Railway Shop Up To Date

Chapter IV

BLACKSMITH SHOP

LOCATION.

THE location of the blacksmith shop is an essential feature not only as influencing the design and arrangement of the building, and the layout of the tools, hammers, forges, etc., but also as affecting the output of the shop. The nature of the work and the conditions surrounding it, require the building to be in an isolated location in order to provide light and air on all sides. In repair work much material travels from the erecting and assembling shops to the blacksmith shop and back again, especially in locomotive work. A large proportion of the material passing between the locomotive and blacksmith shops is heavy and bulky. For this reason the blacksmith shop should be so situated in relation to the locomotive department as to provide for movement over the shortest and most direct route. Such material is usually transported on push cars and trucks so that distances are important in economizing time and increasing output.

With the increased use of forging machines and the general introduction of time and labor saving devices for rapidly forming parts entering into car construction, a large volume of material is delivered to the car department, especially where the construction of new cars is carried on. This material is principally in small pieces; but includes a large number of the same kind and methods of rapid production must be supplemented by efficient means of quick distribution.

From the standpoint of shop production the blacksmith shop is looked upon as a feeder for the other shops. Of prime importance, then—though sometimes overlooked in preparing original plans—is the provision for feeding the blacksmith shop. The blacksmith shop at the principal shop plant of a large railway system turns out the forgings entering into the construction of new cars, the bulk of the car forgings required in keeping up the repairs of both freight and passenger car equipment on the line, as well as the forgings for locomotive repairs and on some systems a certain amount of switch and frog work, together with other repair work for the road department.

While in one building, it is very common practice to separate the work for the locomotive and car departments and place each under the jurisdiction of an individual foreman. As there is a difference in the nature of the work for the two departments, each occupies a section common to itself and the machines, forges and equipment are arranged accordingly. Naturally the equipment for each department is situated in that portion of the blacksmith shop building nearest to the principal shop which it serves.

LAYOUT.

A ground plan in the shape of an L is a convenient arrangement for the blacksmith shop accessible to both the locomotive and car departments, and such a form has been used in several places as at Angus, Collinwood and Burnside. Large hammers with their furnaces are located in the end of the building nearer the locomotive shop, while the open fires occupy convenient positions, and bolt headers, shears, upsetting and forging machines, etc., are placed to provide for rapid movement of finished material to the car department.

In shops of the ordinary rectangular form, the layout of equipment is arranged on the same principle. For instance at South Louisville, on the Louisville & Nashville Railroad, the blacksmith shop is parallel with and next to the locomotive shop. The yard crane passes one end of the shop and the freight car repair shop is parallel to this end, beyond the yard served by the crane. Here the equipment for car department work is in the end adjacent to the crane runway to provide for rapid intake and delivery, while the heavy hammers, etc., for locomotive work are at the other end of the shop and are accessible from the locomotive shop.

SIZE OF SHOP.

The many conditions affecting the demands upon the blacksmith shop and the difference in the dimensions of the shops on the various railway systems, render it impractical to attempt to give a definite proportion based upon any given unit. The introduction of cast steel in many details for which forgings were formerly used almost entirely, has affected the necessary size of the blacksmith shop so far as the locomotive department is concerned and the increased scope of forging machines, assisted by the extended use of formers and dies for rapidly duplicating standard parts of cars, has increased the possible output of car forgings without enlarging the area required by the shop building.

The dimensions of several prominent shops will in some measure serve as a guide for others where conditions may be expected to be somewhat similar. In this connection it is worthy of note that in several instances the building for the blacksmith shop is partially given over to some other work, in some cases for temporary work or until the enlargement of principal departments increases the demands on the blacksmith shop. At Silvis one end of the blacksmith shop is used as a brass foundry. At Collinwood a brass foundry and a bolt shop are included within the smith shop building. The spring shop frequently occupies a portion of the smith shop, though a small, individual building is sometimes built for this work exclusively.

For both car and locomotive work, the smith shop at Topeka, A. T. & S. F. Ry., is 400 feet by 100 feet, providing an area of 40,000 square feet. At Angus, C. P. Ry., where much freight car building is done in addition to locomotive repairs and the construction of new passenger cars, the area is approximately 84,200 square feet. One wing of the building is 303 feet by 146 feet and the other 303 feet by 130 feet. At Danville, C. & E. I. R. R., the smith shop is 136 feet by 100 feet, an area of 13,600 square feet. At Elizabethport, C. R. R. of N. J., the dimensions are 300 feet by 82 feet, an area of 24,600 square feet. At Silvis, C. R. I. & P. Ry., the building is 465 feet by 99 feet and with 85 feet used as a brass foundry, the area of the smith shop is approximately 33,000 square feet. At Collinwood, L. S. & M. S. Ry., the area of the smith shop proper is approximately 25,000 square feet. While not as large as the shop at Angus, yet greater than the average, the area at South Louisville, L. & N. R. R., is approximately 60,000 square feet. The blacksmith shop at McKee's Rocks, P. & L. E. R. R., contains about 14,000 square feet.

CONSTRUCTION.

The construction of blacksmith shops on different railway systems varies principally in the span of roof trusses between side walls, the design of the roof structure and the form of the roof for the disposition of smoke. The walls are usually of brick, though at Elizabethport the walls are of concrete and at Topeka the ends of the building above the windows are enclosed with corrugated galvanized iron supported by steel framing.

A very general practice has been to span the entire floor without providing intermediate supports for the roof trusses and in a number of cases this distance equals 100 feet. The trusses are usually supported by the side walls which carry the weight of the roof structure and roof. At Topeka the steel skeleton is entirely independent and the roof structure is carried by built up steel columns, to which the walls are secured to provide stability. The roof trusses span a distance of 100 feet.

The elimination of supporting columns and the long span of roof trusses without intermediate supports, allows a free scope in the distribution of equipment on the floor. The method of handling heavy work in the blacksmith shop by means of swinging jib cranes requires freedom of action for the crane arms and the absence of obstructions facilitates the arrangement of these cranes.

The long span of roof trusses together with the requirement of a stiff frame construction to withstand the additional load imposed by supporting the upper ends of the crane columns, calls for heavy parts and careful design of the roof structure. The horizontal loads imposed by the swinging jib cranes, require stiff lateral bracings. Good design to meet these requirements are particularly noticeable at Topeka and Collinwood.

In some shops of recent construction, and at others not yet completed, the shop is divided into three bays, or sections, by two rows of columns supporting the roof structure. Such an arrangement prevails at Angus, South Louisville and Beech Grove (Indianapolis, Big Four). The central bay is narrower than the other two.

DOORS FOR DISTRIBUTION OF MATERIAL.

A very essential feature in the construction of the blacksmith shop, especially where a large amount of work is done for freight car construction, is a provision for a large number of doors in the walls toward the storage yard, in addition to the usual doors for the delivery and distribution of material.

By providing such doors at intervals of a few yards, raw material may be so stored that it will be easily accessible to the several machines through which it will pass in the process of manufacture. Through these doors it will travel over the shortest and most direct route and workmen consume minimum time in securing material for their work.

HEIGHT FROM FLOOR TO ROOF TRUSS.

While the distance from the floor to roof trusses at some of the older shops is about 20 feet, there is a decided tendency to increase this height, noticeable at the prominent shops of recent design and a height of 28 feet has been recommended. The actual dimensions of a number of shops are instructive. At Elizabethport, C. R. R. of N. J., the height of bottom of roof truss above floor of blacksmith shop is 20 feet; at Sedalia, Mo., M. P. Ry., this height is 22 feet; at Collinwood, L. S. & M. S. Ry., 24 feet; at Danville, C. & E. I. R. R., 24 feet; at Silvis, C. R. I. & P. Ry., 25 feet 6 inches; at McKees Rocks, P. & L. E. R. R., 25 feet 9⅜ inches; at Topeka, A. T. & S. F. Ry., 30 feet.

At South Louisville, L. & N. R. R., the bottom line of roof trusses is 35 feet 3 inches above the floor of the central bay, while this distance in the side bays is 20 feet. At Angus, C. P. Ry., this distance is 32 feet and 20 feet in the center and side bays respectively. At Beech Grove the central bay is to have a clear height of 38 feet.

FLOOR.

Almost without exception, the floor of a blacksmith shop is of earth of some kind. This is frequently covered with a coating of cinders well tamped, or with clay.

CRANE SERVICE.

With few exceptions, crane service in blacksmith shops has been confined almost entirely to the use of swinging jib cranes. The impression has prevailed that there is not sufficient service for a traveling crane to justify the cost of its installation and maintenance and the amount of smoke and gas present in some blacksmith shops would make it very uncomfortable for an operator of an overhead crane.

In later years, however, the use of traveling cranes has gained in favor and improved ventilation has rendered it more practical. The entire floor of the blacksmith shop of the Philadelphia & Reading Railroad at Reading, is served by an overhead traveling crane and the central bay of the shop at South Louisville is served by one of 10 tons' capacity. In order that the crane operator may suffer no discomfort from the effect of gases that might accumulate near the roof, the cage for the crane operator at South Louisville is only 10 feet above the floor. The central bay of the smith shop at Beech Grove, Big Four, also is to be served by a traveling crane of 10 tons' capacity.

VENTILATION AND LIGHT.

The ventilation necessary in a blacksmith shop and the amount of natural light needed, require a high, free space not only to allow the smoke and gas to rise away from the floor, and forges but to permit the wide diffusion of light from long windows. It is a very noticeable fact that the cleanest, brightest and most airy blacksmith shops are those with high walls. Without criticism of the appearance of other shops, the condition always to be found in the blacksmith shops of the New York Central at Depew and the P. & L. E. at McKees Rocks, is particularly commendable.

While the roof of the blacksmith shop is usually surmounted by a wide monitor extending nearly the entire length of the roof, this is provided for the sake of ventilation rather than to distribute light. The windows in the walls are depended upon principally for natural light and it is generally considered that the window area should equal at least sixty per cent of the wall area.

In order to offer least obstruction to the free circulation of air throughout the shop in warm weather and in warm climates, when it is desired to have the windows open, it is very common for at least some of the sashes in each window, usually at or near the top, to be hung on pivots. A greater opening is thus provided than by merely raising and lowering the sashes. At South Louisville all sashes of the windows in the side walls are hung on pivots.

At some shops the roof is built with a high pitch and a comparatively narrow monitor, while at others the roof is almost flat with a wide monitor. Where the building is divided into three sections by two rows of columns supporting the roof structure, the roof of the central section is higher than the roofs of the side sections and the higher roof is surmounted by a monitor of ample dimensions. Windows above the roofs of the side sections admit light to the central section and aid in ventilation.

An arrangement frequently followed in the construction of the monitor is to alternate the windows along the sides with spaces having wooden slats built in on an angle, thus permitting the circulation of air while excluding rain or snow. The entire length of both sides of the monitor is sometimes equipped with glass sashes. In some cases all of the sashes are hung on pivots and in others alternate sashes are permanent and those between are pivoted.

HAND FORGES.

Hand forges are usually arranged in a row along the wall, placed conveniently according to the class of work which they serve. The distance between centers of forges varies from 14 to 16 feet and 15 feet is a very common spacing. A spacing of 18 feet between centers of forges has been used successfully for heavy locomotive work, and it is believed that this distance will become more common in shops of the future. In the case of single forges a distance of 5 feet from wall to center line of forges is considered ample, with a free space of about 20 feet from the center line toward the interior of the shop for working room. This gives an area of about 375 square feet per forge.

The arrangement of the forges in the blacksmith shop of the P. & L. E. at McKees Rocks is a good example of the use of double forges. Here, a row of double forges is situated on a center line 15 feet from the wall and each forge is placed at an angle of 54 degrees with this line. They are spaced 15 feet between centers and an area 20 feet wide from the center line of the forges toward the interior of the shop is allowed for working room. Such an arrangement provides a working area of 525 square feet for each double forge or about 262 feet for each fire. In addition to the floor space gained, this arrangement has the further advantage of reducing the number of stacks and holes in the roof by one half, where hoods are used over the forges. Forges are arranged at uniform height, say about 24 inches and are usually of uniform shape and size.

Careful provision for tool racks is a necessary detail not to be overlooked, for while the care and maintenance of tools and equipment is the duty of the energetic foreman, it is within the province of the designer to prepare for maximum output by providing for such seemingly minor details as well as for the larger details.

The removal of smoke and gases from the forges is provided for by different methods. In some shops the air supply and exhaust are carried in underground ducts and placing the forges in groups of four simplifies the arrangement. Individual exhaust connections from the forges lead into a main duct and smoke and gases are discharged by fans through short stacks above the roof.

In other shops each forge is served by the ordinary hood with a stack extending through the roof, or one stack serves two forges placed back to back. It is not uncommon for blast pipes to be carried along the wall with individual leads between the main blast pipe and the several forges. The equipment, then, is all above ground and is accessible at all times.

At still other shops there are no hoods or stacks over the forges and all smoke and gas is expected to pass out of the building through windows in the sides of the monitors and through ventilators above the monitors. The experience at some shops, where great care was used in their design to provide for efficient ventilation, is said to have proved that smoke hoods are unnecessary and that the interior of the building is clear and free from smoke and gas at all times.

FUEL FOR FURNACES.

Oil is the most common fuel used in blacksmith shop furnaces. In later years it has rapidly displaced coal and coke, not only proving more satisfactory and economical as a fuel, but it improves the appearance of the shop by removing the necessity of unsightly coal and coke boxes about the shop. Comparative costs of coal and coke for fuel as against oil depends upon the locality in which the shop is situated. It has been demonstrated by practice that with oil as fuel it is possible to obtain a larger output, better grade of work, greater intensity of heat, as well as a more even heat, to eliminate the necessity of attending to fires, to shorten the time required to bring the furnace to the desired working temperature and to improve the conditions under which furnace men work.

It is worthy of note that at the Altoona and Juniata shops of the Pennsylvania Railroad, the furnaces for heavy work burn gas as fuel and a gas producer plant is operated in connection with the blacksmith department at each of these points.

FURNACE EQUIPMENT.

It is a noticeable fact that in a majority of the new shops particular attention has been paid to the furnace equipment, the design of the various furnaces for the various machines and their location in relation to the machines and movement of material.

No part of the general railroad repair plant has undergone a greater change during the past ten or fifteen years than the blacksmith shop, for the reason that, whereas, a few years ago a majority of the work passing through that shop was done on open fires and a large quantity of the new material was purchased from manufacturing concerns, today, due to the introduction of forging machinery, a majority of the work in the new shop is, or should be machine work.

The output of the machines using heated material being primarily governed by the rapidity with which the material can be furnished has led to careful consideration of the shop furnace proposition. Properly designed oil furnaces occupy approximately 50 per cent less shop space than coal or coke furnaces, and, due to the absence of coal or coke bins, trucking of coal to or ashes from blacksmith shop, permit of almost ideal arrangement of the tools and furnaces, and a good economical movement of raw material to the machines and finished material to storeroom.

In machine blacksmithing it is very important that the material be heated in a nice, soft, reducing heat, as excess scale or oxidation is detrimental to good die work and hard on the dies. Furnaces should be designed to meet the particular requirements of each class of machines, so that the maximum output may be obtained, the operation of the furnaces may be as economical as possible, and as nearly as possible ideal shop conditions for the machine operators prevail.

BLAST.

In connection with furnace equipment and open fires particular attention should be paid to the layout of blast piping. Efficient blast is a very important consideration to the blacksmith shop, as it practically governs the heating capacity not only of the furnaces but of the open fires. Where blast is inefficient, not only are the fires and furnaces poor heaters but combustion is poor owing to the tendency of the men to crowd the fires and furnaces, and poor blast conditions make an expensive proposition generally. A majority of the new shops are furnishing blast to open fires and furnaces at a velocity equal to about 8 or 9 ozs.

In laying out blast lines it is very important that main delivery pipe be of sufficient size not only to supply the required tuyere area, but also to take care of some future extensions. Otherwise it is necessary to resort to the expensive practice of speeding up the fan equipment. Bends in blast piping should be calculated so as to give the least frictional resistance. Several of the new shops have had considerable difficulty due to extreme frictional losses in their blast systems.

ARRANGEMENT OF EQUIPMENT.

Properly grouping machines and equipment minimizes the expense of manufacture and repair by reducing the extent to which it is necessary to handle material. Bolt headers, forging machines, bolt cutters, are grouped near together and the punches and shears are situated conveniently to the headers as well as to the bulldozers and belt hammers. In locating machines care is required in providing ample space not only for working room about the individual machine, but also for tracks to provide for the movement and delivery of material.

The classes of work done in the blacksmith shop require the use of steam hammers varying in size from 800 pounds to 6,000 pounds. The equipment to serve each hammer depends on the class of work to which it is devoted and the extent to which it can be kept in continual service. In some instances a single large furnace will keep one heavy hammer busy almost continually. In others one steam hammer will serve two large forges and for some classes of work, one hammer will serve six forges.

The extent to which oil furnaces are used in blacksmith shops, allows many machines to be served by individual furnaces. The furnace and the machine are so close together that material is handled rapidly and in large quantity. By placing the machine and furnace near a door providing entrance from the storage yard material for a given class of work will be piled adjacent to the machine through which it passes and delivery from the yard is simplified. This provision is supplemented by convenient crane and track service. For instance, each bulldozer and the oil furnace adjacent to it are usually served by a swinging jib crane, so arranged as to cover the machine, furnace and an adjacent track.

Where a large amount of work of certain classes is to be done, provision for rapid movement and minimum handling reduces the cost of operation and increases the output. For instance, take the manufacture of truss rods. By placing two sets of machines of the same type in proper locations, rods may be passed from furnace to machines in such manner that both ends of the same rod are heated, upset and threaded without reversing the rod, opposite ends being worked in different furnaces and machines.

METHODS OF OPERATION.

The design, arrangement and layout of the shop are so dependent upon the class and amount of work to be turned out that it is interesting to study some of the methods introduced for rapid delivery in large bulk.

In ordering raw material for new rolling stock it is the practice of some shops to order iron cut to lengths for the various purposes required. For instance, in ordering arch bar iron, instead of calling for standard bars, the iron is ordered in pieces of required length. Such practice eliminates waste and the expense of frequent handling and allows material of a given class to be directly unloaded and piled together in locations convenient to the various machines, and advances the interest of contract workers, but it increases the difficulty of checking deliveries.

At one large railway shop where twenty-eight or thirty new box cars are built per day, in addition to the passenger car and locomotive work, such large quantities of material are delivered that a system has been developed for checking the intake and output of the shop for certain orders by determining the amount of material used in each car and recording the iron used by a count of the cars built each day. The record of all material received is then checked according to the tally of material entering into the construction of the car.

To illustrate the magnitude of the problem in checking the intake of a blacksmith shop operated on a large scale and to give some idea of the large volume of iron to be delivered for car construction work alone, attention is called to the fact that in a thirty-ton box car there are about 5,600 pounds of wrought iron and mild steel and about 23,000 pounds in a standard coach or diner.

Some of the smaller pieces made in the blacksmith shop, such as nuts, bolts, etc., require so much handling during the process of manufacture, that unless transferred in bulk the cost of handling equals or exceeds the cost of forging. The necessity of cheap and rapid movement has developed methods whereby the pieces are not allowed to touch the floor. This includes the use of specially designed boxes, in some cases mounted on wheels, so that in passing through the several machines material passes from one box or wagon to another and all deliveries are made in bulk.

List of Equipment in Representative Railway Blacksmith Shops

A., T. & S. F. RY.—TOPEKA.

Machine.	Size.	Maker.
4 Steam generating furnaces	90 h. p.	A., T. & S. F. Ry.
1 large furnace	No. 3	A., T. & S. F. Ry.
3 Spring furnaces		A., T. & S. F. Ry.
2 Band furnaces		A. T. & S. F. Ry.
6 Miscellaneous furnaces	Small	A., T. & S. F. Ry.
2 Feed water pumps	No. 8	Knowles
2 Double frame steam hammers	5,000 lbs.	Chambersburg Eng. Co.
1 Double frame steam hammer	4,000 lbs.	Niles, Bement, Pond Co.
1 Single frame steam hammer	2,500 lbs.	Niles, Bement, Pond Co.
1 Single frame steam hammer	1,500 lbs.	Niles, Bement, Pond Co.
1 Single frame steam hammer	1,100 lbs.	Niles, Bement, Pond Co.
1 Single frame steam hammer	1,100 lbs.	Morgan
2 Single frame steam hammers	250 lbs.	Morgan
1 Single frame steam hammer	150 lbs.	Morgan
2 Single frame steam hammers	250 lbs.	Bement
1 Single frame steam hammer	850 lbs.	Bement
1 Single frame pneu. hammer		A., T. & S. F. Ry.
1 Forging machine	4 ins.	Ajax Manufacturing Co.
1 Bulldozer	Large	Williams, White & Co.
2 Bulldozers	Small	A., T. & S. F. Ry.
3 Bolt headers	1½ in.	Oliver
1 Bolt header	2½ ins.	Ajax Manufacturing Co.
1 Bolt header	¾ in.	Burdick
1 Bolt header	2 ins.	National
1 Motor-driven punch and shear	2½ ins.	Williams, White & Co.
1 Steam punch and shear	3 ins.	Hercules Iron Works
1 Washer punch	13-in. throat	
1 Punch and shear	¾ in.	Colton
1 Spring punch and shear		John Evans' Sons
1 Taper rolls		John Evans' Sons
1 Eye bolt machine		Williams, White & Co.
1 Brake lever rolls		Ajax Manufacturing Co.
1 Arch bar drill	6 spindle	Niles-Bement-Pond Co.
1 Heavy grinder (double)	24 ins.	A., T. & S. F. Ry.
1 Emery grinder	24 ins.	A., T. & S. F. Ry.
1 Band press		Tinnis, Oleson & Co.
1 Nibber and trimmer		John Evans' Sons
1 Spring tester		Riehle
1 Case hardening furnace		A., T. & S. F. Ry.
1 Annealing furnace		A., T. & S. F. Ry.
1 Pressure blower	No. 10	B. F. Sturtevant & Co.
1 Pressure blower	No. 9	B. F. Sturtevant & Co.
1 Pressure blower	No. 8	B. F. Sturtevant & Co.
40 Smith fires		

B. R. & P. RY.—DU BOIS.

Machine.	Size.	Maker.
1 Double frame steam hammer	3,000 lbs.	Niles-Bement-Pond Co.
1 Single frame steam hammer	800 lbs.	Niles-Bement-Pond Co.
1 Dead stroke hammer	50 lbs.	Scranton & Co.
1 Comb. power cutting-off saw	No. 2	Newton Machine Tool Wks.
1 Flue cleaner		Otto
1 Flue-welding machine		Hartz
1 Flue-welding furnace		Railway Materials Co.
1 Pair flanging clamps, air operated	12 ft.	
1 Pair flanging clamps, hand operated	9 ft.	
1 Spring forming machine		
2 Tube rolling and cutting out machines		Acme Machinery Co.
1 Band saw	48 ins.	Clement
1 Heavy pattern single spindle radial vertical right-hand boring machine	No. 6B	Greenlee Bros. & Co.

CANADIAN PACIFIC RAILWAY—ANGUS.

Machine.	Size.	Maker.	Motor H.P.
Hammer	2,000 lbs.	Niles-Bement-Pond Co.	
Hammer	6,000 lbs.	Niles-Bement-Pond Co.	
Hammer	3,500 lbs.	Davy Bros.	
Hammer	1,200 lbs.	Davy Bros.	
Hammer	3,000 lbs.	Niles-Bement-Pond Co.	
Hammer	1,200 lbs.	Davy Bros.	
Hammer	1,500 lbs.	Niles-Bement-Pond Co.	
Upsetting machine	5 ins.	Ajax Manufacturing Co	15
Hammer	600 lbs.	Davy Bros.	
Hammer	400 lbs.	J. Bertram & Sons Co	
Hammer	600 lbs.	Davy Bros.	
Hammer	250 lbs.	Niles-Bement-Pond Co.	
Hammer	250 lbs.	Niles-Bement-Pond Co.	10
Punch and shears		J. Bertram & Sons Co	10
Beaudry hammer		Beaudry Manufacturing Co	3
Flat iron saw		C. P. R.	5
Spring rolls		Craven Bros.	5
Spring taper machine		Craven Bros.	5
Hammer	200 lbs.	C. C. Bradley & Son	5
Hammer	100 lbs.	C. C. Bradley & Son	3
Hammer	100 lbs.	C. C. Bradley & Son	3
Hammer	100 lbs.	C. C. Bradley & Son	3
Eye bolt machine		Williams, White & Co	3
Bolt header	1½ in.	National Machine Co	5
Eye bolt machine		Williams, White & Co	3
Forging machine	2 ins.	Ajax Manufacturing Co	10
Rivet Machine	1½ in.	Ajax Manufacturing Co	5
Forging machine		Ajax Manufacturing Co	5
Single shears		J. Bertram & Co	3
Upsetting machine	2 ins.	Ajax Manufacturing Co	10
Bolt cutter	2 ins.	J. Bertram & Co	3
Upsetting machine	3 ins.	Ajax Manufacturing Co	10
Bolt cutter	2 ins.	J. Bertram & Co	3
Nut burring	2 ins.	Ajax Manufacturing Co	3
Forging machine	3 ins.	Ajax Manufacturing Co	10
Nut burring machine	1½ in.	Ajax Manufacturing Co	3
Nut machine	1½ in.	National Machine Co	10
Nut burring machine		Ajax Manufacturing Co	3
Nut machine	⅝ in.	National Machine Co	5
Bolt header	1½ in.	National Machine Co	5
Round iron shears		J. Bertram & Co	3
Round iron shears		J. Bertram & Co	3
Bolt header	1½ in.	National Machine Co	5
Round iron shears		J. Bertram & Co	3
Bolt header	2 ins.	National Machine Co	5
Bulldozer	No. 6	Williams, White & Co	15
Bulldozer	No. 5	Williams, White & Co	10
Bulldozer	No. 6	Williams, White & Co	15
Bulldozer	No. 4	Williams, White & Co	10
Bulldozer	No. 5	Williams, White & Co	10
Bulldozer	No. 4	Williams, White & Co	10
Punch and shears		J. Bertram & Co	10
Hammer	2,000 lbs.	J. Bertram & Co	
Hammer	1,200 lbs.	J. Bertram & Co	
Hammer	2,000 lbs.	Niles-Bement-Pond Co.	
Punch and shears		J. Bertram & Co	15
Punch and shears		J. Bertram & Co	10
Bulldozer	No. 4	Williams, White & Co	10
Punch and shears		J. Bertram & Co	15
Hammer	600 lbs.	Davy Bros.	
Bolt header	1½ in.	National Machine Co	5
Fire brick crusher		C. P. R.	
Hyd. Buckles press		C. P. R.	
Hammer	4,400 lbs.	Niles-Bement-Pond Co.	
Hammer	2,000 lbs.	Niles-Bement-Pond Co.	
Upsetting machine	2 ins.	Ajax Manufacturing Co	
Eyebolt machine		Ajax Manufacturing Co	
Beaudry hammer	350 lbs.	Beaudry Manufacturing Co	5
Hammer	200 lbs.		
Brake key rolls			

LIST OF FURNACES AT ANGUS, C. P. RY.

Extra large forging furnace, 6 ft. 6 ins. deep x 18 ft. long, with two doors, for 6,000-lb. hammer.

Large forging furnace, 5 ft. deep x 7 ft. long, with two doors for 3,500-lb. hammer.
Case-hardening furnace, 5 ft. x 7 ft., standard design, clear opening in front.
Large forging furnace, 5 ft. deep x 7 ft. long, with two doors, for 3,000-lb. hammer.
Large forging furnace, 4 ft. 2 ins. deep x 36 ins. long, with one door for 1,500-lb. hammer.
Small forging furnace for upsetting machine.
No. 2 forging furnace for Beaudry hammer.
No. 2 forging furnace for Beaudry hammer.
Small forging furnace for brake key rolls.
Spring bending furnace, 28 ins. wide x 31 ins. deep, with one door, for buckle press.
Spring tempering furnace, 15 ft. 6 ins. long x 5 ft. wide, furnished with eight doors, arranged four on each side, for four fitters and four helpers.
Spring tempering and nibbing furnace, for spring rolls.
No. 2 forging furnace for Bradley hammer.
No. 2 forging furnace for Bradley hammer.
No. 2 forging furnace for Bradley hammer.
No. 2 forging furnace for Bradley hammer.
Small forging furnace, bricked up, for bolt header.
Small forging furnace, bricked up, for eye-bolt machine.
Small forging furnace, bricked up, for bolt header.
Small forging furnace, bricked up, for eye-bolt machine.
Forging machine, 5 ft. deep x 28 ins. wide, with one door for continuous rivet-making machine.
Small forging furnace, bricked up, for forging machine.
No. 2 forging furnace for 2-in. upsetting machines.
No. 2 forging furnace for 3-in. upsetting machine.
Forging furnace, 31 ins. deep x 28 ins. wide, with one door for nut machine.
Forging furnace, 5 ft. deep, 28 ins. wide with one door, for nut machine.
Forging furnace, 5 ft. deep, 28 ins. wide with one door, for nut machine.
Small forging furnace, bricked up, for bolt header.
Small forging furnace, bricked up, for bolt header.
Small forging furnace, bricked up, for bolt header.
Double bulldozer furnace, with two furnaces for heating material, each 8 ft. 11 ins. long x 36 ins. wide, with one door for 15 h. p. bulldozer.
Double bulldozer furnace, with two furnaces for heating material, each 8 ft. 11 ins. long x 36 ins. wide, with one door for 20 h. p. bulldozer.
Double bulldozer furnace, with two furnaces for heating material, each 8 ft. 11 ins. long x 36 ins. wide, with one door for 15 h. p. bulldozer.
Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 15 h. p. bulldozer.
Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 10 h. p. bulldozer.
Large forging furnace, 4 ft. 2 ins. deep x 36 ins. long, with one door for 2,000-lb. hammer.
Large forging furnace, 5 ft. deep x 7 ft. long, with two doors for 2,000-lb. hammer.
Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 10 h. p. bulldozer.
Furnaces in this list provided by Railway Materials Co.

C., R. I. & P. RY.—SILVIS.

Machine.	Size.	Maker.
Hydraulic bar shears	2-ft. round	Niles-Bement, Pond Co.
Double stay-bolt cutter	1½-ins.	Acme Machinery Co.
Bolt pointer		Acme Machinery Co.
Forging machine	No. 3	Ajax Manufacturing Co.
Long-stroke hammer	1,600 lbs.	Chambersburg Engr. Co.
Single-stand hammer	1,500 lbs.	Chambersburg Engr. Co.
Single-stand hammer	1,500 lbs.	Chambersburg Engr. Co.
Hydraulic bar shears	1¼ by 12	Niles, Bement, Pond Co.
Hydraulic punch and shear	20-ins.	Niles, Bement, Pond Co.
Bolt header	1½ ins.	Ajax Manufacturing Co.
Cold saw		Hegley-Cambria
Double-stand steam hammer	5,000	
Single-stand steam hammer	1,100	
Single-stand steam hammer	1,000	
2 Double staybolt cutters	1½ in.	
Hammer riveter, pneumatic	84 in. reach	John F. Allen
Portable mud ring riveter, pneumatic		Pedrick & Ayer
Portable riveter		Pedrick & Ayer
Arch bar drill	Six spindle	
Cushioned hammers	200 lbs.	C. C. Bradley & Son
2 Bolt headers	1-in.	Ajax Manufacturing Co.

L. S. & M. S. RY.—COLLINWOOD.

Machine.	Size.	Maker.	Motor H. P.
Volume Blower	No. 11	Buffalo Forge Co.	50
Steel Plate Exhauster	110 ins.	Buffalo Forge Co.	
Bolt Header	1½ ins.	Acme Machinery Co.	
Bolt Header	1½ ins.	Acme Machinery Co.	20
Forging Machine	2½ ins.	Ajax Machinery Co.	
Bolt Header	1½ ins.	Acme Machinery Co.	
Triple Head Bolt Cutter	2 ins.	Acme Machinery Co.	
Triple Head Bolt Cutter	1½ ins.	Acme Machinery Co.	
Triple Head Bolt Cutter	1½ ins.	Acme Machinery Co.	15
Double Head Bolt Cutter	2½ ins.	Acme Machinery Co.	
Nut Tapper	6-spindle	Acme Machinery Co.	
Nut Tapper	6-spindle	Acme Machinery Co.	
Large Tapering Rolls		John Evans' Sons	
Combined Nipper and Trimmer Machine		John Evans' Sons	15
Combined Punch and Shear		John Evans' Sons	

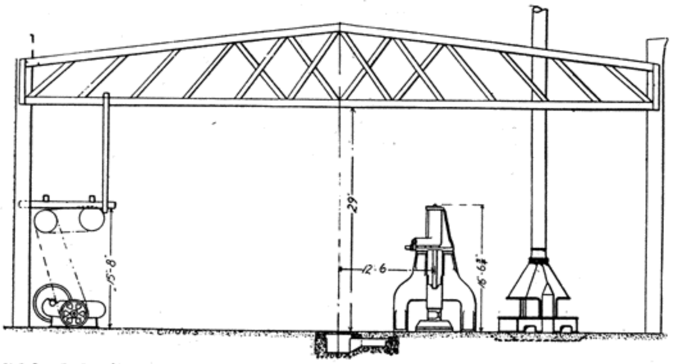
Compact Hammer	200 lbs.	C. C. Bradley & Son	
Compact Hammer	200 lbs.	C. C. Bradley & Son	
Compact Hammer	200 lbs.	C. C. Bradley & Son	20
Compact Hammer	200 lbs.	C. C. Bradley & Son	
Compact Hammer	50 lbs.	C. C. Bradley & Son	

L. & N. R. R.—SOUTH LOUISVILLE.

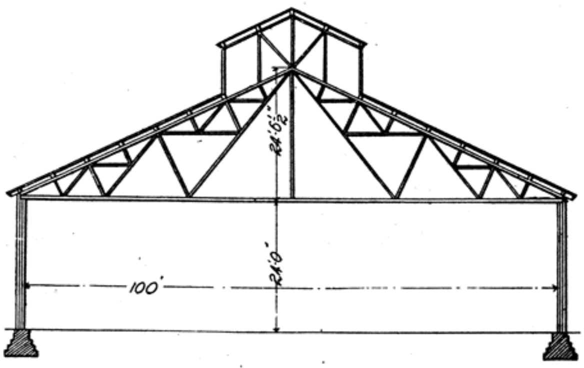
Machine.	Size.	Maker.
1 Steam Hammer	6,000 lbs.	Chambersburg Engr. Co.
1 Steam Hammer	4,500 lbs.	Niles-Bement-Pond Co.
1 Steam Hammer	3,500 lbs.	Chambersburg Engr. Co.
1 Steam Hammer	2,500 lbs.	Niles-Bement-Pond Co.
2 Steam Hammers	1,500 lbs.	Niles-Bement-Pond Co.
1 Steam Hammer	1,000 lbs.	William Sellers & Co.
4 Hammers	200 lbs.	C. C. Bradley & Son
1 No. 9 Forging Machine		Ajax Manufacturing Co.
1 Forging Machine	4 ins.	Ajax Manufacturing Co.
1 Forging Machine	2 ins.	Ajax Manufacturing Co.
1 Forging Machine	1½ ins.	Ajax Manufacturing Co.
2 Forging Machines	1 in.	Ajax Manufacturing Co.
2 Forging Machines	1 in.	Oliver
3 Compressed Air Bulldozers	18 ins.	L. & N. R. R.
1 Compressed Air Bulldozer	10 ins.	L. & N. R. R.
1 Eye Bolt Header		Williams, White & Co.
1 Combination Punch and Shear	Punch reach 27 ins. Shear, 28 ins.	Niles-Bement-Pond Co.
1 No. 5 Punch	15 ins. reach	Hilles & Jones
1 Shear and Trimmer	24 ins. reach	William Sellers & Co.
2 Round Iron Shears		Niles-Bement-Pond Co.
3 Drill Presses	34 ins.	Harrington & Son
1 Drill Press	36 ins.	Niles-Bement-Pond Co.
1 Drill Press	30 ins.	Putnam Machine Co.
1 Drill Press	30 ins.	David W. Pond Co.
1 Drill Press	36 ins.	Aurora Tool Works
1 Drill	4 spindle	W. F. & J. Barnes Co.
3 Threading Machines	1½ ins., 2 spindles	Acme Mach. Co.
1 Threading Machine	2 ins., 2 spindles	Acme Mach. Co.
1 Threading Machine	1½ ins., 4 spindles	Acme Mach. Co.
1 Threading Machine	2 ins., 3 spindles	Acme Mach. Co.
1 Nut Tapper	2 ins., 6 spindles	Acme Mach. Co.
1 Nut Tapper	1½ ins., 6 spindles	Acme Mach. Co.
1 Nut Tapper	¾ in., 2 spindles	
1 Nut Tapper	1 in., 6 spindles	Acme Mach. Co.
1 Nut Tapper	2 ins., 4 spindles	
1 Nut Tapper	7-8 in., 6 spindles	Niles-Bement-Pond Co.
4 No. 1 Heating Furnaces		Railway Materials Co.
9 No. 2 Heating Furnaces		Railway Materials Co.
5 Box Furnaces		Railway Materials Co.
Case Hardening Furnace		Railway Materials Co.
Axle Furnace		Railway Materials Co.
Emery Grinder		L. & N. R. R.

PENNSYLVANIA RAILROAD—OLEAN.

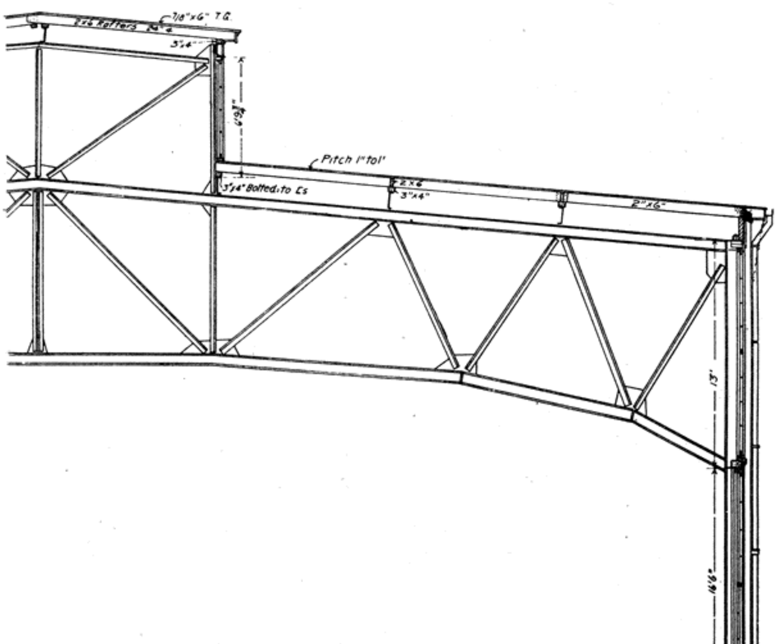
Machine.	Size.	Maker.	Motor H. P.
Tempering Furnace			
Single Frame Steam Hammer	250 lbs.	Chambersburg	
2 Single Frame Steam Hammers	2,000 lbs.	Chambersburg	
Double Frame Steam Hammer	4,000 lbs.	Chambersburg	
Frame Fire			
Scrap Furnace			
Case Hardening Furnace			
Flue Tester			
Flue Heating Furnace		Railway Materials Co.	
Flue Cutting Off Machine	(Indiv. Drive, 1-H. P. motor).		
Spring Heating Furnace			
Spring Annealing Furnace			
Spring Band Heating Furnace			
Hydraulic Spring Unbanding Press			
Hydraulic Spring Banding Press			
Flue Welding Furnace		Railway Materials Co.	
Flue Welding Machine			
Flue Cutting Off Machine			
Spring Cambering Machine			20
Rolls, Shears and Nibbing Machine			
Punch and Shears			
Heating Furnace			
Spring Testing Machine	50,000 lbs. capacity	Riehle	
Shears		Hilles & Jones	
Upsetting and Forging Machine	2½ ins.	Acme	
Upsetting Machine	1½ ins.	Ajax	
Triple Head Bolt Cutter	2 ins.	Landis	25
Bolt Cutter	2 spin. 3 in.	Acme	
Bolt Cutter	2 spin. 2 in.	Acme	
Bolt Cutter	2 spin. 1½in.	Acme	



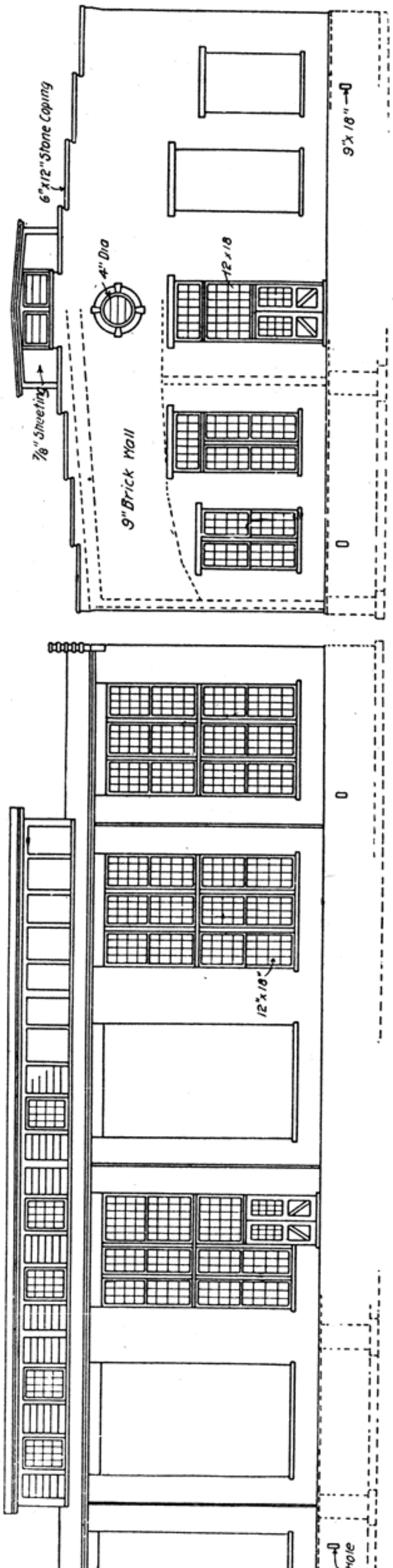
CROSS SECTION OF BLACKSMITH SHOP AT OLEAN, P. R. R.



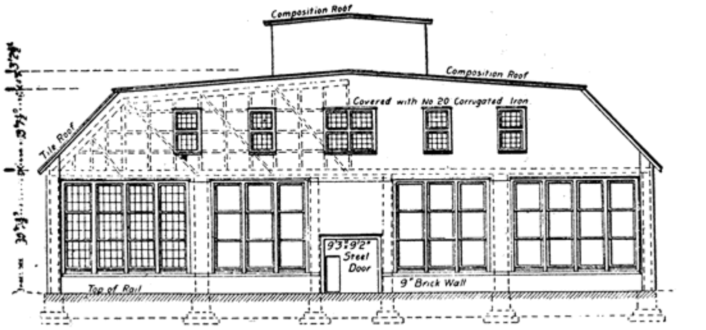
CROSS SECTION OF BLACKSMITH SHOP AT DANVILLE, ILL., C. & E. I. R. R.



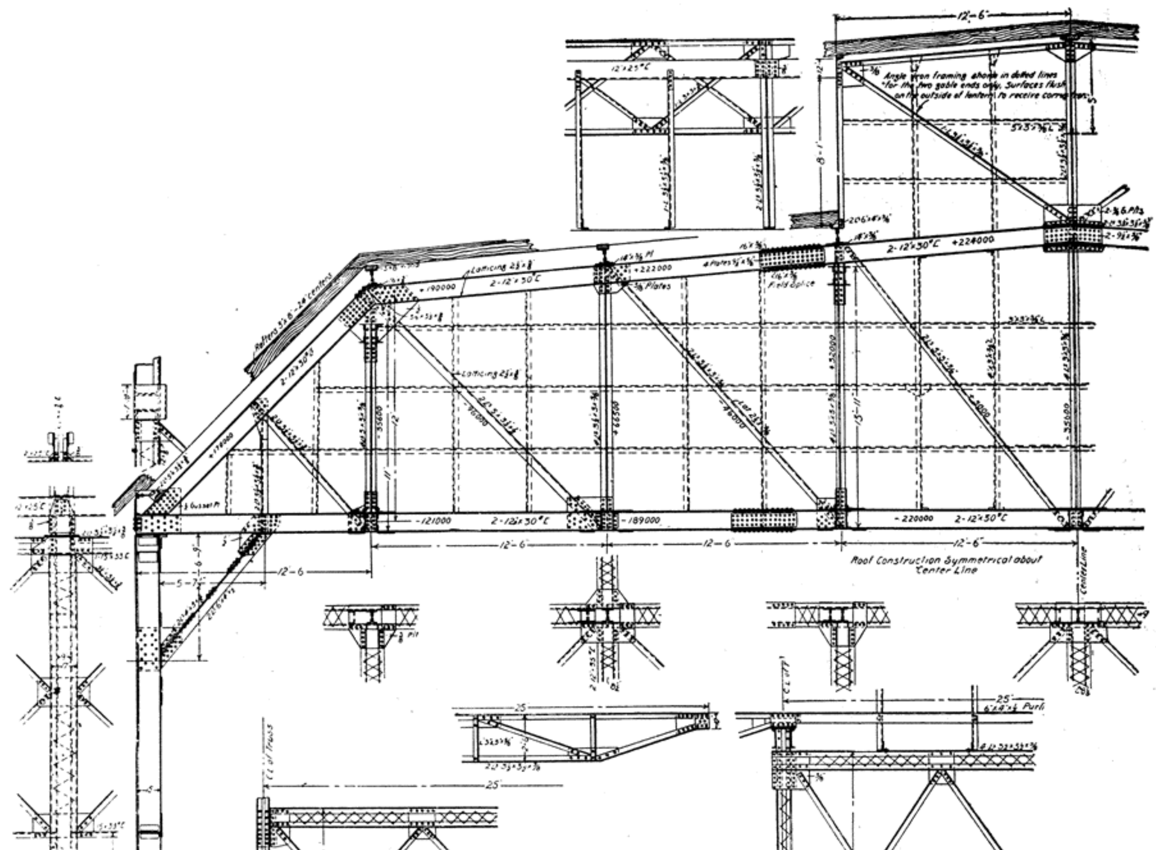
CROSS SECTION OF BLACKSMITH SHOP AT LA JUNTA, COL., A. T. & S. F. RY.



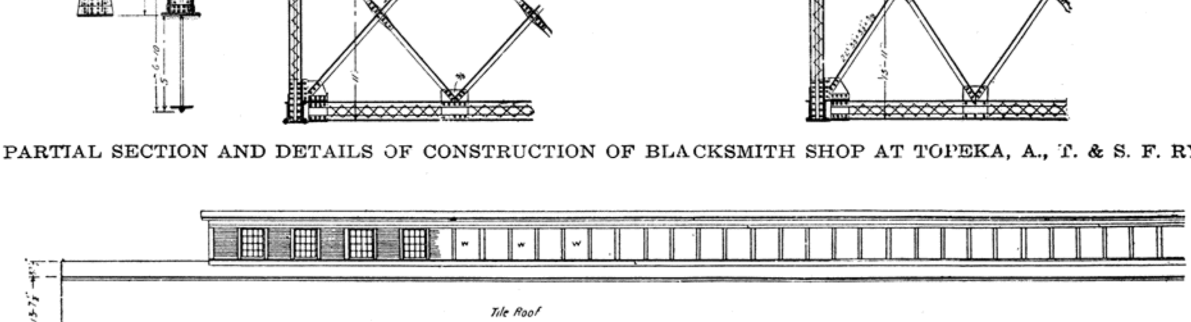
ELEVATION OF BLACKSMITH SHOP AT LA JUNTA, COL., A., T. & S. F. RY.



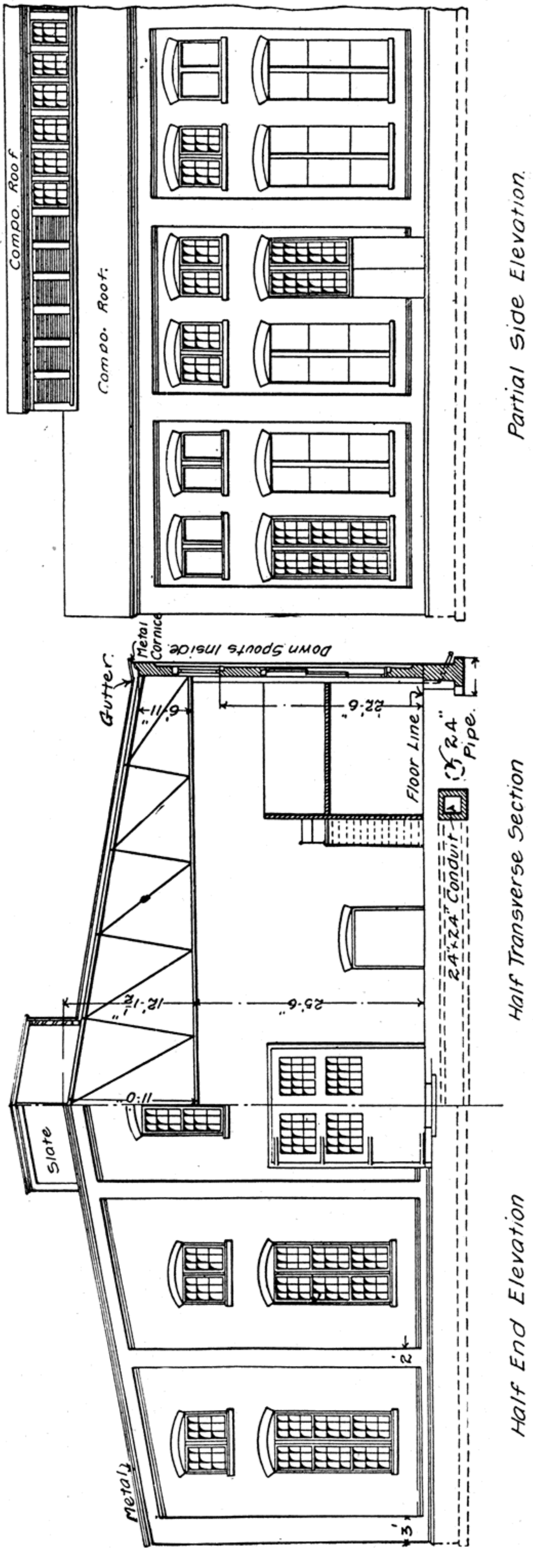
END ELEVATION OF BLACKSMITH SHOP AT TOPEKA, A. T. & S. F. RY.



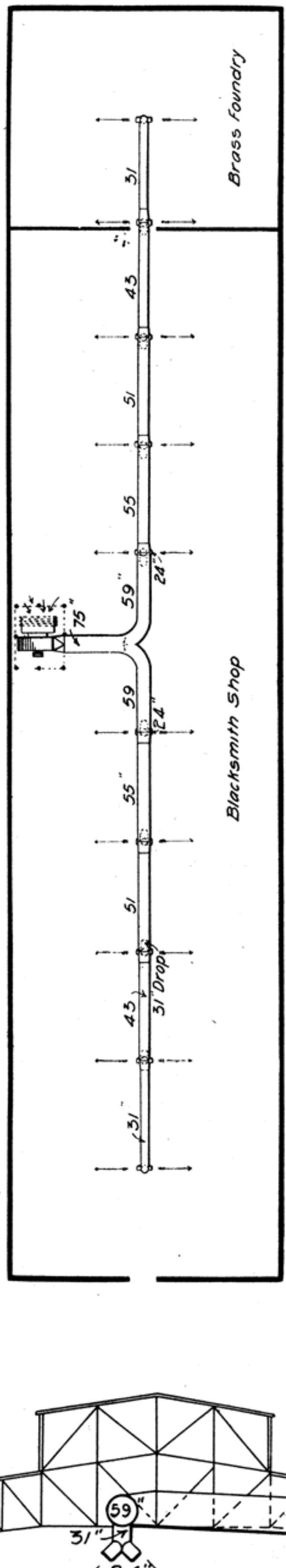
PARTIAL SECTION AND DETAILS OF CONSTRUCTION OF BLACKSMITH SHOP AT TOPEKA, A., T. & S. F. RY.



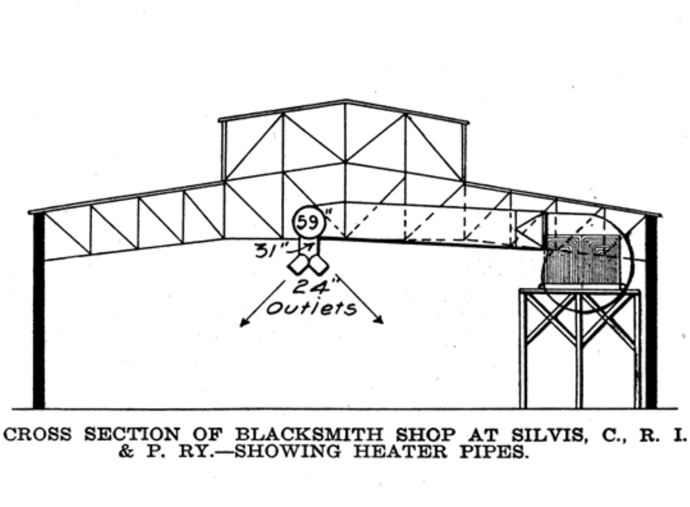
HALF SIDE ELEVATION OF BLACKSMITH SHOP AT TOPEKA, A., T. & S. F. RY.



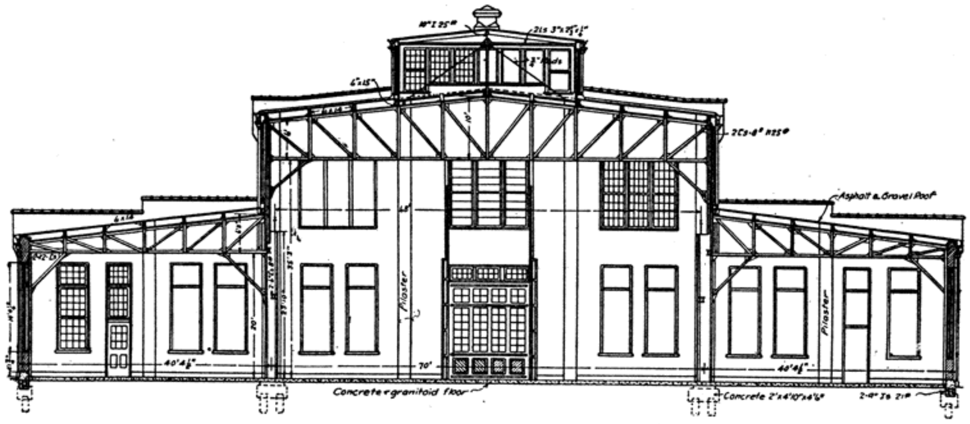
PARTIAL ELEVATION AND SECTION OF BLACKSMITH SHOP AT SILVIS, C., R. I. & P. RY.



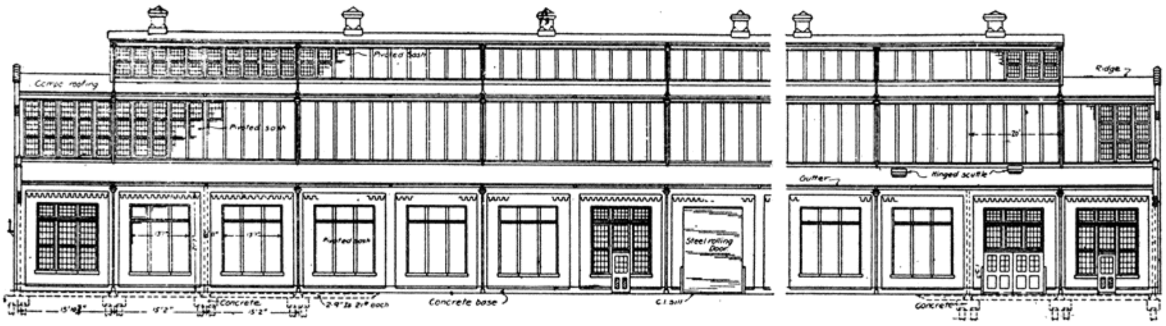
PLAN OF HEATING SYSTEM IN BLACKSMITH SHOP AT SILVIS, C., R. I. & P. RY.



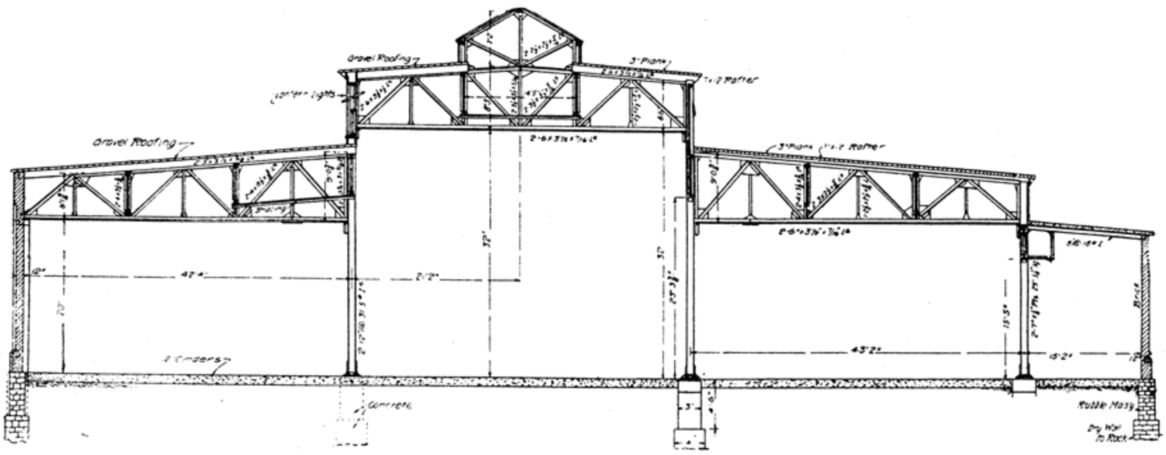
CROSS SECTION OF BLACKSMITH SHOP AT SILVIS, C., R. I. & P. RY.—SHOWING HEATER PIPES.



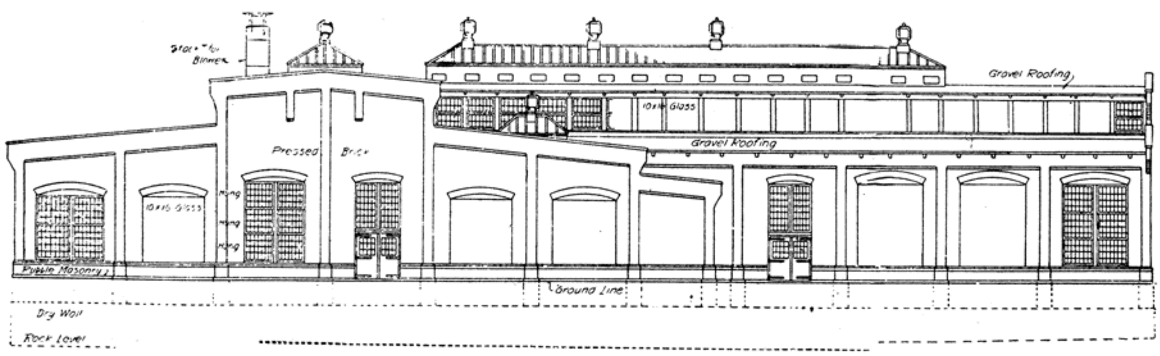
CROSS SECTION OF BLACKSMITH SHOP AT SOUTH LOUISVILLE, L. & N. R. R.



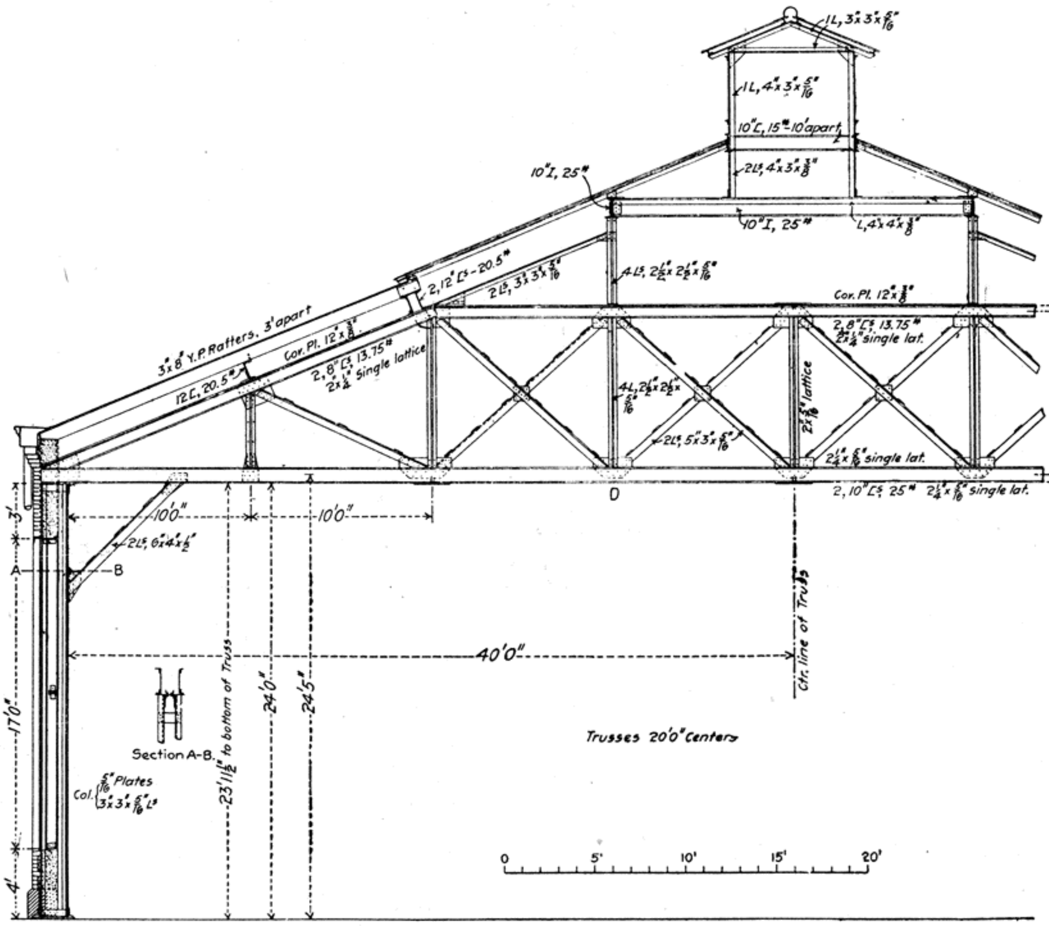
SIDE ELEVATION OF BLACKSMITH SHOP AT SOUTH LOUISVILLE, L. & N. R. R.



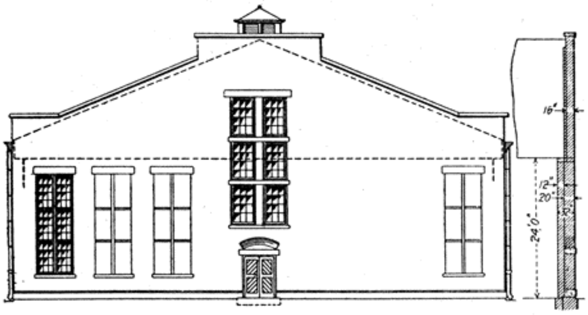
CROSS SECTION OF BLACKSMITH SHOP AT ANGUS, C. P. RY.



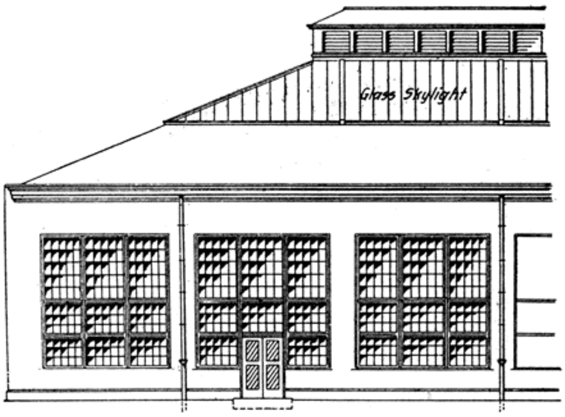
ELEVATION OF BLACKSMITH SHOP AT ANGUS, C. P. RY.



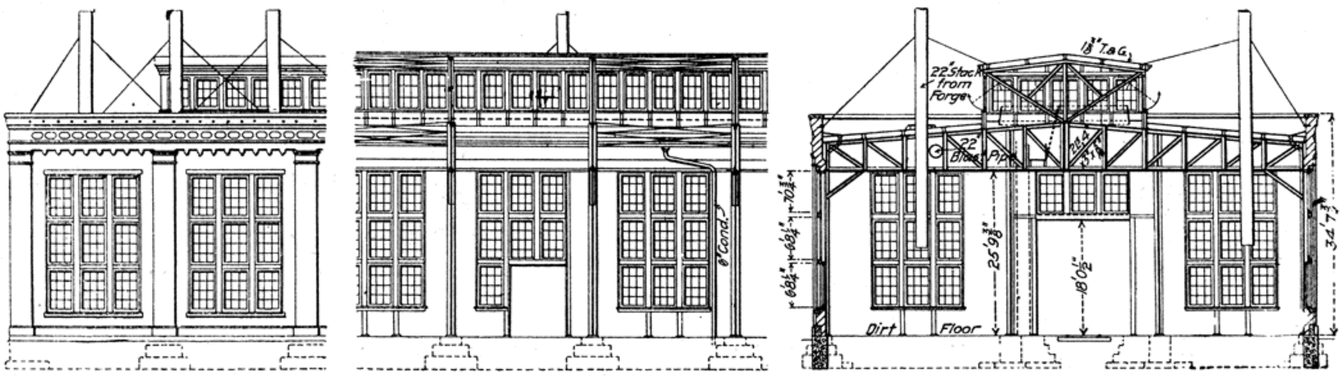
CROSS SECTION OF BLACKSMITH SHOP AT COLLINWOOD, L. S. & M. S. RY.



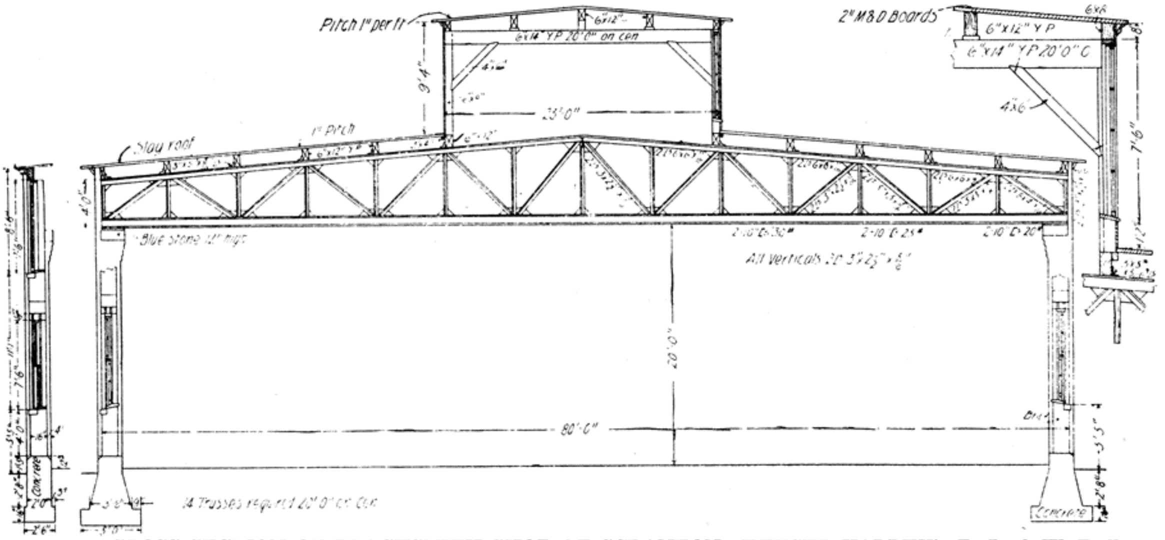
END ELEVATION OF BLACKSMITH SHOP AT COLLINWOOD, L. S. & M. S. RY.



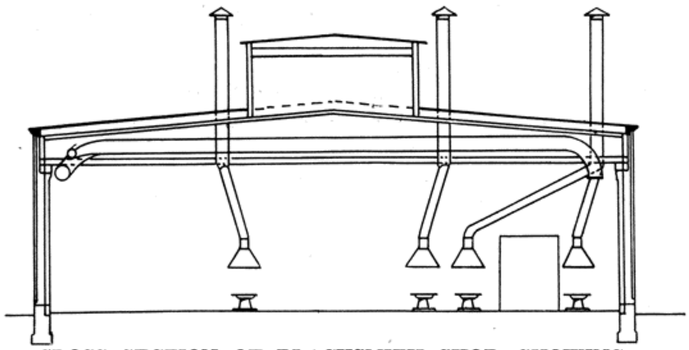
SIDE ELEVATION OF BLACKSMITH SHOP AT COLLINWOOD, L. S. & M. S. RY.



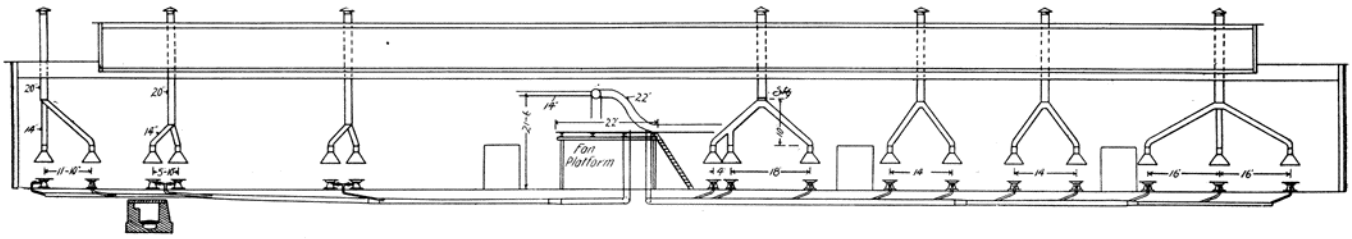
PARTIAL ELEVATIONS AND SECTIONS OF BLACKSMITH SHOP AT M'KEES ROCKS, P. & L. E. R. R.



CROSS SECTION OF BLACKSMITH SHOP AT SCRANTON (KEYSER VALLEY), D. L. & W. R. R.

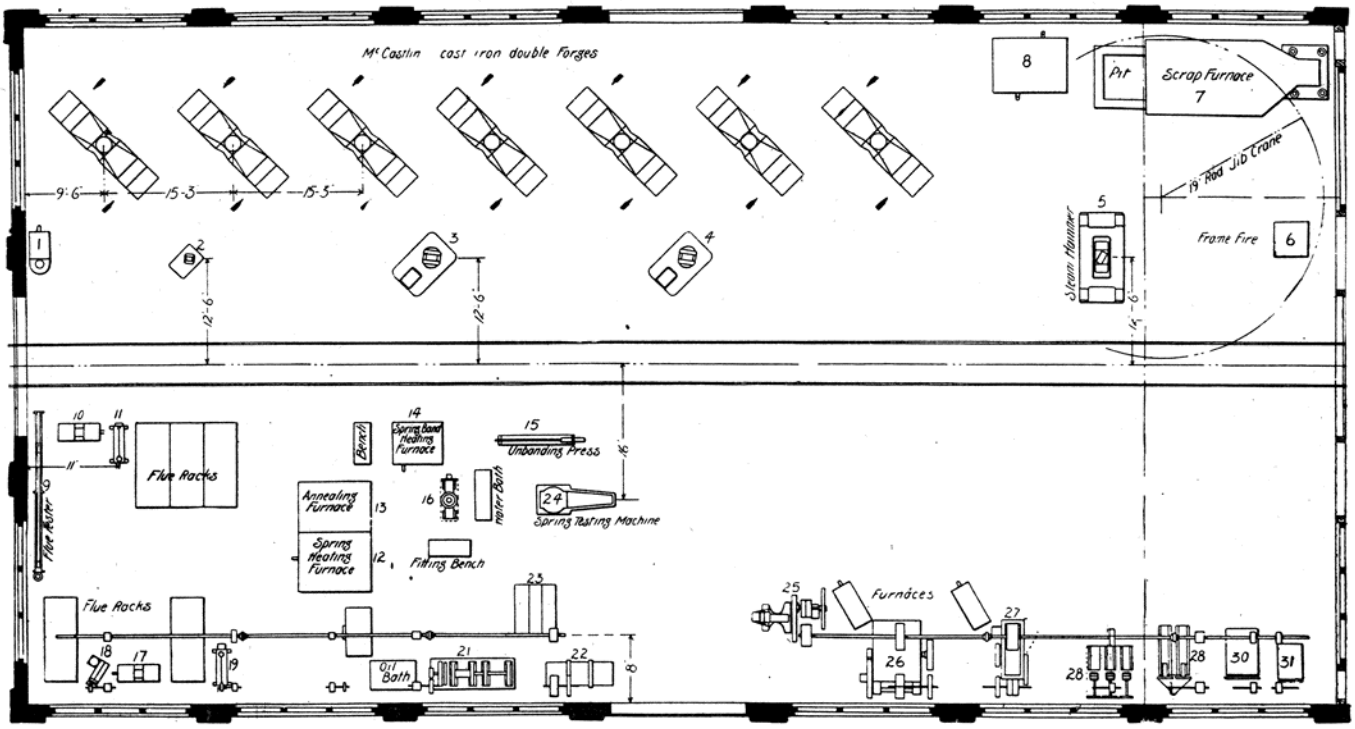


CROSS SECTION OF BLACKSMITH SHOP, SHOWING ARRANGEMENT OF EXHAUST PIPES AND HOODS AT SCRANTON, D., L. & W. R. R.

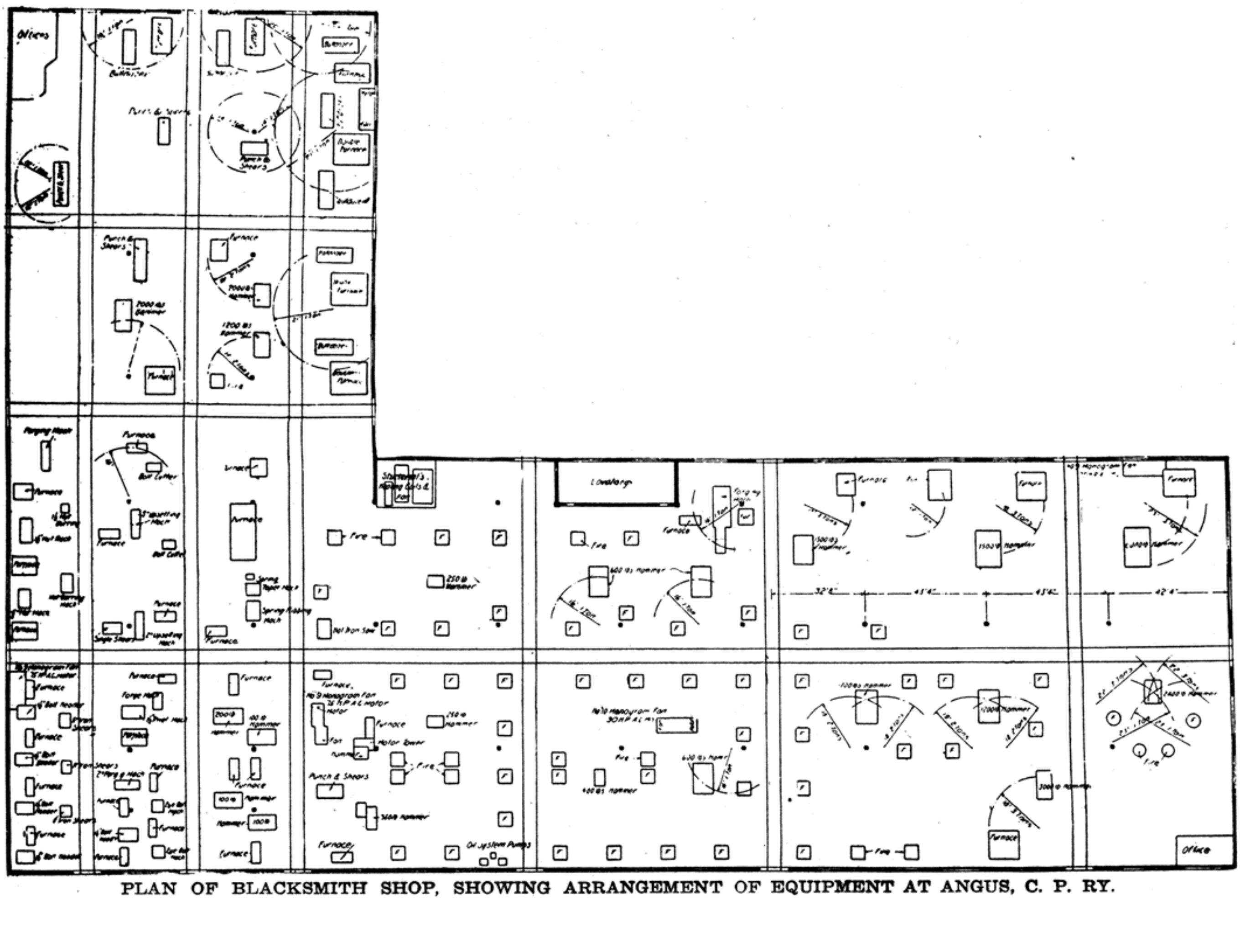


LONGITUDINAL SECTION OF BLACKSMITH SHOP, SHOWING ARRANGEMENT OF EXHAUST PIPES AND HOODS AT SCRANTON, D., L. & W. R. R.

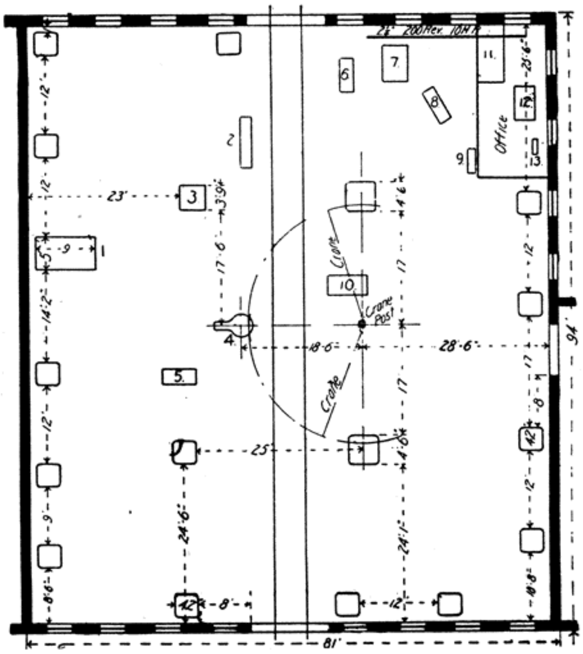
END AND SIDE ELEVATION OF THE BLACKSMITH SHOP



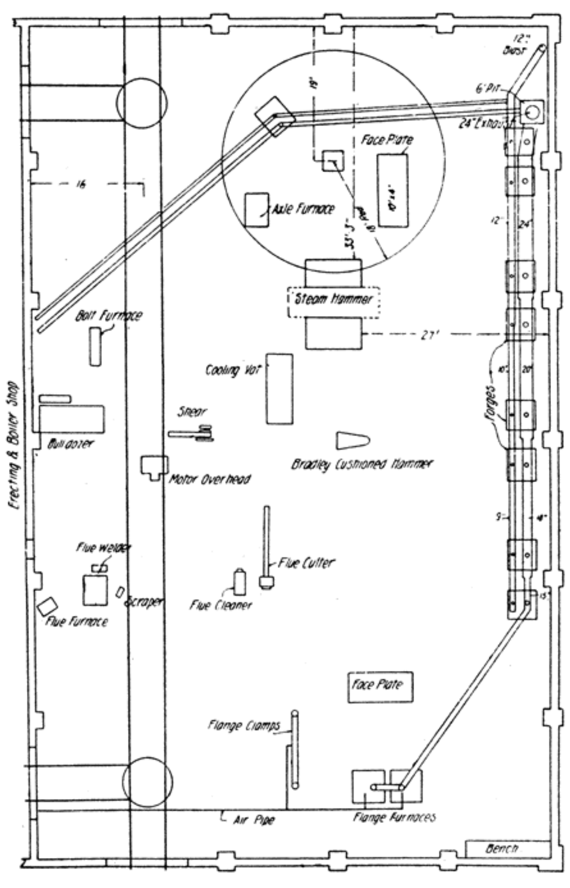
PLAN OF BLACKSMITH SHOP, SHOWING ARRANGEMENT OF EQUIPMENT AT OLEAN, N. Y., P. R. R.



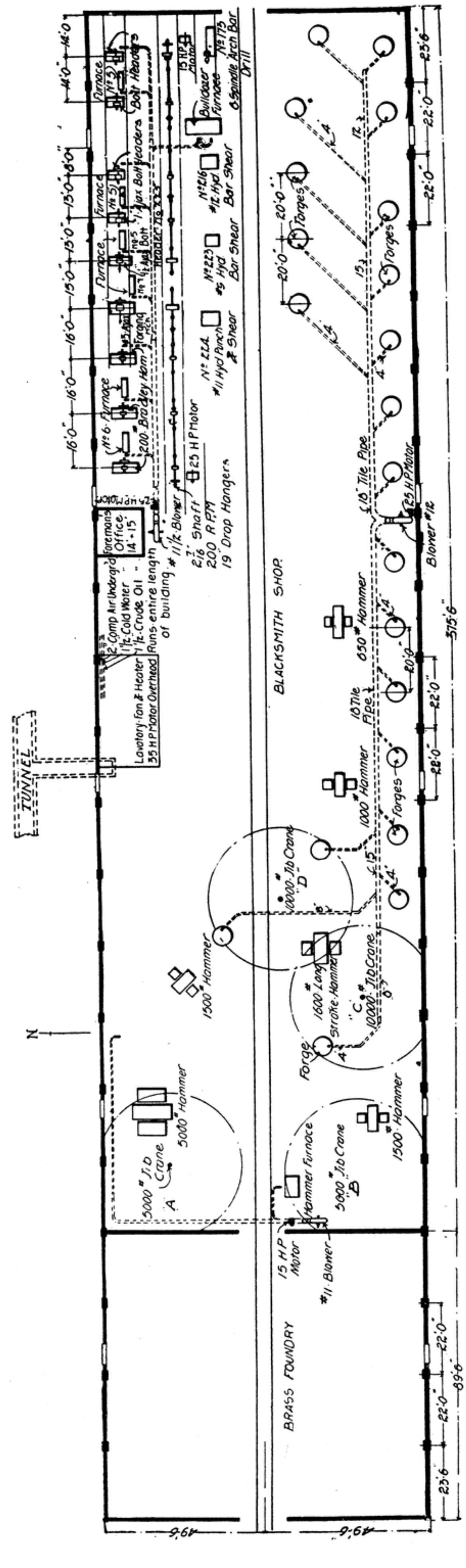
PLAN OF BLACKSMITH SHOP, SHOWING ARRANGEMENT OF EQUIPMENT AT ANGUS, C. P. RY.



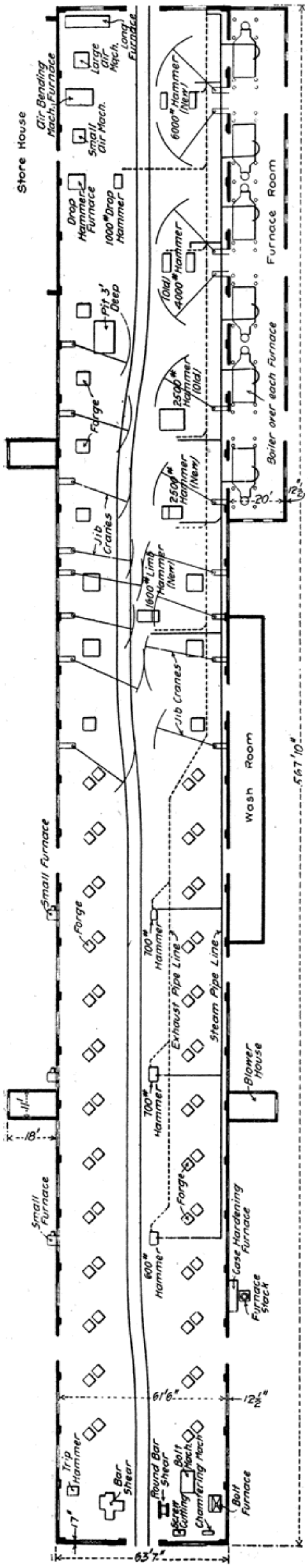
PLAN OF BLACKSMITH SHOP AT OELWEIN, C. G. W. RY.



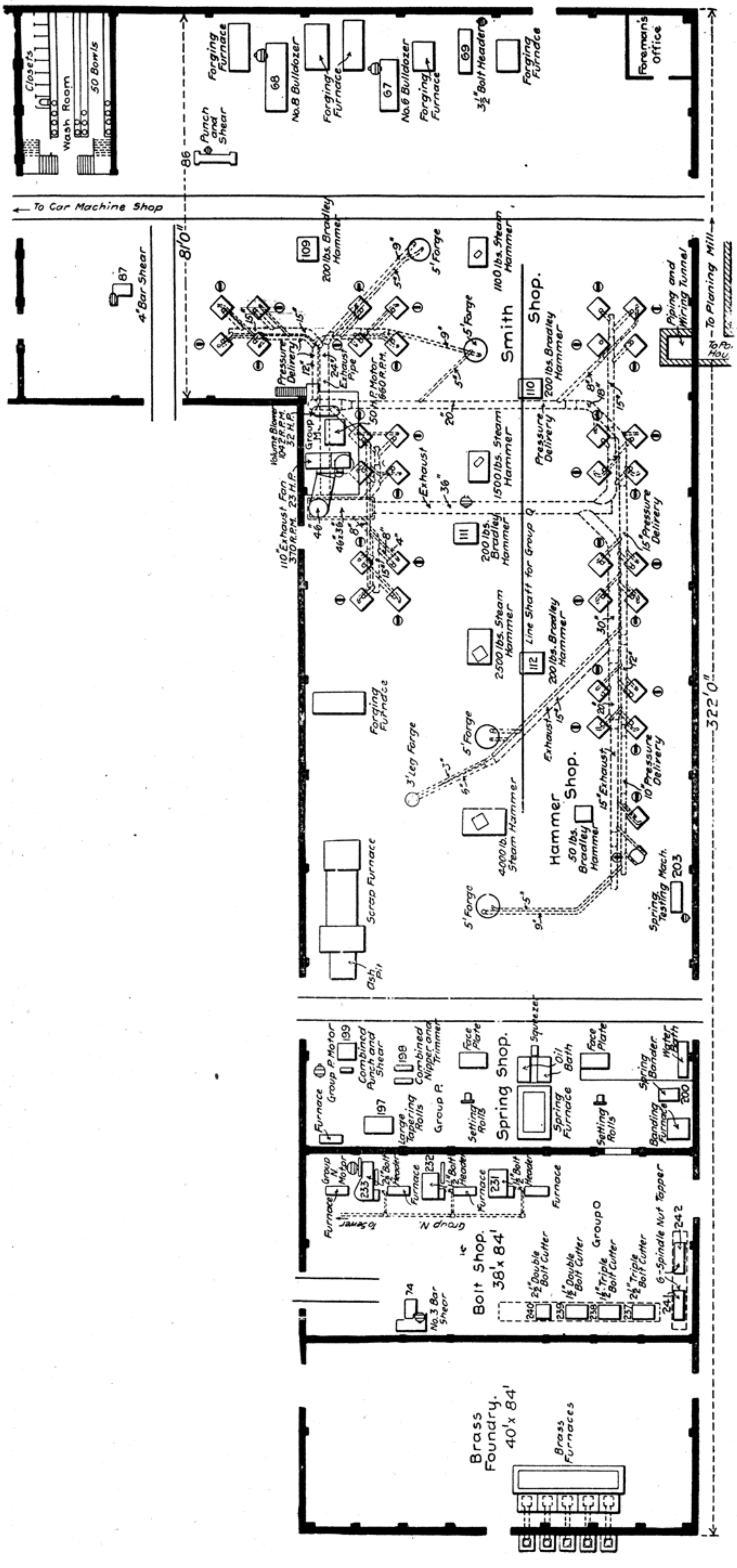
PLAN OF BLACKSMITH SHOP, SHOWING LAYOUT OF EQUIPMENT AT EAST ST. LOUIS, T. R. R. ASSN. OF ST. LOUIS.



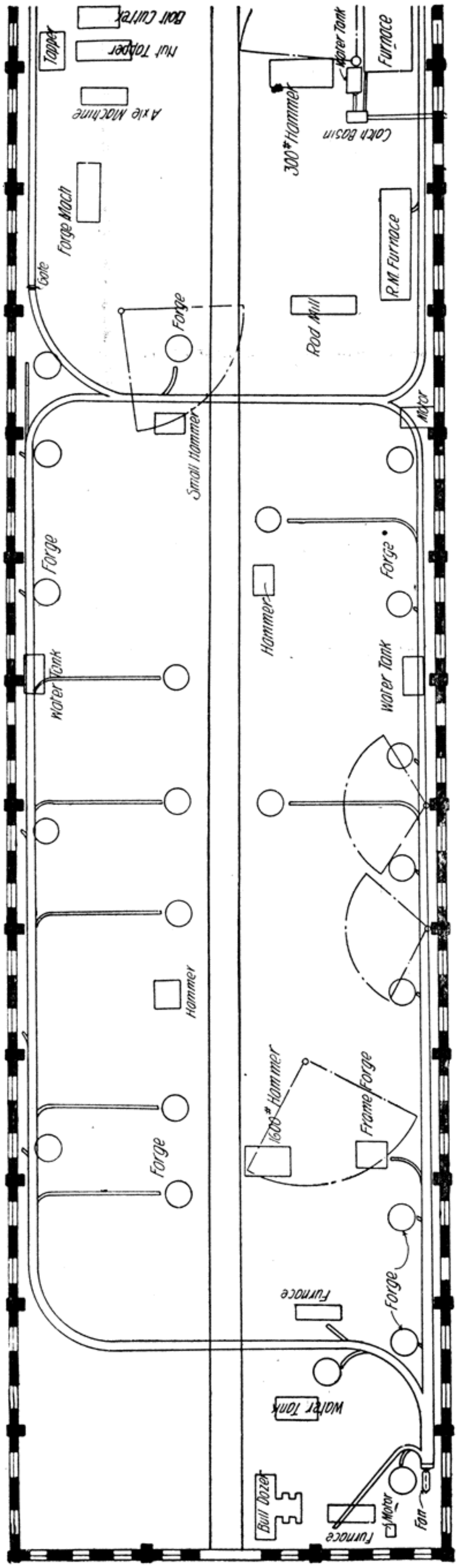
PLAN OF BLACKSMITH SHOP, SHOWING LAYOUT OF EQUIPMENT AT SILVIS, ILL., C., R. I. & P. RY.



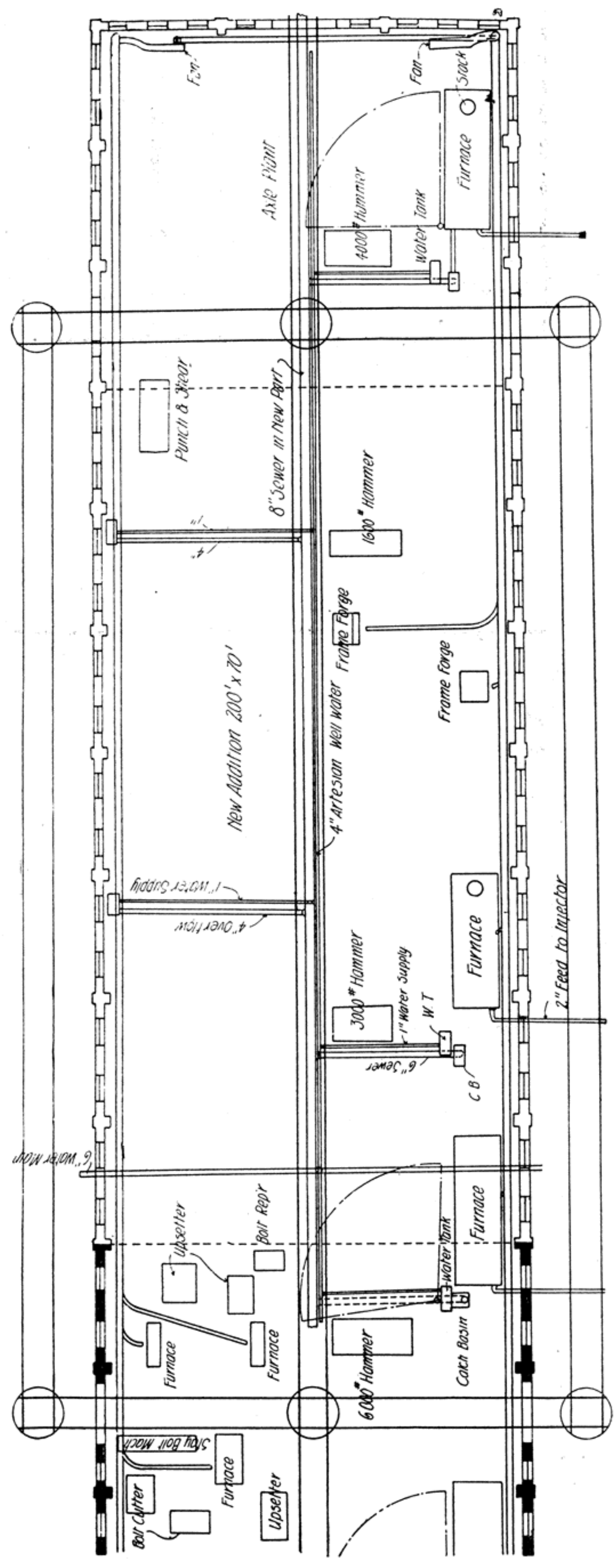
PLAN OF BLACKSMITH SHOP, SHOWING LAYOUT OF EQUIPMENT AT READING, PA., P. & R. R. R.



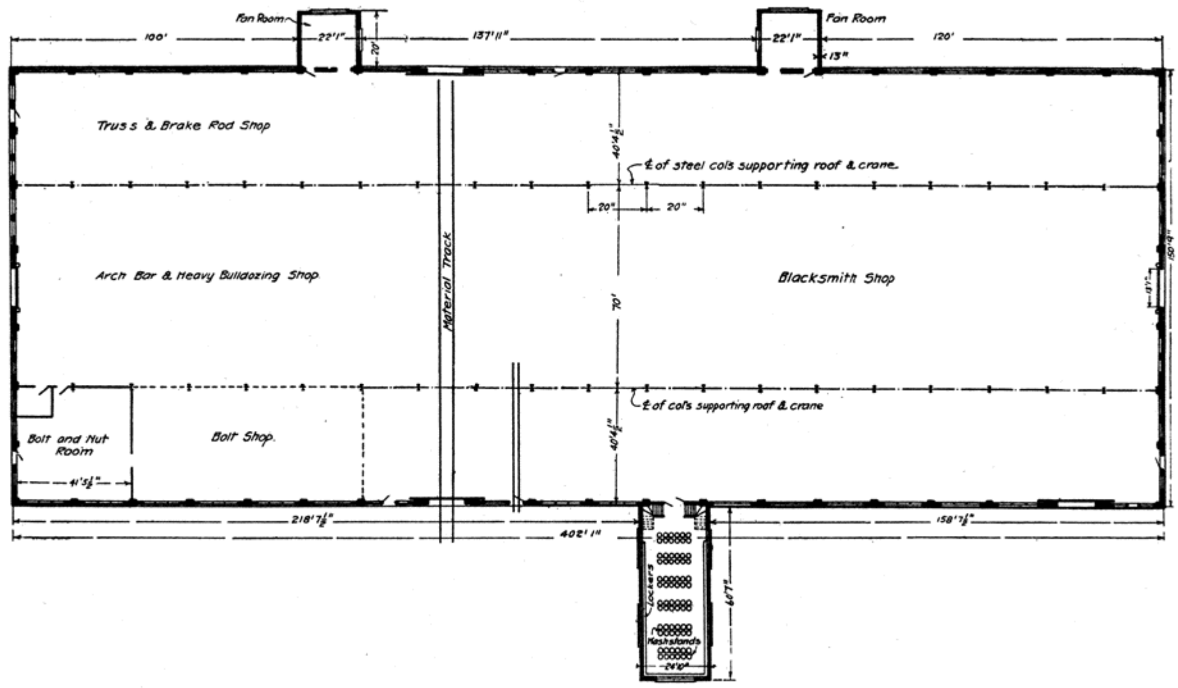
PLAN OF BLACKSMITH SHOP AT COLLINWOOD, O., L. S. & M. S. RY.



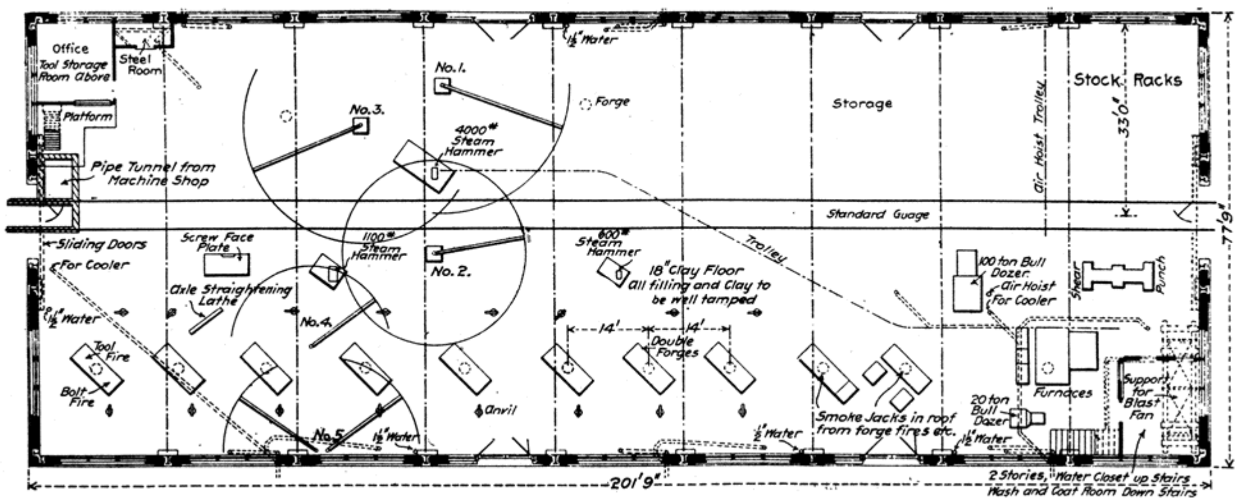
PLAN OF OLD SECTION OF BLACKSMITH SHOP AT MILWAUKEE, WIS., C., M. & ST. P. RY.



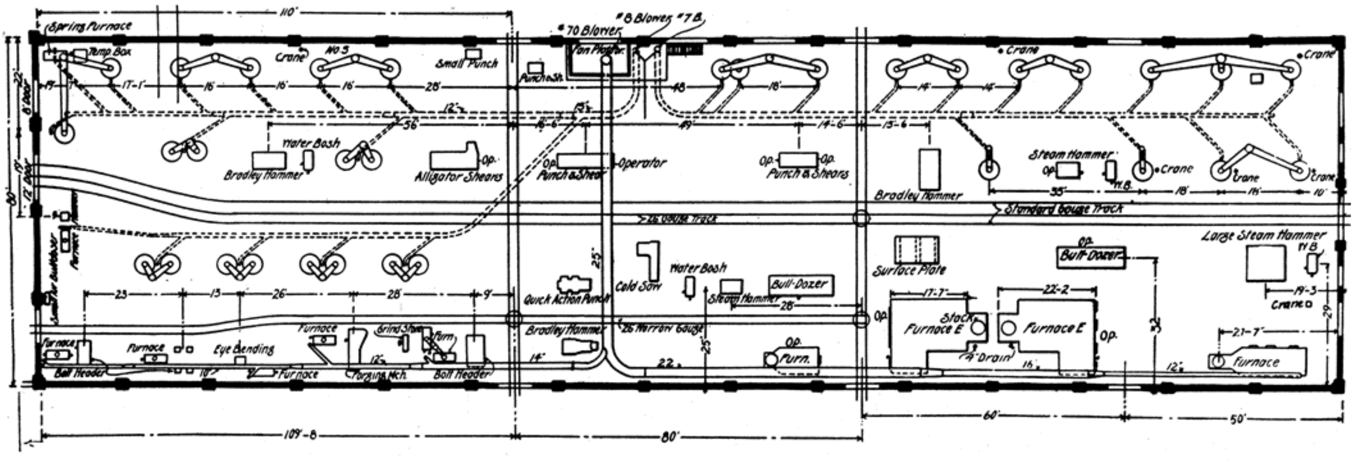
PLAN OF ADDITION TO BLACKSMITH SHOP AT MILWAUKEE, WIS., C., M. & ST. P. RY.



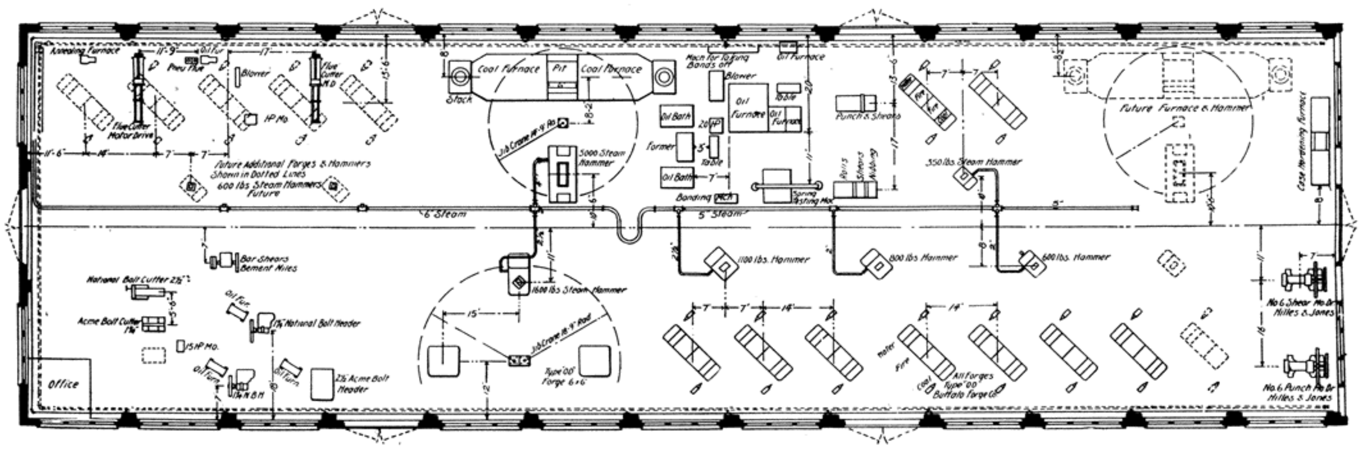
PLAN OF BLACKSMITH SHOP AT SOUTH LOUISVILLE, L. & N.R. R.



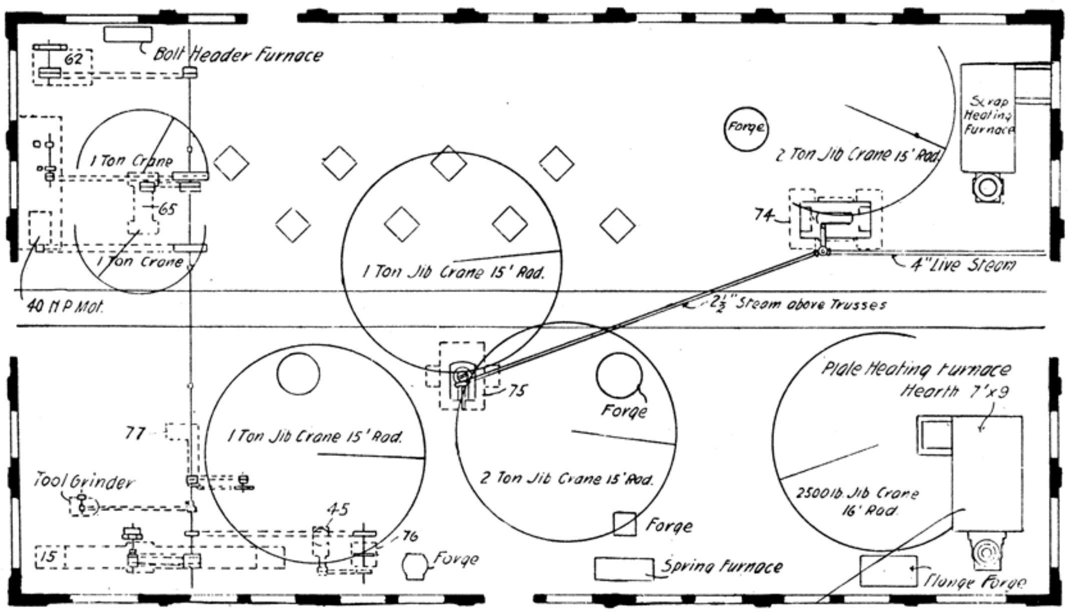
PLAN OF BLACKSMITH SHOP AT M'KEES ROCKS, P., & L. E. R. R.



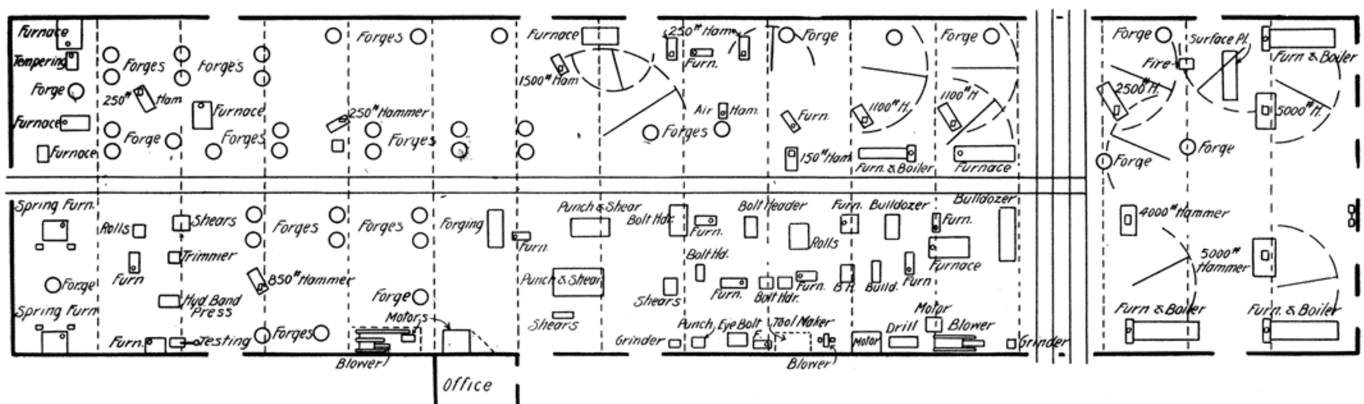
PLAN OF BLACKSMITH SHOP, SHOWING LAY-OUT AND ARRANGEMENT OF MACHINES AND FORGES AT SCRANTON FREIGHT CAR SHOPS, D., L. & W. R. R.



PLAN OF BLACKSMITH SHOP, SHOWING LAY-OUT OF EQUIPMENT AT TRENTON, N. J., P. R. R.



PLAN OF BLACKSMITH SHOP, SHOWING LOCATION OF EQUIPMENT AT DU BOIS, B., R. & P. RY.



PLAN OF BLACKSMITH SHOP, SHOWING LAYOUT OF EQUIPMENT AT TOPEKA, KAS., A., T. & S. F. RY.

Railway Shop Up to Date

Chapter V.

FREIGHT CAR SHOP

THE freight car department includes the equipment for the construction of new cars, heavy repair work, and light or running repairs to cars. Provisions for these several classes differ to some extent at the shops of the various railway systems. At the Angus shops of the Canadian Pacific Railway, practically all freight car work is confined to the construction of new cars. The shops at Angus include a locomotive department and a passenger car department, as well as that for freight car work. The Keyser Valley shops of the D. L. & W. Railroad at Scranton, Pa., are operated almost exclusively for the construction and repairs of freight cars and include no other departments. The Wabash Railroad has built new car shops at East Decatur, Ill., to provide for the repair of both passenger and freight car equipment. The Readville, Mass., shops of the N. Y. N. H. & H. are operated for the maintenance and repair of both freight and passenger car equipment, and the Sedalia, Mo., shops of the M. K. & T. Ry. are operated entirely for car work.

LOCATION.

The majority of American shops include both locomotive and car departments and the several buildings of each shop plant are placed according to requirements for the most economical operation of the plant as a whole.

Inasmuch as the freight car shop is an assembling point for a large amount of material, both wood and metal, the principal features are its location with regard to delivery, ample storage space adjacent to the shop and facilities for the rapid handling of material in large quantities.

In view of the large amount of material assembled, communication with the several auxiliary or sub departments, should be direct and convenient, for instance, from the mill, storage yard, truck shop, car machine shop, blacksmith shop and foundry. Where a single foundry serves both the locomotive and car department, its location near the locomotive shop is preferable inasmuch as heavier castings go to the locomotive shop and the smaller castings of the car department are more easily delivered in bulk over the greater distance.

The freight car repair shop is usually adjacent to the freight car repair yard or covers a portion of the yard tracks. This provides for minimum amount of switching of bad order cars and locates both heavy and light repair work adjacent to the same base of supplies.

BUILDING.

The structural work of the freight car repair shop is comparatively simple. The principal requirements are a long narrow building, protection for men and equipment against the weather and ample natural light.

The modern freight car shop is similar to the other principal shop buildings in being constructed with a steel skeleton and brick walls. The introduction of heavier cars, both wood and steel, makes overhead cranes desirable in at least a portion of both the freight car repair shop and the shop for erecting new cars. With the larger cars of today, the cost of construction and maintenance is increasing, so that the need of cranes and other facilities for the economical operation of the shop is felt.

By arranging four longitudinal tracks on 20-foot centers and so placing them that the centers of the outer tracks will be 15 feet from the faces of crane columns, a span of 90 feet may be had for the crane. Assuming that it is desired to provide a standing capacity of 80 cars, a floor area of 90,000 square feet would be required. Allowing 50 feet per car, the length of each track would be $50 \times 20 = 1{,}000$ feet. With four tracks arranged on 20-foot centers and with 15 feet from centers of outer tracks to face of columns, the width of floor between columns would be $(3 \times 20) + (15 \times 2) = 90$ feet and 1,000 (length of track) x 90 (width of floor) = 90,000 square feet, area of floor.

A feature very necessary for the construction of new cars is ample entrances to the building by which delivery of material may be made.

ARRANGEMENT OF TRACKS.

It is generally conceded that longitudinal tracks are the most satisfactory, both for the erection of new cars and the repair of old. Such an arrangement provides a feasible method of handling cars in strings, and lends itself most readily to an economical distribution of material due to the large amount of comparatively light material to be handled and to the frequency with which one car is replaced by another on the same working space.

Some shops still in existence would indicate that several years ago there was a question as to the most desirable arrangement of tracks. However, such shops are confined principally to the smaller and older ones, and the more recently constructed are almost uniform in providing longitudinal tracks for freight car work. Those plants at which the principal departments are served by a single transfer table, as well as some others of a different general layout, include a transverse freight car shop to which access is usually had by a system of ladder tracks at the side of the shop opposite the transfer table, as at the Colorado and Southern shops at Denver, the Wisconsin Central at Foud du Lac, the Oregon Short Line at Pocatello, the Missouri, Kansas and Texas at Sedalia and others. At the Oelwein shops of the

Chicago Great Western access to the freight car shop is by the transfer table only. At the Collinwood shops of the L. S. & M. S. Railway the freight car shop was originally in a building in which the tracks are arranged transversely and are served by a transfer table. This building has since been assigned to caboose repairs and other work and a new longitudinal shop has been erected.

The freight car shops and yards recently built indicate that a distance of 20 or 22 feet between centers, with an even spacing between the tracks throughout, is found most satisfactory.

Some yard tracks for light repairs are placed evenly on 16- to 20-foot centers, while the yard tracks for heavy repairs and those in the shop are spaced from 20- to 22-foot centers. Usually with this arrangement, material tracks are placed in each space between tracks.

At other points the working tracks are grouped in pairs on centers from 16 to 20 feet, and the groups are spaced from 20 to 26-feet apart with material tracks between the groups.

Where the even spacing prevails the tracks are from 20 to 22 feet between centers with usually a distribution track in every alternate space.

INDUSTRIAL TRACKS.

While narrow and standard gauge distribution tracks are both in use, the standard gauge now meets with greater general favor for the industrial system of communication and delivery. This system provides greater scope for the movement of push-cars, as it allows of their transportation over any of the tracks of the yard and the standard track facilitates the delivery of mounted wheels. While using standard gauge, material tracks are frequently made up of lighter rails than those used in working tracks and road tracks.

METHODS OF OPERATION.

In the construction of new cars the most economical operation, for the assemblage of large quantities of material and for the erection of cars in stages by gangs of specially trained men, provides for the advancement of each car from one stage to the next in regular sequence. In accomplishing this result trucks, sills and other material from the auxiliary shops are delivered at one end of the erecting shop where erecting work is begun and as the stages of construction advance, each car is pulled forward. Thus there is a string of cars in different stages of construction advancing along each longitudinal track, until, at the opposite end of the shop, each car is delivered, complete, painted and ready for service.

A satisfactory method of moving a string of cars as the work of construction progresses is to locate a motor, or motors, at the end of the shop to which the finished car advances, provide coupling rods for coupling the cars of a length standard to the shop, and pull each track as the work requires. By installing a shaft located beneath the floor and suitable clutches, together with a drum at each track, one motor will serve four or six tracks. The motor for this purpose is sometimes placed in a cabin beyond the end of the shop, but its location within the shop would seem the more desirable.

A coupling rod about 10 feet in length is recommended. This keeps the cars separated a certain distance at all times and allows free movement among the cars, a feature which is especially desirable in the vicinity of doors in the sides of the shop for the delivery of material from the storage yard. In a shop of great length, much material is delivered through side doors instead of at the end where construction work begins, thus economizing in the delivery of material by shortening the distance between points of storage and assemblage and reducing time consumed in delivery.

Consistent with ample storage space is the provision for classifying and piling material. Rods for framing of box cars may be ordered in required lengths and when threaded, sorted and stored in racks, the rods are made to follow the most direct route from the storage pile to the car. Such racks should be carefully stenciled with the length and diameter of rod, so that laborers in transferring material can make no mistake. This system also provides a simple means by which a store department clerk may readily determine an estimate of the amount of material of each size on hand.

A similar plan may be applied to the classification and storage of the various castings which enter into car construction. This method not only classifies the castings and keeps them together, but requires much less time in storing them, in that they may be dumped into bins from the trucks of the industrial system, whereas the time necessary to pile and segregate small pieces is decidedly wasted.

The same plan applies well to the distribution of bolts, nuts, cotter keys, washers, lag screws, nails, etc. For bolts and nuts large bins may be provided and as a truck load is delivered the boxes may be dumped directly into the bins. This plan serves to classify and store bolts and nuts in a place where a given size is always to be found duly labeled. It further removes the unsightly piles which are difficult to maintain and segregate.

The most economical method of distributing small material is to handle it in bulk, either in small wagons specially designed for the purpose or in sheet iron boxes arranged to be handled by light cranes as well as by trucks.

The latter arrangement lends itself readily to the method of storing bolts, nuts, etc., in bins, for the boxes may be handled by air hoists in transferring them from the trucks to the bins. Where this method is followed the bins are served by traveling air hoists. Bins for bolts are not covered so that material may be delivered over side partitions. To facilitate getting in and out of these bins when the stock is low, a wooden strip is nailed along the outside and on the inside an old grab iron is bolted in order that workmen may climb in and out of them conveniently. The bins in which nuts, washers, cotter keys, lag screws, etc., are stored are equipped with hinged covers and these covers are locked after the bins have been filled. A hole in the side partition near the floor provides a means for workmen to get at stock. A little thought concerning the large number of kegs which would be required for the storage of nuts, nails, etc., for a shop turning out, say 28 to 30 cars per day, will show the advantage obtained by storing this material as described.

CANADIAN PACIFIC—ANGUS.

The freight car erecting shop of the Canadian Pacific Railway at Angus has been used exclusively for the construction of new cars. It is located at one edge of the area devoted to shop buildings and is tributary to the "Midway," or avenue of distribution which traverses the entire shop area and is served by an overhead traveling crane as well as by standard gauge tracks the industrial system. The car erecting shop is directly across the midway from the mill building. Next to the car erecting shop is the truck shop; while the car machine shop is just beyond. The lumber yard is so situated with regard to the mill building, and the blacksmith shop, car wheel foundry, etc., are so placed with relation to the car machine shop and truck shop and the storage yard is so disposed around the car erecting shop, that material entering into the construction of cars advances from the several sources of supply and through the various departments in regular sequence, to the point of assemblage.

The shop building is 540 feet long by 107 feet wide and is well lighted naturally. It is divided into two bays and there are three standard tracks in each bay, two of which are used for erecting work and the central track is kept open for the delivery of material throughout the shop. The tracks in each bay are spaced evenly at a distance of fifteen feet between centers. Between the centers of the adjacent tracks of the different bays is a distance of 20 feet.

The erection of cars is begun at the end of the shop near the Midway, where trucks are delivered from the truck shop. A portion of each bay near this end of the shop is served by three traveling cranes driven by air and operated by hand from the floor. In the construction of box cars the roof frames are built on the car decks and are then hoisted by these cranes while the supporting frame is constructed between them. As the work of construction progresses the cars are gradually moved to the further end of the shop in order that each gang of men may handle that class of work at which they are specialists. The first gang applies sills and draft rigging, the deck is applied by the second gang, the roof and frame by the third, and so the car proceeds until it is finished at the further end of the shop. The cars are hauled forward by a motor at the end of the shop.

Bolts, nuts, washers, lag screws, etc., are stored in bins to facilitate storage and classification. In the storage yard along one side of the erecting shop, is a system of bins for the storage of small castings. In the storage yard on the opposite side of the shop a number of forgings, castings, springs, etc., are stored and it is intended to provide for this storage by constructing a long shed about 40 or 50 feet from the building to protect this material from snow in winter.

The paint shop is practically a continuation of the erecting shop and is separated from the latter by a fire wall and rolling steel doors. Cars are handled through this shop by motors as described for the erecting shop.

In this connection it is appropriate to call attention to the advantage provided by the location of the paint shop in such relation to the erecting shop, an arrangement which seems far superior to that which exists in some other railroad shops where it is necessary to transfer and switch cars over several tracks in moving from the erecting to the paint shop.

Tracks beyond the paint shop provide a standing capacity for about the same number of cars as the paint shop and during the summer months a large portion of the cars are painted outside on these tracks.

At Angus freight cars are painted with air machines.

D., L. & W.—SCRANTON.

The Keyser Valley shops of the D. L. & W. Railway at Scranton are devoted almost entirely to the construction and repair of freight car equipment. In addition to other facilities, the shop plant includes a car erecting shop, a car repair shop for heavy repairs, and a repair yard for light repairs.

The car erecting and repair shops are similar in size, construction and arrangement, except that the central bay of the erecting shop is served by a 15-ton traveling crane and contains some equipment for the construction of new cars, while the car repair shop is not so provided

Each building is 400 feet long by 150 feet wide and has a capacity of 48 cars. The buildings are of brick supported by structural steel frame work, and while they are plain as regards architectural embellishment, they present a very neat appearance. They are extremely well lighted by natural light, ample space between buildings aiding in this particular. In addition to the ordinary windows, which are large, much of the wall space above is fitted with window sashes, which adds much to the diffusion of light throughout the interior. Above the centers of the roofs are monitors which extend nearly the full length of the buildings and the sides of these monitors are equipped with glass lanterns. Saw-tooth skylights are placed at intervals along the roof. All glass surfaces are vertical with the exception of those in the skylights, so that there is very little opportunity for discomfort to be caused by direct rays of the sun pouring down upon the floor beneath.

Each building is divided into three bays. In the main, or central bay, there are two standard gauge tracks extending the full length of the building and connected with yard leads. These tracks are arranged on 22-foot centers and in each side bay are two working tracks, similarly spaced. The adjacent tracks of the different bays are spaced 24 feet between centers. The center bay is served by three narrow-gauge tracks. In the side bay one narrow-gauge track is between the two working tracks, while the other distribution track is between two outer tracks and the wall. The floors are of concrete.

In the yard for light repairs about 250 or 300 cars are repaired per day. This yard contains eight tracks arranged on 20-foot centers, and in every alternate space between working tracks is a narrow-gauge track of the industrial system. In this yard one track is reserved for the repair of steel cars.

For convenience in storage and delivery of material the yard contains a series of long, narrow material sheds in which are kept bolts, nuts, finished lumber, sheathing, car doors, couplers, etc.

There are two scrap platforms, or docks, near the repair yard for the accumulation of scrap material gathered from cars undergoing repairs. Each one is equipped with air operated shears, and the various kinds of scrap are assorted into classified bins. The platforms are level with a car floor and industrial tracks traverse the length of each platform.

The freight car repair shop is situated near the mill building and the centers of distribution, where sills and other comparatively heavy material may be delivered conveniently. Beyond the fact that cars held for heavy repairs are repaired under cover, there is practically little difference between the work done here and that at the average yard.

The greatest interest centers in the freight car erecting shop, where the bulk of the material from the various shops and sub-departments is assembled. At the time that work was begun on a large order of box cars having underframes reinforced with steel frames of commercial shape, the erecting shop was equipped to handle steel and other work economically, and it is interesting to note the methods followed.

In ordering steel for the construction of this framing, the practice of the company is to purchase proper lengths for the various parts. This material is delivered either in the yard at the end of the shop or just within the shop.

Both side bays are equipped with scaffolds suspended from the roof trusses to facilitate work on the superstructure. In the center way, served by a crane, trucks are erected, the steel reinforcing frame is assembled, sills are mounted and decks laid. In the side bays box frames are erected, roofs built, sheathing applied, trimming work is done, and before leaving the shop one coat of paint is applied.

A drill press and a punch and shear are located in the end of one side bay nearer the machine shop. In the same end of the main bay are air-operated riveters, portable forges and other equipment for assembling the reinforcing frames, for riveting couplers, yokes, etc.

Over a portion of one track in the main bay is a raised track supported on cast iron pedestals. Trucks are erected on this raised track and the arrangement provides facility for the truck erecting men in getting at bolts.

One end of this raised track is inclined to a height sufficient to reach the deck of a flat car. Cars loaded with wheels are switched into the shop and delivered to a point at which wheels can be unloaded easily over this incline.

When trucks have been completed they are piled one above the other by the crane, in order that they will occupy minimum floor space until required. This provides a convenient method of storing trucks in an accessible location when the supply exceeds the demand, and when needed they are readily delivered by the crane to the car erecting track.

During the erection of trucks, bolsters are delivered by the crane, so that truck erecting men have practically no handling of bolsters.

All parts of trucks, bolsters, sand planks, arch bars, boxes, brasses, bolts, etc., are delivered by laborers within easy reach of erecting men, so that work of erection progresses rapidly and without unnecessary interruption.

In drilling and punching the several I-beams used in the construction of the reinforcing frames, the webs are punched according to forms. Holes are then laid out according to templates and pass to the drill press, whence they are delivered to the riveters. A portion of flanges on draft beams are sheared off to provide for application of couplers, and this work is done cold.

Angle irons, queen posts, malleable castings, etc., are riveted by air riveters and the parts pass to the assembling gang.

To provide convenience in forwarding this work rapidly and at the same time insure accuracy and proper angles, the frames are constructed on specially designed tables, two of which are provided in this end of the shop in order that two reinforcing frames may be constructed at one time. These tables are illustrated by line drawings presented at the end of this chapter.

Upon completion the frames are transferred by the traveling crane to the center of the shop or to the further end, where they are lowered upon the trucks which are previously placed in proper position to receive them.

Frames are transferred by a specially designed carrier hung from the crane hook. The carrier is composed of 9-inch channels, 15 pounds per foot, 24 feet 11 inches long, having a chain attached to its center for connection with the crane hook and a chain at each end to which the frame is secured. When not in use this carrier is stored at some point on the floor near the frame erecting tables.

After the reinforcing frame is placed on the trucks, sills are applied, brake rigging attached, deck nailed down and frame castings placed on deck before the car is moved.

Following this work, cars are pulled out of the main bay by an electric motor located in a shanty near the main bay lead and about 300 feet from the shop building. In good weather decks are nailed down after cars have been pulled out of doors.

Cars are switched by yard engines from the main bay lead to the side bays, where the erecting work is finished as before described.

Sills are transferred from the mill to the erecting shop on industrial cars and inside the shop they are handled by the crane. When laying the sills the crane is again used. Castings entering into car construction are brought in from the storage yard in wheelbarrows and placed where they will be conveniently loaded upon the cars. Air brake cylinders and rigging are started near the point of erection so as to avoid further transfer when ready for application. Lumber for sheathing frames, purlines, roofs, etc., are delivered from the mill to the erecting shop in carloads and placed in side bays easy of access to the various cars under construction. Where such lumber is delivered when partially finished cars are standing either in the main bay or on the outside leads, it is placed on the truss rods so that it will be transferred with the car in its movement to either side bay for completion.

The car repair and erecting shops are situated side by side with a distance of 70 feet between them. The freight car paint shop is situated a distance of 166 feet beyond the ends of these shops and on a center line passing midway between them. Cars are transferred from the erecting shop to the paint shop by the yard engine, and by the time a car has been switched from the central bay of the erecting shop to the side bay and again to the paint shop, it would seem to have been moved several times unproductively.

While the shop under discussion has many points of advantage and is well equipped, it would seem that an arrangement whereby a car advances from one stage of construction to the next without doubling in its course would give greater output.

N. Y., N. H. & H.—READVILLE.

At the Readville car repair plant of the New York, New Haven & Hartford Railroad, the freight car repair shop is situated between two car repair yards and spans the track extensions of these yards. The shop is 350 feet long and 160 feet wide and has a standing capacity of 60 cars. The tracks in the shop and yards are spaced on 20-foot centers. The yard at the east end of the shop will accommodate about 500 cars at one time. Cars enter through the yard at the east end and move progressively through the shop and out at the west end.

The location of the shop and yards with reference to the other buildings of the plant is such that raw material may be delivered easily from the various sources of supply and other departments.

The freight car erecting shop is a brick building in which the roof trusses and supporting columns are of yellow pine. The columns supporting a second floor at one end of the building are of cast iron. The roof of this portion is covered with slate, while the remainder is covered with eastern granite roofing. Natural day lighting is provided for by large windows in the side walls and by sashes in the end doors. The flooring is of concrete.

L. & N.—SOUTH LOUISVILLE.

At the South Louisville locomotive and car plant of the Louisville & Nashville Railroad the freight car repair shop is situated between a storage yard having a capacity of 325 cars and a repair yard capable of standing about 50 cars. The building is 400 feet 7⅜ inches long by 145 feet wide and contains six working tracks spaced 20 feet between centers, as well as a material track which extends along one side of the building. The shop has a standing capacity of 60 cars.

With the exception of two, the tracks in the yards are continuations of those in the shop and are spaced the same distance apart.

The shop for the construction of new cars is tributary to the transfer table and is situated next to the mill building. The building is 300 feet 7⅜ inches long by 134 feet 8 inches wide. It contains six working tracks arranged in three groups, with two working tracks in each group. The working tracks of each group are spaced 20 feet between centers and the adjacent tracks of the different groups are spaced 22 feet 6 inches between centers. Between the working tracks of each group is a material delivery track of standard gauge. This shop has a capacity of 42 cars.

Both the freight car repair and erecting shops are of steel construction with side sheathing of corrugated iron.

In the erecting shop for new cars the bays in which the working tracks are situated are separated by the rows of columns supporting the roof trusses. The ends of the building are covered with corrugated galvanized iron to within 16 feet 9 inches of the ground, and the sides are of the same material to within 10 feet of the ground. Both the sides and ends of the building are equipped with rolling steel doors. Above the roof over the center of the main bay is a monitor extending the full length of the building, the sides of which are equipped with glass lanterns. A row of skylights, placed at intervals, extends along the roof above the center of each side bay. Above the corrugated iron sheathing much of the wall space is fitted with stationary window sashes. The building is covered with a composition roofing and the floor is of concrete with a granitoid finish.

The scaffolding for the building tracks are of permanent construction and are suspended by angles hung from the roof trusses. The platforms are 4 feet wide and are situated about 7 feet above the floor. The platforms are provided with extensions 2 feet 6 inches wide on each side, which are so hinged that they may be swung out of the way when not in use. When in use the extensions are held in position by ¼-inch wire rope cables secured to the roof trusses.

Ordinarily, erecting work is done on three of the working tracks at one time, while material is being brought in and placed conveniently for the other three.

If necessary, however, all six tracks may be used at the same time. In such an event maximum output would be obtained by delivering material at night.

Car sills and the larger material from the planing mill are delivered to the erecting shop over the transfer table, while the lighter material is delivered direct by push cars. Trucks and other material pass to the shop in sequence and are delivered direct to the shop from the transfer table, much of it being delivered to the table by the yard crane which serves the storage yard located at right angles with the transfer table pit. Much of the small material delivered to the erecting shop, such as bolts, nuts, washers, lag screws, etc., is stored beneath the scaffold platforms along the sides of the shop. Larger and heavier surplus material is stored between the tracks, just outside of the shop at the end further from the transfer table.

While the cross-section of the freight car repair shop is very similar to that of the erecting shop for new cars, the building is lower and the arrangement of trusses is different. The roof trusses are supported by a single row of columns and the shop is divided into two sections only. The arrangement of glass in the monitor, skylights and stationary side sashes is similar to that of the erecting shop. The sides and ends of the building are equipped with rolling shutters. The floor is of cement with a granitoid finish. In alternate spaces between pairs of tracks are air connections attached to hose extending from an air system carried along the roof trusses.

The foreman's office is situated in the northwest corner of the building and is elevated at such a position as to furnish a good view of the interior of the entire shop as well as over the freight car repair tracks. Along the west side of the building is a long platform or balcony for the workmen to store their tool boxes. A row of work benches is located along the east side of the shop. Stoves are situated at different points throughout the building to provide means for the men to warm themselves during severely cold weather.

In both the repair and erecting shops the natural day lighting is ample and is well distributed.

WABASH RAILROAD—EAST DECATUR.

At the new East Decatur shops of the Wabash Railroad no large provision has been made for repairing freight cars under roof. The climate is comparatively mild at this point, and due to the almost complete absence of snow it is possible to repair freight cars out in the open most of the year.

The repair yard is situated at the extreme south side of the plant and contains four working tracks. The tracks are arranged in two groups, those of each group being spaced on 20-foot centers. Each group is served by a material track located between the working tracks, and a third material track passes near the adjacent shop buildings. Between the two groups of working tracks are three material racks 56 feet long by 8 feet wide. The repair tracks have a capacity of 170 cars.

The shop plant includes a large repair shop 463 feet long by 88 feet wide, containing four longitudinal tracks spaced 20 feet between centers. Though this shop is intended principally for passenger coach repair work, a portion of it may be used for heavy repairs to freight cars during bad weather.

C. C. C. & ST. L.—BEECH GROVE (INDIANAPOLIS).

At the Beech Grove shops of the Big Four Railway, situated near Indianapolis, the freight car repair yard is adjacent to the main freight switching yards, so that the switching of bad order and repaired cars will be reduced to a minimum. The freight car repair shop, 403 feet by 156 feet, is approximately at the center of the south edge of the repair yard. The working tracks through shop and yard are spaced alternately on 18-foot and 22-foot centers. In the wider space between tracks a narrow-gauge track is installed for the delivery of material.

P. & L. E.—M'KEES ROCKS.

The freight car repair shop of the Pittsburg & Lake Erie Railroad at McKees Rocks, Pa., is a brick and steel structure 654 feet 7 inches long by 154 feet wide, arranged in three longitudinal bays. An extension on the east side of the shop, 23 feet wide by 450 feet long provides a convenient location for the furnaces, straightening presses, storage rooms, and machine shop.

The walls are of brick with steel framing conforming to the uniform design of the other shop buildings. The roof is of saw tooth construction with transverse skylights, and is supported by steel trusses resting upon steel columns. The windows in the skylights are vertical and face toward the north so that an abundance of light is admitted to the shop from above. Large windows in the side and end walls also contribute materially to the natural lighting.

The hot air system of heating is installed, with overhead supply pipes and down drop outlets. The shop is piped with both air and natural gas, for the operation of tools and heaters.

Two of the three longitudinal bays are devoted to the repair of wooden cars, while the third or east bay is given over entirely to steel car work. In each bay are two longitudinal working tracks on 24 foot centers, with a standard material gauge track located centrally between them. The centers of the two outer tracks are 14 feet 3 inches from the crane columns and the center of the inner tracks 12 feet from the main columns, allowing ample space for carrying on repairs simultaneously on all tracks, without confusion or interference. The span of each outside bay is 53 feet and that of the center bay 48 feet, with a clear height from floor to roof truss of 30 feet. Each bay is served by an overhead electric crane operating the full length of the shop, the crane in the west bay being of 40 tons and those in the other bays 20 tons capacity each.

The wood working shop and lumber storage house are located adjacent to the main shop, on the west and are arranged for direct handling of material. A system of standard gauge material tracks provides a convenient method for the distribution of material from one building to another. The store room, although located a greater distance away than the mill, is easy of access and through the system of material tracks is provided with a ready means of communication with all departments. The scrap platforms and bins are located beyond the store house. The platforms are level with a car floor for convenience in loading and unloading scrap, while a material track extends the length of the platform for handling the scrap from the shop.

According to the practice common to longitudinal shops, cars undergoing repairs advance progressively. Bad order cars enter the north end of the shop and as repairs are made they are moved toward the south end where the finished cars leave. In this shop repair men are not organized in gangs of specialists assigned to certain classes of work, but each gang is capable of making all classes of repairs. Thus a gang assigned to a car entering the shop is held responsible for all repairs marked up against the car. All air brake work, packing journal boxes and a few other special jobs are assigned to regular men. While up to date practices are followed throughout the shop there is nothing absolutely distinctive in the methods of repairing wooden cars.

The bay devoted to the repairs of steel cars provides space under cover for 30 cars, assigning 15 cars to each working track, and approximately 43 feet is allowed to each car. The machine shop extension practically constitutes a separate bay adjacent to the east bay, so that direct access is afforded to all machines, furnaces, etc. At the south end is a large oil furnace for heating bent parts.

When a large number of bent parts has accumulated they are heated in the furnace and straightened on the table or by presses provided. Near the furnace is a coke fire for heating the rush parts which are necessary to prevent delay to the movement of cars. A large pneumatic press is within convenient reach of the furnace and dies are provided to fit all regular repair parts. For straightening angles, beams, stakes, etc., is a large pneumatic press. Adjacent to this press is a horizontal pneumatic riveter, for riveting all parts which can be conveniently handled. Beyond the riveter are the storage rooms, containing a stock of end sills, extension center sills, side stakes, buffer plates, center pockets, structural iron, etc. At the north end of this bay a carpenter and pipe shop are partitioned off and equipped with the necessary tools. An overhead trolley line crane and 2 hand cranes operate the full length of the machine shop and storage room, on a line of 10 inch I beams, suspended about 12 feet above the floor. This provides an easy method of handling material undergoing repairs and also for the delivery of heavy parts in stock. This bay is well lighted by windows and has a plank floor similar to that in the remainder of the shop.

The ordinary service of a car in the ore and iron trade in the Pittsburg district is much shorter than in other localities and the severe handling which cars are subject to, makes it necessary to give heavy repairs to a large proportion of those going to the shops. Common causes for shopping steel cars are derailments, cornering, etc., which distort or twist the body. Repairing a car in this condition is generally a slow and expensive operation. To meet the requirements of this class of repairs a steel car repair frame has been erected. The design and construction of this frame are original and its operation is unique. The frame is of steel construction, firmly secured upon a concrete foundation. It supports a number of screw jacks which may be adjusted readily in various positions. The frame is so strongly constructed and so carefully devised that a steel car having a twisted body may be jacked into shape without removing the body from the trucks. Actual service tests have demonstrated that by this method of straightening steel cars a saving of 400 hours per car is effected.

The jack frame is built of 12-inch channels arranged in 5 pairs forming a skeleton steel box. Horizontal braces of 12-inch channels riveted to the tops of the vertical members bind them firmly together. Diagonal braces of 3 by 2 inch angles and longitudinal braces of 6 by 6 inch angles, connect the five sections of the frame. A system of braces at the lower end of the vertical members similar to that employed at the upper ends completes the structure making a frame work having a width inside of 13 feet, height of 11 feet 6 inches and a total length of 30 feet 9⅞ inches. The vertical and cross channel members are arranged in pairs 3¼ inches apart and form the supports for screw jacks of special construction which may be adjusted at any place and clamped in position.

ISOLATED REPAIR YARDS.

In view of the economy and advantage of keeping the number of bad-order cars at a minimum, a word in behalf of the isolated repair track seems appropriate. The facilities afforded for the repair of freight equipment at isolated points are, in most cases, totally inadequate. The fact that a repair yard is not near a shop makes it all the more necessary that such a point should be well equipped with tools and facilities as well as a generous store of those parts apt to be required on short notice.

On most roads the freight cars held for repairs each day average from 2 to 3 per cent of the total equipment owned, but if the "bad orders" increase to over 3 per cent, the situation becomes serious and calls for special attention.

Much that concerns the equipment and facilities of isolated repair yards applies as well to the terminal repair yards and those run in connection with building and repair tracks. The importance of good facilities is quite frequently underrated, and it is difficult to estimate the loss of car service resulting from inferior repair facilities.

Among the items of most importance for the prompt repair of freight cars are a sufficient supply in convenient locations, of all standard kinds of car repair material, such as bolts, castings, mounted wheels, framed timbers, etc.; it is almost equally important to have good facilities for handling material between the point of storage and the cars to which the same is to be applied.

For this purpose material tracks with push cars running between the car repair tracks are exceedingly useful and not very expensive. There are various handy devices for moving such heavy material as draw-bars, journal boxes, car wheels, and also the heavier tools such as jacks, many of which have been illustrated in the technical papers.

It is a rare thing to find a gang of car repairers fully equipped with the right kind of tools to do their work to the best advantage, as they almost always lack a sufficient number of jacks, air-boring machines, or even of wrenches or similar small tools, the first cost of which could be saved every day. The capacity of a car repair track which turns out more than eight or ten cars a day will be very largely increased by furnishing a few woodworking machines, with the necessary power to operate them, the most essential being a rip-saw, cross-cut saw, and boring and mortising machine. There is an instance on record where such tools were furnished to a repair gang turning out 50 to 75 cars a day, and the consequent increase in the output represented an addition of at least ten or fifteen men to the force, and also caused a reduction in the average time required per car for repairs.

A blacksmith fire near the repair track for straightening bent brake connections and other odd jobs will save a great deal of loss of time both to the car repairers and to the cars, unless the main blacksmith shop is very near the repair yard.

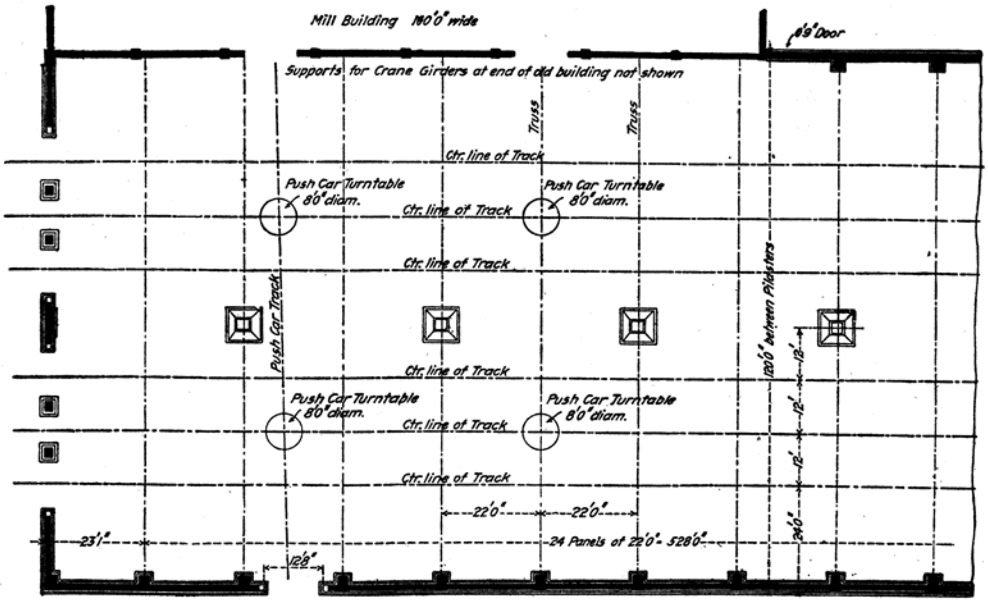
A sufficient supply of compressed air has come to be one of the most essential requisites for prompt car repair work, as it is generally used for boring, and frequently for jacking up cars.

The prompt switching of repair tracks and removing of finished cars and replacing them with bad-order cars is most important and should be done at such time as it will interfere least with the car repair gang.

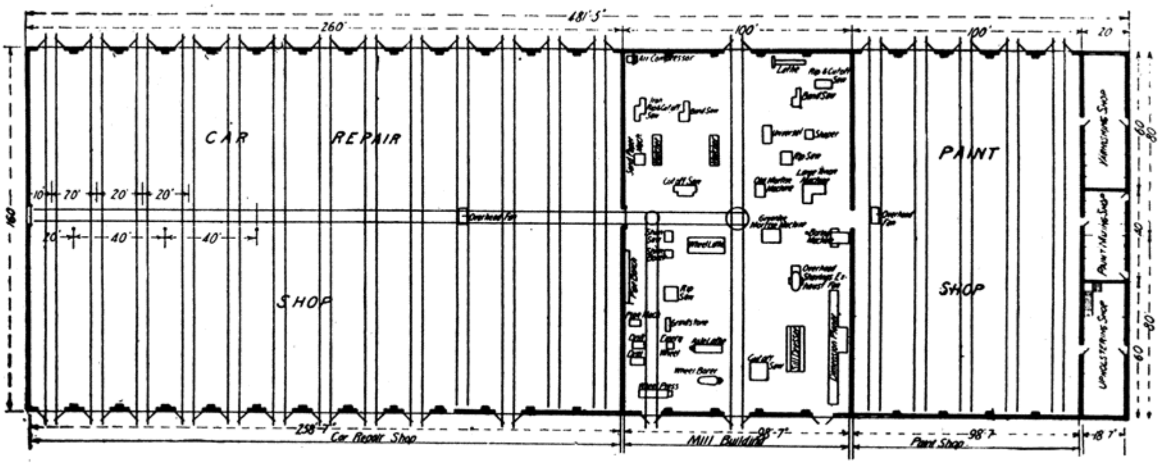
Freight repair sheds are generally furnished throughout the south for protecting car men from the sun, but are seldom seen in the north, where they would be fully as useful in protecting men from rain, snow and wind storms. There are many places where such sheds would enable men to work instead of going home during bad weather, and thereby shorten time cars are held for repairs.

A system of air pipes installed throughout freight repair and switching yards will save much loss of car service, besides insuring greater safety to trains on the road, but very few yards are so equipped.

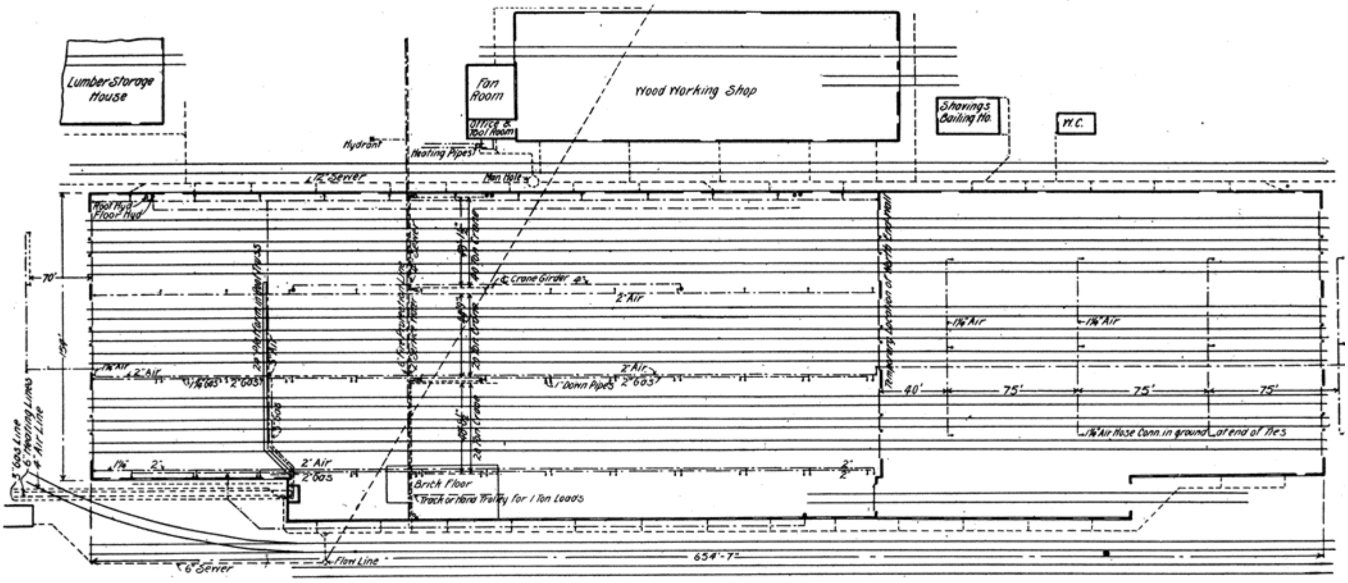
There are not many places on a railroad where a comparatively small expenditure will bring such large returns as in providing better facilities for freight car repair yards.



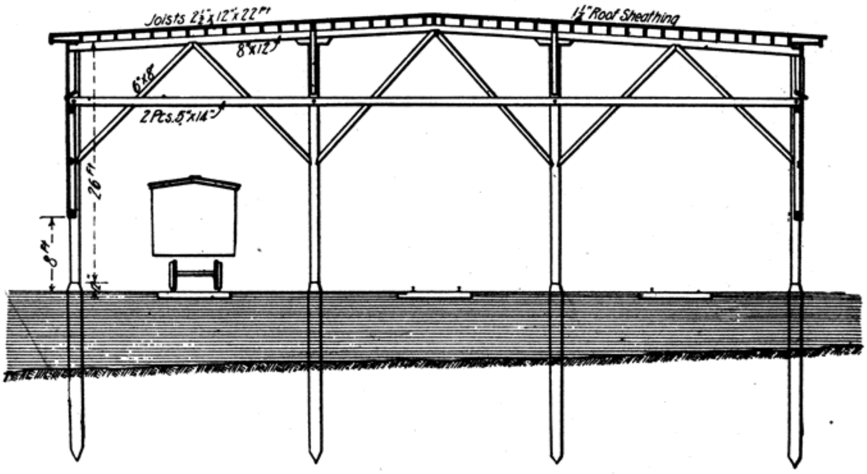
PARTIAL PLAN OF FREIGHT CAR SHOP AT BURNSIDE, ILL., I. C. R. R.



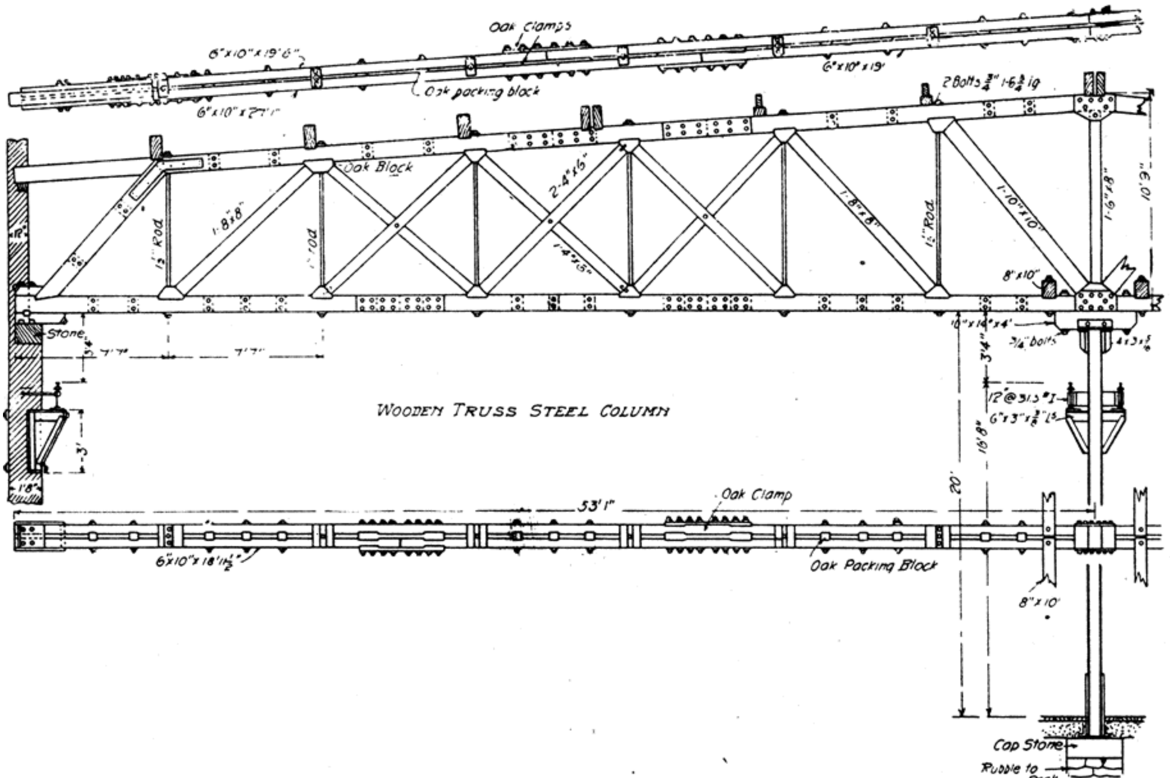
PLAN OF CAR REPAIR SHOP, PLANING MILL AND PAINT SHOP AT FOND DU LAC, WIS., WISCONSIN CENTRAL RY.



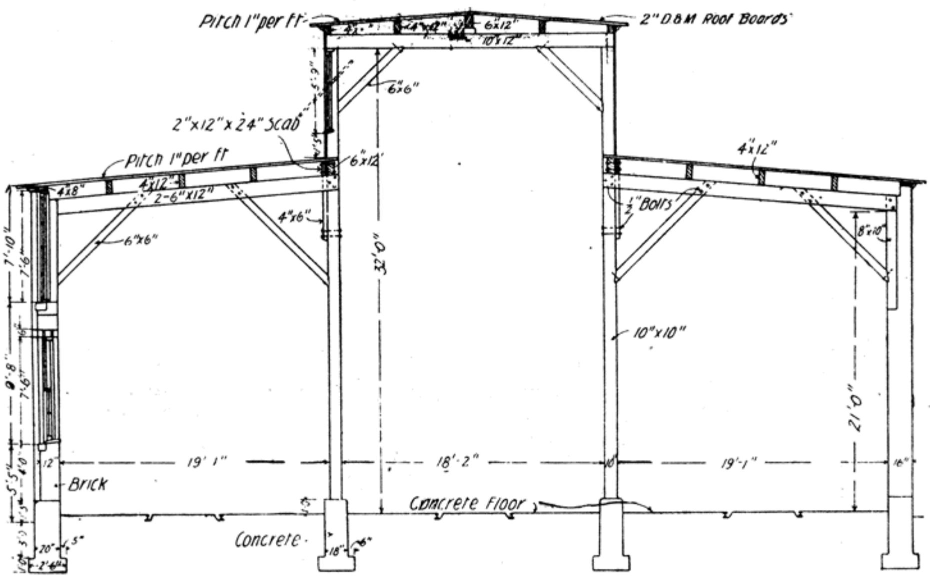
PLAN OF FREIGHT CAR SHOP AT McKEES ROCKS, PA., P. & L. E. R. R.



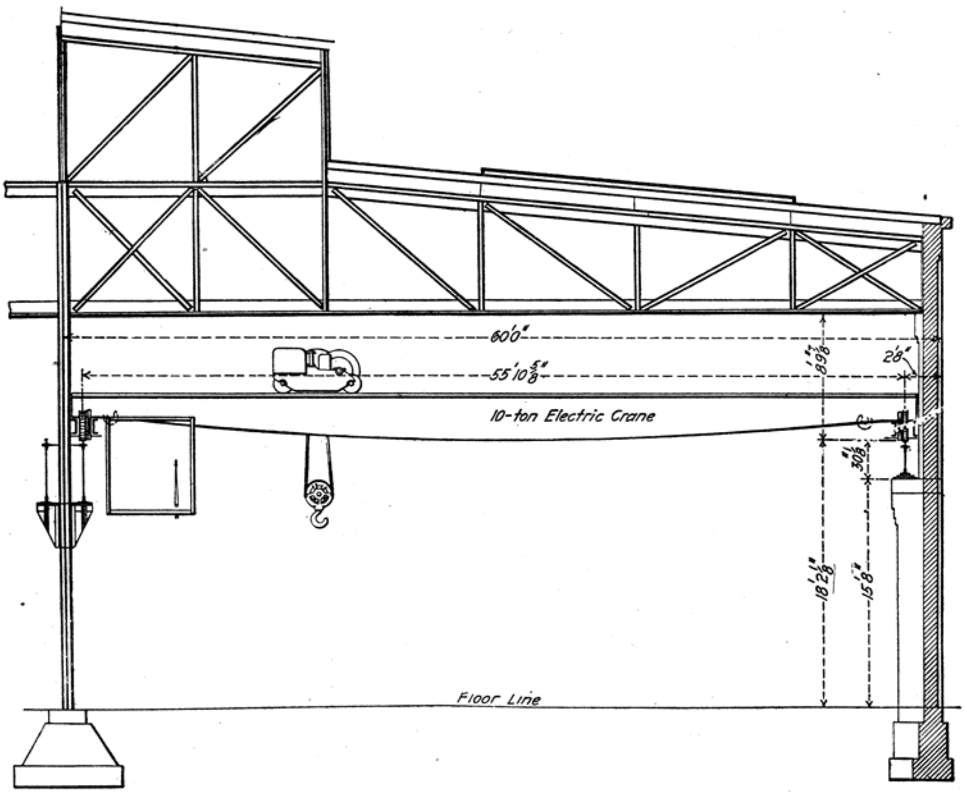
CROSS SECTION OF FREIGHT CAR REPAIR SHED AT BARING CROSS, ARK., ST. L. I. M. & S. RY.



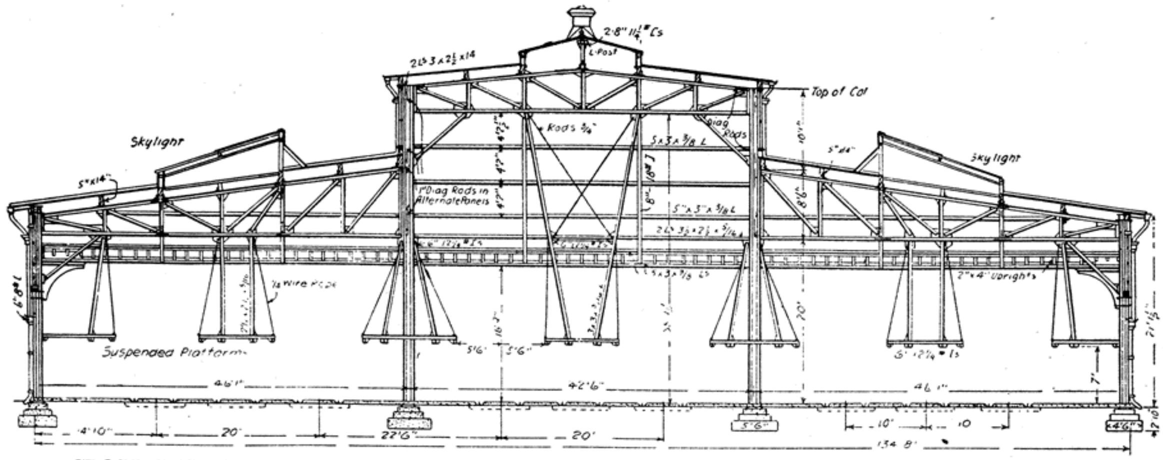
DETAILS OF CONSTRUCTION OF FREIGHT CAR SHOP AT ANGUS C. P. RY.



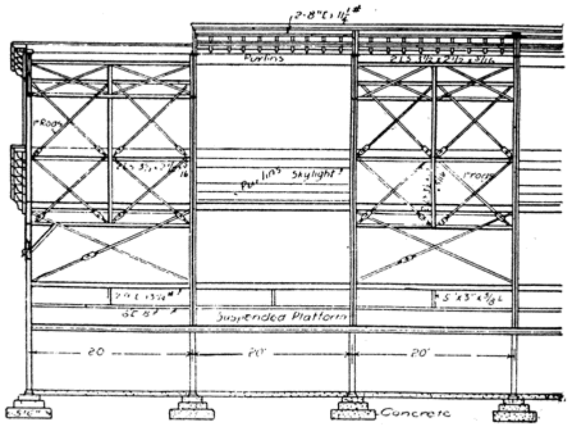
CROSS SECTION OF FREIGHT CAR PAINT SHOP AT SCRANTON, PA., D. L. & W. R. R.



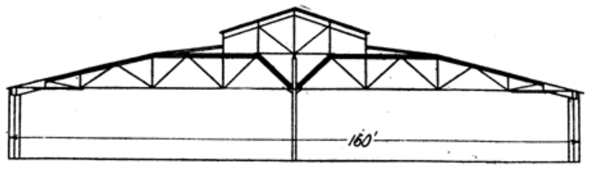
HALF CROSS SECTION OF FREIGHT CAR SHOP AT BURNSIDE, ILL., I. C. R. R.



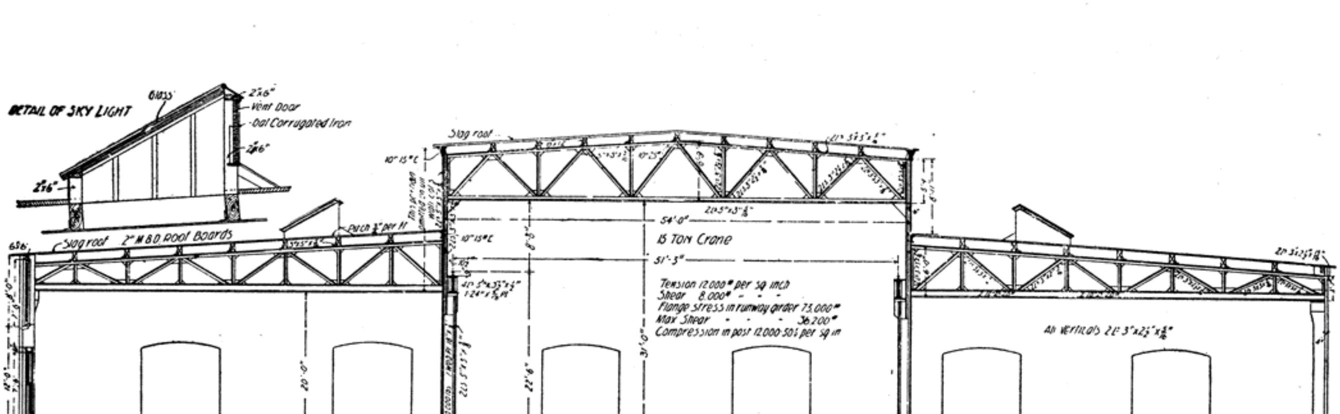
CROSS SECTION OF FREIGHT CAR BUILDING SHOP AT SOUTH LOUISVILLE, KY., L. & N. R. R.



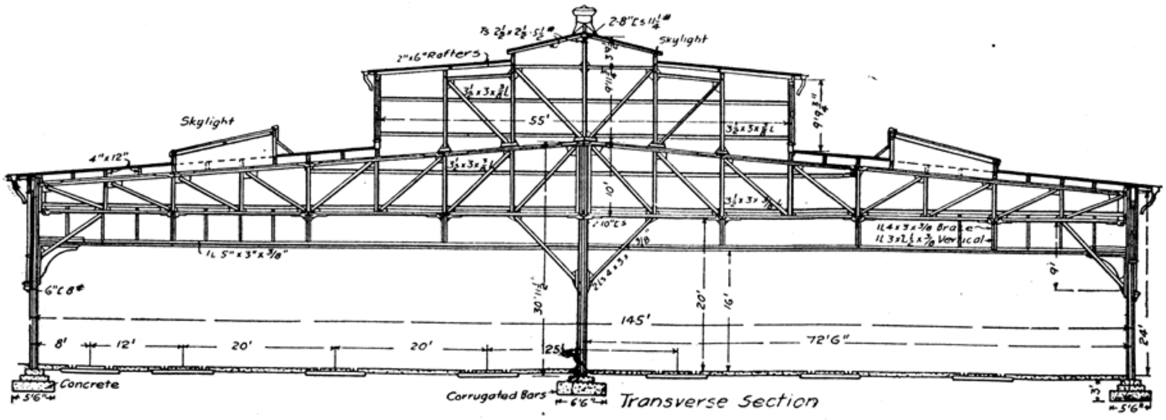
HALF LONGITUDINAL SECTION OF FREIGHT CAR BUILDING SHOP AT SOUTH LOUISVILLE, KY., L. & N. R. R.



SECTION OF FREIGHT CAR SHOP AT FOND DU LAC, WIS., WISCONSIN CENTRAL RY.



CROSS SECTION OF FREIGHT CAR REPAIR SHOP AT SCRANTON, PA., D., L. & W. R. R.



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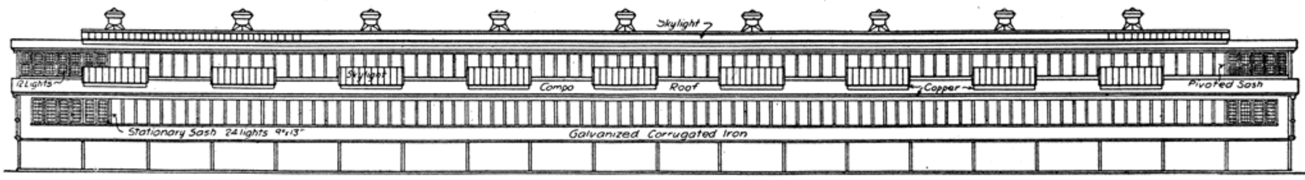
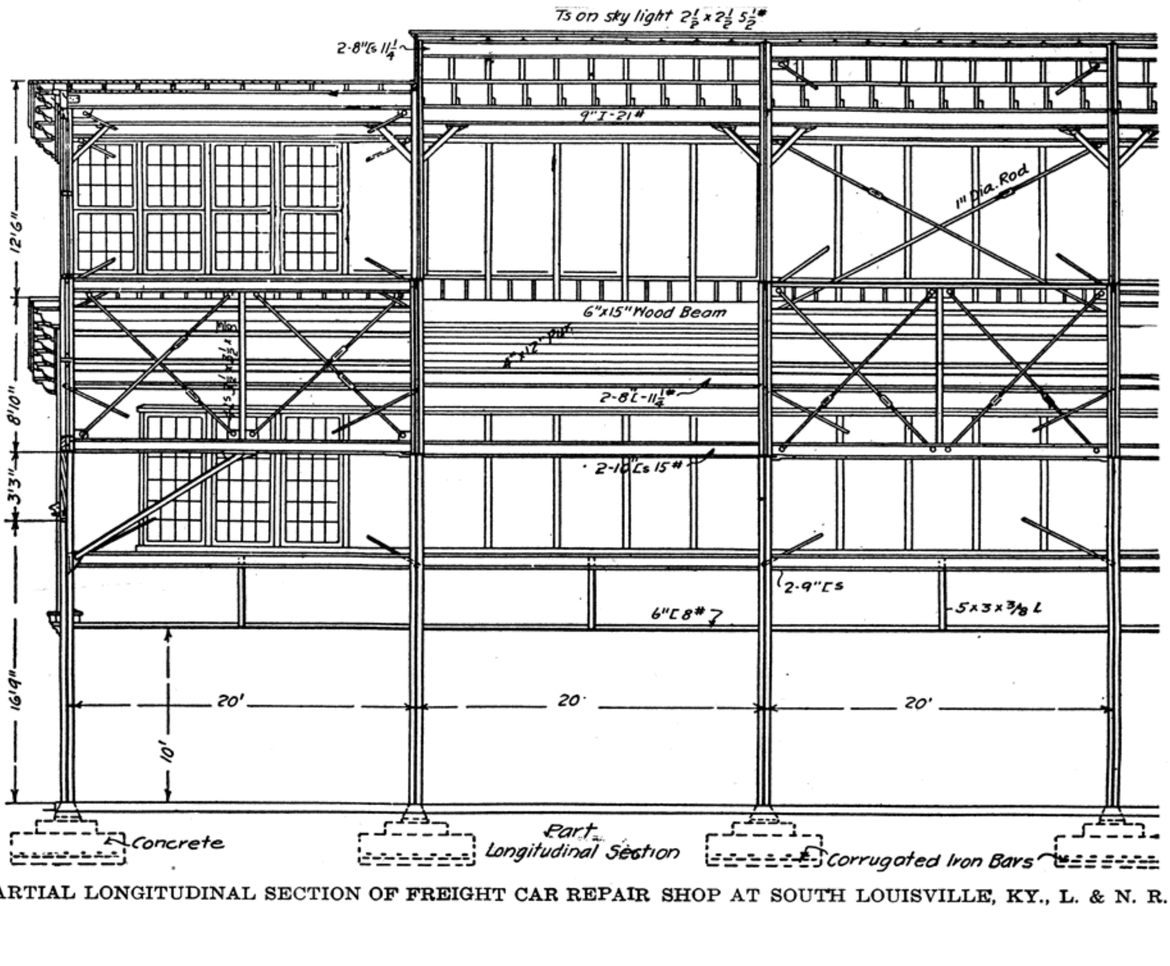
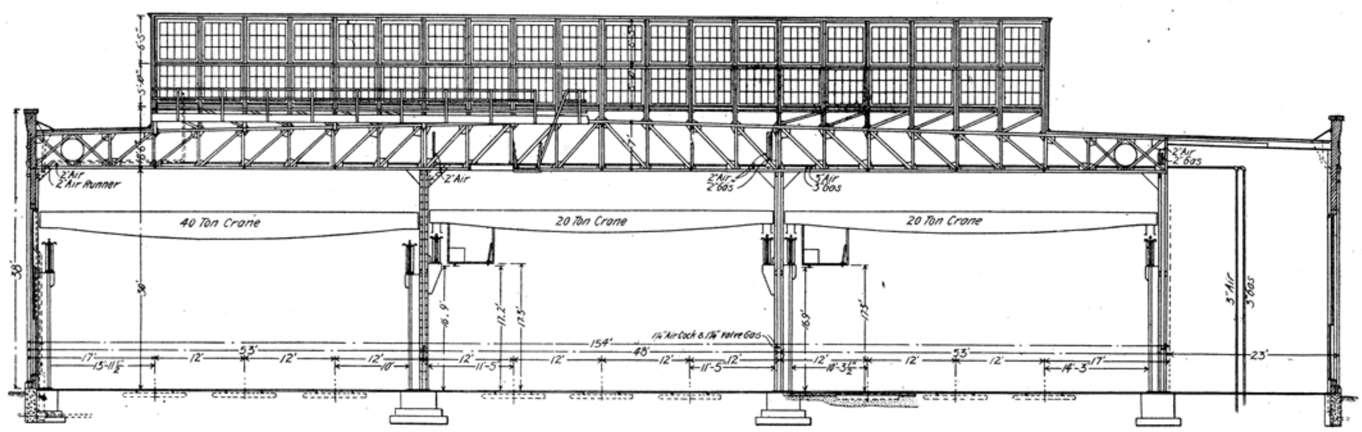


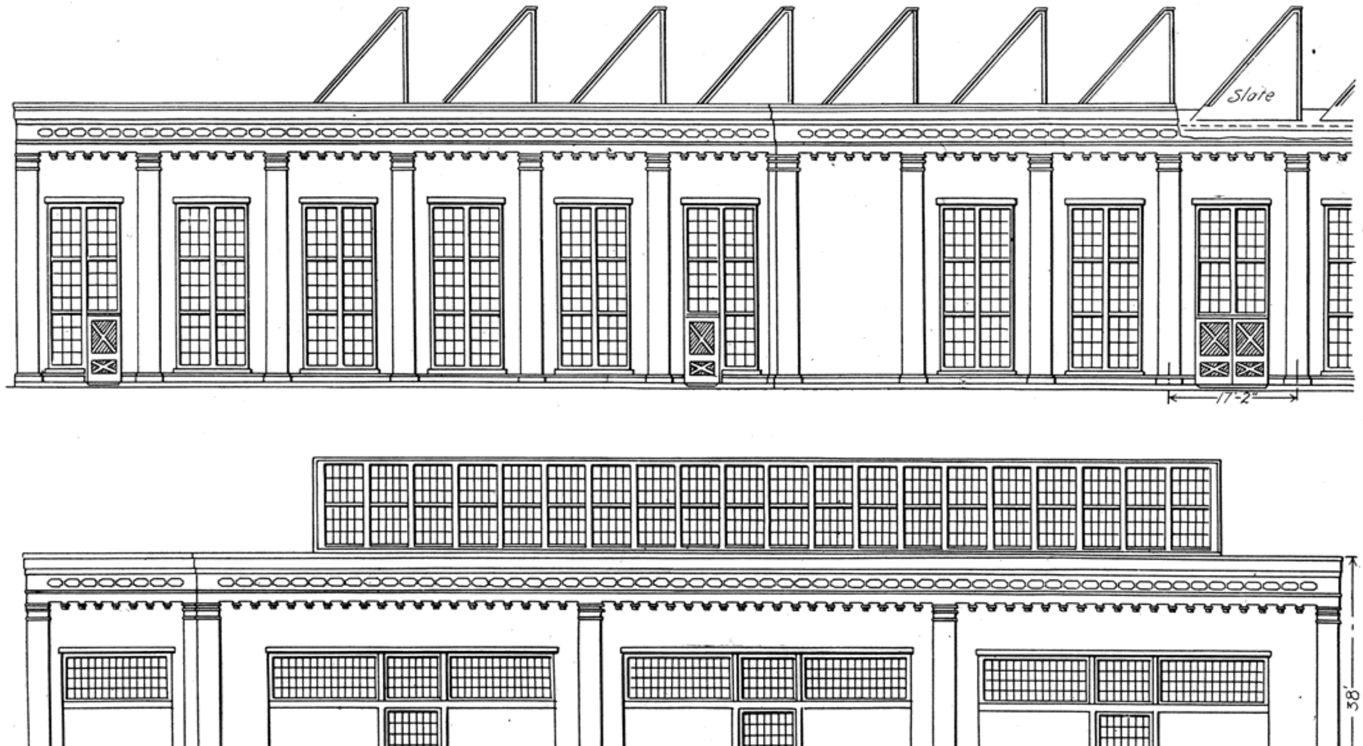
SIDE ELEVATION OF FREIGHT CAR REPAIR SHOP AT SOUTH LOUISVILLE, KY., L. & N. R. R.



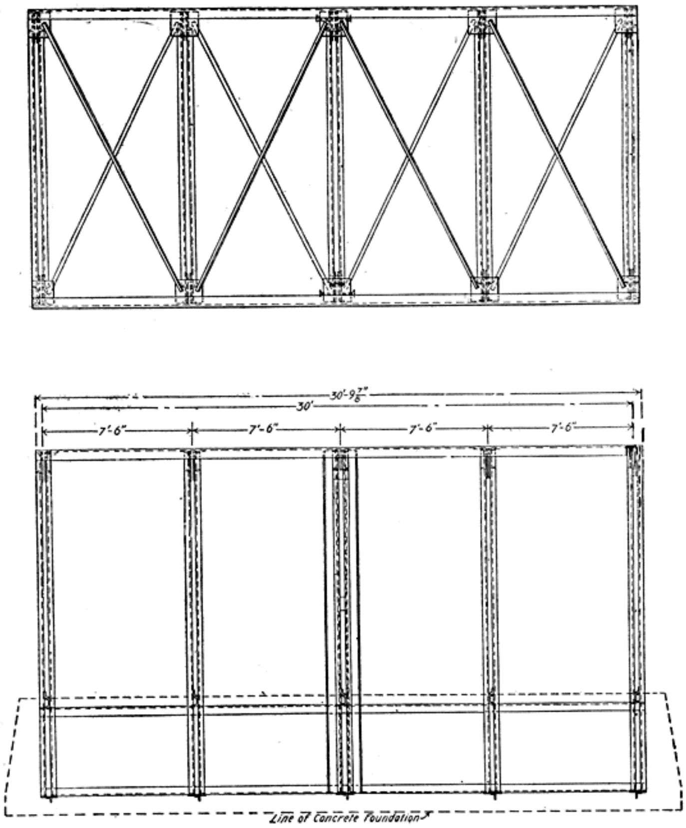
PARTIAL LONGITUDINAL SECTION OF FREIGHT CAR REPAIR SHOP AT SOUTH LOUISVILLE, KY., L. & N. R. R.



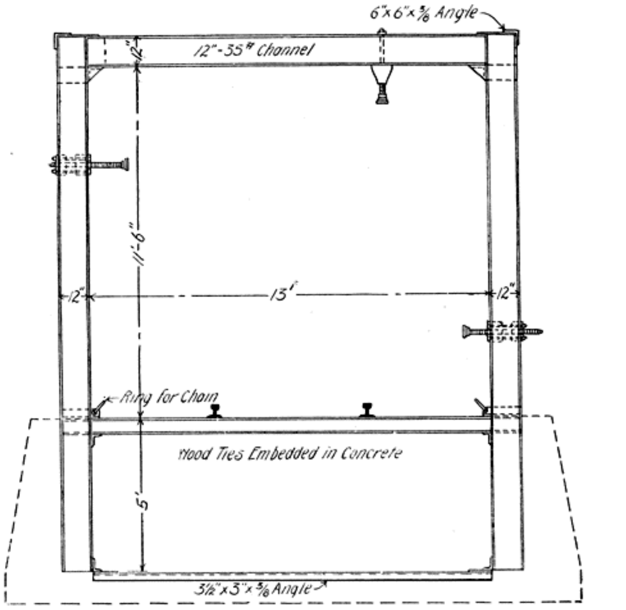
CROSS SECTION OF FREIGHT CAR REPAIR SHOP AT MCKEES ROCKS, PA., P. & L. E. R. R.



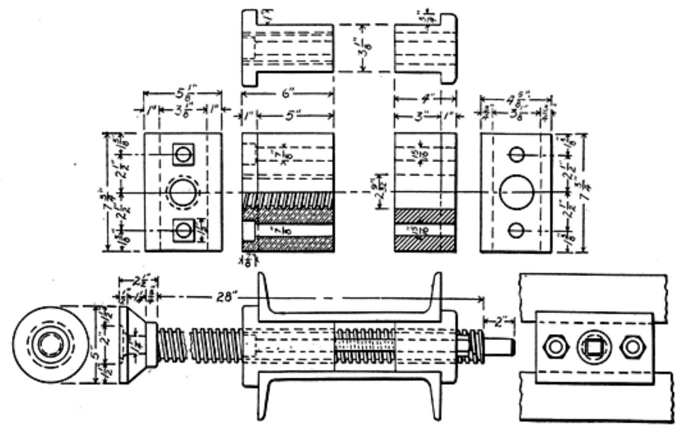
PARTIAL SIDE AND END ELEVATION OF FREIGHT CAR REPAIR SHOP AT McKEES ROCKS, PA., P. & L. E. R. R.



PLAN AND SIDE ELEVATION OF STEEL CAR REPAIR FRAME IN FREIGHT CAR REPAIR SHOP AT McKEES ROCKS, PA., P. & L. E. R. R.



END ELEVATION OF STEEL CAR REPAIR FRAME IN FREIGHT CAR REPAIR SHOP AT McKEES ROCKS, PA., P. & L. E. R. R.



SIDE AND END ELEVATIONS OF SCREW JACK USED WITH STEEL CAR REPAIR FRAME IN FREIGHT CAR SHOP AT McKEES ROCKS, PA., P. & L. E. R. R.