drawing above line D-D, and is composed of six 8"x8" columns, three gables and two eave beams. Figure 3, shows section E-E of drawing No. 1. Figure 5, is a horizontal section through the lantern.

The forms for the beams at the eaves, and the columns, were made of two inch lumber. Those for the gables were made of the ship lap lumber. The forms were all very light and were hoisted to the top of the station, by hand. The gable forms and also those for the eave beams were shored up by 4"x4" timbers placed under their centers.

The steel reinforcement is very simple and its placing requires no explanation. A plan of the rodding is shown on drawing No. 4. The roof purlins were placed in the forms for the gables and the forms were ready to receive the concrete.

The same proportions in the concrete as used in the substructure were used for the lantern, namely 1:2:4 - 3/8" stone. There were only four cubic yards in the entire pour. Nearly all the concrete had to be placed by hand, so it was very expensive. The total cost for building and setting the forms, pouring the concrete and setting the steel, amounted to $21.44 per cubic yard of concrete.

This completes the description of all the concrete work on the building except the cement mortar floor, placed in the hopper pit. View No. 6 was taken after all this work had been completed. Most of the forms had been removed, and the workmen are shown on the
and then lowered them to the ground with ropes. The roof purlins are shown clearly. Oars, loaded with steel, and conveying machinery can be seen standing on the material track waiting to be unloaded.

The derrick is still in position and will be used in handling the steel work as it is put in. The concrete hoisting tower is dispensed with and is ready to be torn down at any time now.
The elevator casing is not shown clearly on any of the available drawings, but it encloses the vertical run of the G.D. elevator. This casing is situated between the two large columns at the west end of the station. It extends from the top of the foundation walls to the bottom of the upper run of the elevator, in the lantern.

The frame work for this casing was made up of angles and plates, riveted together in sections, in the shop, ready to be erected, and bolted up in the field. A block and tackle was attached to one of the beams in the lantern and the sections of the casing frame were hoisted up by this tackle and bolted in place. Bolts had already been set in the columns and beams and the casing was anchored to the building by these bolts.

The guide brackets were bolted to the beams and to the brackets the angle guides were temporarily bolted. This was done before the angle frames were erected, so that the casing would not interfere with the work.

SCALE HOUSE.

The position of the scale house is shown in the general drawing. Its frame was made up just as was that of the elevator casing. The shoveling boards, described later, formed the side of the scale house next to the track hopper.

THE ROOF.

There were three roofs on the entire station, one on the scale house and two on the station proper. The rafters carrying the
roof were of concrete and the purlins were six inch channels. The purlins were all tied together by means of rods. The roof frame of the scale house was made up of angles, similar to its sides.

The specifications called for a fire proof building, so a cement tile roof was selected. The tile used is a manufactured product, made by the Federal Cement Tile Company. The tile is also patented. They are made in various standard sizes and the roof purlins were placed so that these sizes could be used. The tile was fastened to the purlins by means of metal strips.

The Tile.

The roof tile has a light, reddish color. It is made by placing cement mortar upon expanded metal, and a rib down the center of each tile carries a \( \frac{1}{4} \) steel rod. The product is very fragile, and requires the utmost care in handling. It is shipped, packed well in straw, and is braced and nailed up, so as to prevent any possible movement. Even with all this care in shipping, several of the tile are found to be cracked or injured in some manner, showing that they are very easily broken. Each broken tile means a considerable cost to replace because they are very expensive. The tiles usually come in sizes two feet wide and vary in length, by half feet, from four to six feet.

The Manufacturing Company does not allow a car of tile to be unloaded unless they have a foreman in charge of the work. If unloaded any other way they take no risk whatever. The foreman is furnished by the tile company but has to be paid for by the company buying the tile, at the rate of six dollars per day and all expenses. He oversees the unloading, storing, and the placing of the tile on the roof.

The roof on the lantern was the first to secure any tile,
and the large roof on the station and the scale house came next in succession. The tile were hoisted by hand, using a block and tackle. They were placed by ordinary laborers, the superintending being in the hands of the tile foreman.

View No. 7 is the only photograph available showing the roof clearly. This was taken after the station had been completed, and gives the reader a very good idea of how the roof appeared. The ribs containing the \( \frac{1}{2} \)" rods are in considerable evidence. In the distance may be seen the round house, mentioned in the introductory discussion.
The entire superstructure, the lantern, the elevator casing, the scale house, and a portion of the substructure, was all enclosed by a coat of plaster. During the time between pourings of concrete, the carpenters had been kept busy, bolting in place, the door and window frames. The lantern contains four windows on either side and one at each end. The superstructure contains eight windows and the scale house two.

A metal lath, called "Trussit" was used on the building. It is lath having herring-bone ribs and comes in sheets, similar to corrugated steel. A description and the advantages of this lath may be obtained by consulting a catalogue of the manufacturers of "Trussit".

Swinging scaffolds were hung from timbers, extending out over the edge of the roof, and the men placing the lath worked from these scaffolds. The lath was started at the bottom and worked toward the top, the men hoisting the scaffold up and down as the work progressed. The lath was fastened to the columns by means of the wires in the columns, shown on drawing No. 4 at upper right hand corner. At the window and door frames and wherever wood was encountered, the lath was fastened by using staples. In fastening the trussit on the scale house frame and the elevator casing, special clips were used. These were furnished by the manufacturers of the lath.

The ribs of the lath on the elevator and on the scale house were vertical and on all the remaining part the ribs were placed horizontal. The position of the ribs is not essential, because the lath
is guaranteed to take and hold the mortar, placed in any position.

No photograph was taken of the men at work placing the lath, but view No. 8 shows the building after all of it was covered. From a distance this trussit covering gave the appearance of the building being enclosed with glass. The timbers that were used to carry the scaffolding are still in position and are shown projecting over the eaves.

The cost of placing the trussit per square of 100 square ft., was found to be $1,978 on the building and for the casing and scale house $2,198, making an average price of $2,078 per square of metal.

**Plastering.**

The plaster put on the building, was a mixture of hydrated lime, cement, and river sand, in the proportions of 1:5:12. It was mixed in an ordinary mortar box, and was hoisted to the men, on the scaffold, in large buckets, by horse power.

The plaster was put on the walls in three coats, two on the outside and one inside. The first coat put on was a scratch coat, and
the other two were finish coats. The first was scratched so as to give surface for the second coat to adhere to. View No. 9 shows the plasterers at work on the scaffold. At "A" is shown the first or scratch coat, and at "B" is shown the surface, as it appeared, finished. The method of scaffolding is also shown in this photograph. Notice that the railing at the center of the scaffold is left off, this was done so that the plaster bucket could be dumped more easily, as it was hoisted up.

At the extreme right, a timber may be seen at the eave, with a block and ropes attached. This method of placing the timbers in advance of the work was used, so that as little time as possible would be lost by the plasterers. They received 70¢ per hour and a short delay meant considerable expense. Beneath the push car shown in the foreground may be seen the well from which all the water was taken.

View No. 7 shows how the building appeared after the plastering work was all completed. The plaster has a color very near that
of the finished concrete, and presents a very pleasing appearance.
General

The machinery used in this station for handling the coal, is best understood by reading a few extracts from the contract. A few of these are inserted in the discussions following.

The proposal in the contract, covers structure and machinery equipment for five coaling stations, having storage capacity of 100 tons each, with the storage pockets on scales, each station being designed to receive coal from cars on track passing below the pocket, and to serve one track on each of two sides of the Station.

The machinery equipment for each station was to consist of a track hopper, with breaker bars across its top, a reciprocating feeder, a gravity discharge elevator conveyor, a steel pocket with capacity of 100 tons of coal, scales for the pocket, and coaling chutes with gates. The coal is dumped from cars or shoveled by hand to the track hopper, from which the feeder delivers it at a uniform rate to the elevator conveyor, which in turn discharges to the coal pocket.

When installed and properly operated, the equipment for the station is capable of delivering bituminous coal to storage at the rate of 60 tons per hour, (the speed of the elevator conveyor being 60 R.P.M.), provided the coal is delivered to the track hopper at the necessary rate.

Track Hoppers, Etc.

The track hopper is 38' x 40' in plan, and is made of % steel
plate, with angle stiffeners. The hopper is arranged to deliver from two points. It was shipped to the field in sections. These sections were handled by means of the derrick and hoisting engine. The various sections were bolted to the foundation walls and to each other preparatory to being riveted together.

For the support of the railway track across the hopper, were two box girders, each made up of two 15"-42# I. beams, 39'0" long, with cover and bearing plates. These girders were shipped to the field in four sections each. Steel cross girders were provided for the intermediate support of the track girders. The cross beams were 20" - 80# I. beams. They were unloaded, three of them, and set directly in place, by the derrick. In getting the sections of the hopper, girders and cross beams into place, both nigger heads and both drums of the hoisting engine were used. At times the engine was pulling in three directions at the same time, and the engineer was kept pretty busy watching the cables. The rails were fastened to the track girders by rail clips and bolts.

Feeders:

Before either the track hopper or girders had been put in place, the Link-Belt Automatic Double Reciprocating Feeder was installed. This feeder controlled the flow of the coal from the hopper to the elevator conveyor. Its position with reference to the hopper and conveyor is shown at the cross in drawing No. 1. This feeder is of steel construction throughout, with cast iron hangers for support from track hoppers.

The driving machinery for the above feeder is shown in the drawing in sketch. It consists of a drive shaft and a countershaft with all necessary fittings. A steel support made of angle irons is
The last gate mentioned above, 34 inch, is the size used for the standard "Link-Belt" Undercut Gate and Hooded Chute for Locomotive Coaling Stations
Patented February 2, 1904

Provided for the feeder drive and countershafting. This was also lowered into pit before all of track hopper was in place.

The power for driving this feeder is furnished by a 5 H.P. Allis Chalmers Fully Enclosed Motor, 725 R.P.M., compound wound for 220 volts direct current, with cut spur gears to feeder. It is shown in position at 1, in the general drawing. This motor is equipped with a #10 Cutler-Hammer starter which is placed on the wall close to the motor.

Elevator Conveyors.

The elevator conveyor for this station is made up of 36"x20"x3/8" steel plate buckets, reinforced at the lips, attached at intervals of 36" to a double strand of 18" pitch steel bar link chain fitted at articulations with 1 3/8" steel pins. Each strand of this chain is made up of 3/8" x 2 1/2" side bar links and coupling links, 1"x2 1/2" in section, upset at ends to give greater pin bearing.

This chain was hoisted by attaching block and tackle to out-
rigging beam at lantern, and raising the chain in sections containing about ten of the links described. The troughing, guides, discharge gates, spouts, etc., composing the upper run of the G.D. elevator, had already been put in place and the bundles of chain were deposited herein as they were hoisted up. The chain was now ready to be let down the guides at any time.

The elevator is complete with head, counter, and corner shafts, 47" sprocket wheels, pawl to prevent backward motion, and all other necessary fittings, including cut spur gearing for connection to motor drive. The connection between head and first countershaft are made by means of Link-Belt Patented Spur Equalizing Gears. This gearing obviates the pulsating motion, otherwise incident to the use of long pitch chain, such as used here.

All the shaftings and gearing were hoisted from the ground to the outrigging beam in the lantern, and with the assistance of chain
falls, they were placed in their proper bearings. These bearing boxes were all bolted to the box girders carrying the upper run of the elevator. The exact position and the method by which all these accessories were put in place cannot be described in detail. By a close study of the first drawing, a general idea as to the position of the machinery may be obtained. No further discussion will be attempted here.

The chain, when the gearing was in place, was placed over the sprocket wheels, section at a time and lowered down the guides. The guide brackets had all been lined properly, shimmed up and bolted tight to the beams, the angle guides were in turn fastened securely to the brackets. The chain was lowered down both sides of the building until the lower run of the conveyor was reached, it was then passed around the sprockets at the lower corners and by adding a section, the two lower ends were joined. The sprockets at the lower corner, on the south side of the building were equipped with take-ups, so that the chain tension was easily regulated.

The buckets of the elevator were not attached to the chain, until the elevator casing had received its coat of plaster. The buckets are very large and put into such a small place, they would interfere with the plasterers, while they were at work on the inside of the casing. As soon as the plasterers had finished the casing the buckets were bolted to the chain one at a time and lowered down inside the casing.

Power.

The power for running this conveyor was obtained from a 20 H.P. Allis Chalmers Open Motor, compound wound for 220 volts, direct current, 625 R.P.M. A Cutler-Hammer No. 10 starter was placed on the wall near the motor. This motor was placed at the south end
of the lantern and was belted to the spur gearing of the elevator.

Bin and Scale.

The bin, or coal storage pocket is about 21' x 16' in plan, with 5/16" steel plate sides and 3/8" steel plate bottoms, with suitable connections, brackets, etc. The scale for this bin is constructed for a load of 150 tons gross and has a beam graduated for 110 tons net total, with subtracting, recording device. The beam is graduated in tons, hundredweights and decimals thereof, and can be read by any person in the scale house.

The scale beam has graduations on both sides of the fulcrum. On one side there is a plain poise and on the other side there is a poise with a recording device. Previous to drawing off coal the plain poise is adjusted to show the net weight of the coal in the pocket. After the coal is drawn from the pocket, the recording poise is shifted to balance the beam. A card is then inserted in the recording poise and the net amount of coal drawn off is printed on the card in tons and decimals thereof.

In erection, the scale levers and bearings were the first thing put in place. After these, came the large I beams that were to carry the bin. These were hoisted up and set on the scale bearings. The sides of the bin were next to be set up, each side being in one section. These sides were bolted together temporarily. The bottom sections were the last and most difficult to be placed. They were bolted from scaffolding swung under neath the bin. All the riveting was done by a pneumatic rivetter. The rivets were driven from the inside of the bin and were bucked up by men on the scaffold with dolly bars where convenient and with specially constructed bars where needed.

View No. 6 shows the bin and scale levers in place. The
sides of the pocket were tied together by rods, to prevent bulging, and are well stiffened by channels attached inside. The figures from the time book show that it cost $178.21 to place the coal pocket, complete. This includes the cost of unloading, erection, rivetting and painting, and all other labor in any way connected with the coal pocket; except the overhead expense.

**Locomotive Coaling Chutes.**

The coal pocket is constructed so as to deliver coal from either side of the station. The coal is drawn from the bin by chutes. The Link-Belt 1910 Standard Undercut Gates and Hooded chutes, complete with all necessary arrangements, are the type of chutes used. The gates are of cast iron and are arranged to operate by a hand wheel. The chutes are made of steel plate, hooded at the outer end to prevent spilling of coal. A hand chain mechanism and arrangement operates the chutes so that they will remain either in position to discharge coal or in the raised position. The operator who controls the gate and chute does so from a platform attached to the side of the building. This platform is shown at 2, in the general drawing.

The cut shown on page 49 taken from the Link-Belt Co's general catalogue No. 90 shows the gate and chute in two positions. In the first view the gate is closed and the chute up, in the second the gate is open and the chute in position to coal the engine. The chain attached to the chute is weighted in such a manner so as to assist when the chute is being lowered and helps hold it in position when down. On raising the chute the weights act vice-versa, assisting when chute is raised and helping hold it there when up. The hand wheel used in operating the gate is at A, and the chain used to raise and lower the chute, at B.
The shafting carrying the chain wheels of the chute is carried by a bearing held up by an angle frame attached to the side of the coal bin. This frame is shown on drawing No. 1 at 3. To this frame was attached the block and tackle used in hoisting the chutes and gates as they were erected.

**Shoveling Boards.**

As the station was to handle coal from any kind of cars, shoveling boards had to be installed. These can be seen in any of the views shown. They are placed along side of the track hopper, are nine feet high and are made of \(\frac{1}{2}\)" steel, stiffened by angles riveted to the sheets of steel. The sections of the boards were all riveted together with \(\frac{3}{8}\)" rivets, driven cold. Most of them were driven with the air hammer but some were riveted by hand.

**Painting the Steel Work.**

After all the steel work and machinery had been installed, it all had to be painted. It had been painted once, before being sent to the field, but the handling and the weathering made it necessary to repaint it all. Graphite paint was used in doing the work. All the steel was brushed clean of rust and collected dirt before, the paint was applied. Two coats of paint were applied to all the steel and some of it received three coats.
Completing the Station.

All that remained to be done now was to finish up the odd jobs around the station. A cement floor was laid in the hopper pit and drained toward a sump in the corner. The stairways were then all put in. These can be seen in some of the views shown. The runners are made of channels and these carry small angle clips to which the maple treads are bolted. The platforms are of like construction, maple covering on a channel frame. A ladder leads from the top platform to the walkway in the lantern. The discharge gates to the coal bin are operated from this walkway. Another steel ladder descends from the scale house into the hopper pit. All the window frames were painted and the windows put in their respective frames. All surface defects on the building were plastered over and brushed with a cement wash to give a uniform color.

The approach to the station is from the east and has about a 1 o/o grade. The track extends through the station about 200 feet to the west of it. The approach is shown in view No. 7, but when this view was taken the track was yet unballasted.
SUMMARY.

In view No. 10 the station is shown complete, as turned over to the Railroad Company. The brick building in the foreground is a sand house. This house was erected along with the coaling station. The station is equipped with sanding machinery, so that the engine can take sand as it is being coaled.

At a trial run the machinery of the station worked to perfection. Twenty tons of coal were hoisted at this trial run. It is now being used daily and it is thought that this type of station is a decided success.

THE END.