Noteworthy Passenger Terminal Completed at Chicago

Union station provided for Pennsylvania, Burlington, St. Paul and Alton roads

By Walter S. Lacher

The opening of the Chicago Union Station on May 15 marked the successful completion of a $75,000,000 project which had its inception nearly 15 years ago. It represents the replacement of a passenger terminal, which had long served inadequately to meet the demands imposed on it, by a new plant of greatly increased capacity embodying the latest developments in the multifarious facilities which must be provided to meet the heavy requirements of a rail gateway in a large city.

The importance of this station is definitely established by the fact that it serves as a terminal for four railroads in one of the world's largest cities. In point of number...
form tracks. It is the only station of first magnitude in
which baggage and passengers are handling entirely on
separate platforms, an arrangement which made it possible
to introduce an ingenious ramp arrangement whereby
trucking between platforms and the baggage room on a
lower level is accomplished without the use of elevators.
It embodies the most complete station facilities for handling
mail found in any railway terminal on the continent.

It is one of an extremely limited number of great pas-

cenger stations in which the platforms, concourse and
waiting room are on a common level. It is provided with
an entirely new form of train shed. It includes a system
of interior driveways and vehicle platforms that prac-
tically eliminate the use of street curb space by vehicles
in the loading and unloading of passengers, mail and
baggage. It includes a combined office and station
building, which provides for what will be ultimately one
of the most intensive developments of railway lands ever
undertaken. But even more noteworthy than any of

station building fronted on Canal street between Adams
and Monroe streets opposite the transverse axis of the
station track layout which consisted primarily of through
tracks connecting at either end with two approaches, one
from the north and the other from the south. The Fort
Wayne line of the Pennsylvania, and the Alton and the
Burlington lines entered from the south over a four track
line located on property formerly owned jointly by the
Fort Wayne and the Alton, between Van Buren and
Twenty-first street. The Burlington operated over this
line as a tenant to a junction with its own line at Sixteenth
street. The Panhandle line of the Pennsylvania and the
St. Paul entered from the north on a two track line owned
jointly by the Fort Wayne, the St. Paul and the Chicago
& North Western, as far as a point on Canal street near
Carroll avenue.

The tracks throughout this entire station area, except
for a short distance at its northerly end, were depressed,
east and west streets being carried over them on via-

Map of the North End of the New Terminal. A Portion of the North Approach Is Shown in the Upper Left Corner

these distinctive features is the impression created by a
study of the station as a whole and the problems which
were imposed in the development of an effective terminal
in the face of unusually severe obstacles.

The new station is owned by the Chicago Union Station
Company, incorporated in 1913, the stock of which is
held in four equal blocks by the Chicago, Burlington &
Quincy; the Chicago, Milwaukee & St. Paul; and two

Old Station Outgrown

The old station was located on a strip of ground about
134 ft. wide adjacent to the east side of Canal street be-
tween Madison street and Van Buren street. The old
ducts which served also as the west approaches to bridges
over the Chicago river which lies just east of the station
property. The station building had a waiting room on
the street level with three stairways leading down to a
narrow concourse flanking the west side of the train shed.
The physical layout was that of a through station but
from the operating standpoint it was strictly a terminal
station for all of the roads using it. However, the station
tracks were all so short that long trains frequently oc-
cupied portions of the tracks both to the north and south
of the axis of the station and consequently the handling
of trains was much the same as in a through station.

Other Sites Were Urged

Concerted efforts were made at one time during the
course of negotiations preliminary to the development of
definite plans for the new project, to place the station
on an entirely new site at a considerable distance from
the location of the old one. This was objectionable from

the standpoint of the site among the city's most
important approaches. For a terminal of this size the
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the standpoint of the railways for a number of reasons, chief among which is the strategic position of the original site immediately west of Chicago's business center and adjacent to east and west streets which constitute the main arteries of traffic between the loop district and the city's great west side. Furthermore, any project for a change in the location of the station was confronted with one important obstacle, the fact that the station has two approaches. For, whereas the problem of the replacing of a terminal of the stub type has frequently been simplified by withdrawing to a more favorable location on the single approach, the necessity for maintaining two approaches complicated rather than simplified the problem.

However, the various conditions which made the old site a favorable one from the traffic standpoint imposed serious obstacles in the development of an adequate plan for a new terminal as well as the conduct of the actual construction. Therefore, the decision to build the new station on the site of the old one immediately presented a number of serious restricting conditions: (1) high land values, making the acquisition of the necessary additional ground area exceedingly expensive; (2) heavy street traffic, definitely precluding the closing of any streets crossing the terminal area—in fact, the terms of the terminal ordinance required the opening of one additional street (Monroe street) and the widening of four existing streets; (3) the impracticability of making any radical change in the relative grades of the street and tracks; (4) the requirement that the layout of the station must be such that the station tracks would serve two approach routes; (5) the conduct of the construction work in and around the old station without interference with its operation.

Outline of the Plan Adopted

In consequence of these limiting conditions, the general track arrangement of the new station is basically the same as that of the old one, except that the layout has been enlarged sufficiently to effect a great increase in capacity and to permit of an entire elimination of the fundamental defects in the old plan. The primary requisite, that of adequate track capacity, was fulfilled by a process of expansion. The width of the track layout was increased to occupy the entire space between the east side of Canal street and the west bank of the Chicago river, while the length was extended sufficiently to avoid the paradox of a through layout for a station that serves as a terminal for all trains entering it, that is, to provide independent station tracks for trains entering from the north and from the south with adequate capacity to accommodate the longest trains and still leave room between the ends of these two groups of platform tracks to provide ample facilities for the dispatching of passengers and baggage to and from trains.

As it was neither practicable nor desirable to locate the entire headhouse facilities of the station entirely in the space between the two groups of tracks, only the passen-
its proportions fixed by the demands of a dual occupancy, that of station facilities in the lower portion and offices above.

The site is one that presents an unusually fine setting for a monumental piece of construction. The adoption of a low type of train shed, the construction of viaducts without structural members above the roadway level and the presence of the Chicago river immediately east of the station property afford unusual opportunity to view the headhouse and concourse from the south, east and north.

The east elevation has been particularly enhanced by introducing a driveway between the east face of the concourse structure and the river, connecting Jackson boulevard and Adams street, with its supports along the river side emphasized by an arcade of 16 massive arches, supporting the parapets surrounding the walls, but the parapets of the wings are of sufficient height to conceal their flat-arch roofs.

The Headhouse Is a Large Structure

The headhouse structure comprises a hollow square with a central court, the base of which is occupied by the main waiting room. The base of the building occupies the entire block bounded by Canal, Jackson, Clinton and Adams streets, and has a length of 372 ft. north and south by 319 ft. 10 in. east and west. However, the mass of the building above the base, that is, the outline of the office building portion, which has been carried to an elevation of eight stories, is set back 30 ft. 4 in. on the Canal street side, 39 ft. on the Clinton street face and similar amounts

Station Level Plan of the Headhouse and Concourse

ported on the dock wall along the river to afford an appropriate architectural base, while the parapets or railings of the street viaduct are of sufficient height to conceal the train sheds without interfering with the view of the buildings.

The concourse comprises a central mass extending to a height of 108 ft. above the street level, of applied classic outline with its main axis east and west and flanked on the north and south by low wings. The main central portion has a flat gable roof and the east and west faces are treated as ornamental doorways, emphasized by two Roman-Doric columns with Doric pilasters on either side. The entablature above these columns and pilasters is carried entirely around the building at about three-fourths of its height and is surrounded by an attic emphasized on the east and west faces by a segmental arch opening occupied in part by a large clock. Saw-tooth skylights in the gable roof of the main portion are readily discernible on Jackson boulevard and Adams street, giving the effect of a terraced space extending practically to the fourth floor level. On Canal street this is treated as a portico comprising a colonnade of Roman-Doric columns 39 ft. high. Similar treatment is used on Clinton street except that the building wall is flush with the back of the columns. The treatment on Jackson boulevard and Adams street is more severe and consists primarily of a continuous row of open windows which afford the necessary ventilation for the taxi driveways, which will be described later.

Architectural emphasis is given to the two entrances to these driveways on the Clinton street corners by ornamental pavilions and for the sake of symmetry similar construction is provided on the two east corners.

Street Grades Influence Plan

In order to obtain a clear conception of the station plan it is necessary to have a definite understanding of the

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arrangement of the street grades in their relation to those of the tracks and to the Chicago river. The water level is normally at about Elevation minus 10, Chicago city datum, while the streets on both sides of the river are at an elevation that averages about plus 15. However, to obtain adequate underclearance the roadways of the river bridges have been raised to an elevation ranging from 20 to 26, making it necessary to provide ascending grades on all streets approaching the river bridges. But on the west side of the river the street grades are continued at the higher elevation to the east side of Canal street to afford adequate overhead clearance for the station tracks. From the east side of Canal street the east and west streets descend to Elevation 15 at Clinton street, one block west, while Canal street has an elevation ranging from plus 22 to plus 26 from Monroe street to Taylor street, with descending grades beyond these limits to meet the normal street grades at Washington street and Roosevelt road, respectively.

Because the tracks are below the streets and owing to the necessity for dividing the headhouse facilities into two units separated by Canal street, it was necessary and also most desirable to place the main floor of the station below the street level in the north and south ends of the building. This affords the operating advantage of having the station on the same level as the tracks and, what was more important, provides a direct connection between the station facilities east and west of Canal street by a connecting concourse under the street. Accordingly, the floor of the passenger concourse east of Canal street was placed at Elevation plus 8, and the floor of the main waiting room in the center of the headhouse west of Canal street at Elevation plus 10, with a scarcely perceptible slope on the floor of the connecting concourse between the two. The baggage room occupies a basement under the passenger concourse and the east end of the concourse lobby west of it, at Elevation minus 8.7.

Provide Numerous Entrances

With these conditions fixed the interior arrangement was influenced by the all-important requisite of effective and convenient entrances and the maximum simplicity of the entire interior arrangement. Special pains were taken to insure that the routing of the passengers through the station would not only be obvious but would also afford direct access to the various facilities with practically no opportunity for confusion on the part of even the most inexperienced traveler. It is the opinion of the officials of the union station company that the efforts entailed in developing the plan have been entirely warranted by the operating results obtained since the station has been placed in service.

The main waiting room is 100 ft. by 269 ft., back to back of the balconies, at each end, in the exact center of the block bounded by Canal, Clinton and Adams streets and Jackson boulevard. The passenger concourse is 130 ft. long by 192 ft. wide with its longitudinal axis east and west. It is flanked on the north and south by train concourses 36 ft. 9 in. wide abutting on the ends of the station platforms. Under Canal street immediately west of the passenger concourse and connected with it by three stairways always is the concourse lobby, a space 192 ft. north and south by 100 ft. east and west, and continuing west from this on its east and west axis is the ticket lobby passage 90 ft. long by 55 ft. wide, which serves with the central portion of the concourse lobby as the main corridor connecting the waiting room with the concourse lobby and the passenger concourse.

Both Stairways and Ramps in Concourse

The concourse has two main entrances from the street level. Doorways in the east and west faces fronting on Canal street and the river drive, respectively, communicate with balconies overlooking the interior of the concourse, from which duplicate stairways to the left and right lead to the station floor level. These two entrances are supplemented by two others on Jackson boulevard and Adams street, respectively, near the east end of the building where doorways in two kiosks afford entrance through two ramps descending on moderate grades to the east and west axis of the building where they join at the floor level and emerge into the concourse through a wide archway directly under the balcony of the east stairway entrance.

The main entrance to the headhouse comprises duplicate entrance lobbies 40 ft. wide by 85 ft. long on Canal street, 70 ft. 10 in. to either side of the east and west axis of the building. These lobbies enclose broad stairways which lead directly to the waiting room. But more important than these entrances are the facilities for access by taxicabs, which were developed in a most effective manner by taking advantage of the variation in street grades. With Clinton street at Elevation 15, Canal street at Elevation 26 and the concourse at Elevation 8, it was possible to construct two taxi driveways entering the building at the two Clinton street corners with ramps just inside the line of the building leading to cab stands at the north and south ends of the east entrance lobby directly under Canal street at the concourse grade. These taxi ramps may also be used to load and unload passengers at entrance lobbies on the north and south axis of the building that lead directly to the north and south ends of the main waiting room. Arcade entrances are also provided for pedestrians paralleling the taxi ramps and leading from Clinton street to the main waiting room.

Each taxi entrance is also used for access to the baggage and express rooms in the basement by means of a second leg of each ramp extending west outside the first leg and under the sidewalks on Jackson boulevard and Adams street, respectively, to Clinton street, thence along under the walk on that street to a junction of the two driveways on the east and west axis of the building and thence eastwardly to the baggage and express loading platform in the basement. These driveways have an aggregate length of a half mile, all within the walls of the building and all paved with brick.

Separate Entrances to Office Building

To insure an effective segregation of the dual functions of the headhouse, that of a passenger station facility and a large office building, special pains were taken to isolate the entrances to the office building portion of the structure entirely from the station facilities. Accordingly, entrances to the offices have been provided in the center of the Jackson boulevard and Adams street sides of the building at a considerable distance from any of the entrances to the station proper. By providing for a flight of six steps from the sidewalk level, access was obtained to loggias with floors at Elevation 23.5, or sufficiently above the level of the inclined driveways from Clinton street so that these loggias span the driveways with adequate clearance for the vehicular traffic underneath. These loggias lead to entrance lobbies abutting on the ends of the waiting room but at an elevation of 13 ft. 9 in. above the waiting room floor level so that they give the general effect of balconies overlooking the waiting room. To the west of these loggias are corridors leading to duplicate banks of five Otis elevators each. This number affords adequate service to the office space in the building as now completed to a height of eight stories, but provision has been made for the addition of five more elevators in each group at any time that the height of the building is increased.

The auxiliary facilities of the station have been located with a view to the convenience of the patrons, taking into
particular consideration the use which the various classes of passengers desire to make of them. The passenger concourse has been kept entirely clear to afford ample unobstructed space for the movement of passengers to and from trains, particularly those using suburban service of the various railroads, who enter and leave via the ramps or the concourse stairways, also outgoing passengers already having tickets, who enter the station in taxicabs and board trains immediately, or arriving passengers who depart at once in taxicabs, or via the concourse exits.

The parcel checking stand and the baggage counter are located in the concourse lobby to the north and south of the central passageway, while the ticket lobby is located between the main waiting room and the concourse lobby on the south side of the ticket lobby passage where it is within easy reach of passengers entering the station in taxicabs as well as patrons occupying the waiting room.

The other facilities immediately adjacent to the waiting room are those ordinarily required only for passengers who must spend some time in the station. These include a restaurant and supplemental accommodations for men and women on the west side of the waiting room.

A doorway in the center of the west wall leads to a large lunchroom for quick service while a corridor from the same doorway connects with a smaller dining room for more formal service. North of the entrance to the restaurant is a doorway for entrance into the women's waiting room, toilets and lavatories, while to the south a doorway opens into a lobby for access to a barber shop and by a stairway to a men's toilet room in the basement. No provision has been made for a men's waiting room or a smoking room, studies of large stations throughout the country indicating that the smoking room serves no essential need and is difficult to supervise and maintain in a cleanly condition.

Station Tracks in Two Groups

As stated previously, the station tracks are arranged in two groups, one to the south of the concourse and the other to the north. The south group, which is used by the trains of the Burlington, the Alton and the Pennsylvania, comprises 14 passenger tracks, while the north group, which is used by the trains of the St. Paul and a few trains of the Pennsylvania, embraces 10 tracks. Just east of the 14 passenger tracks in the south group are 5 tracks which serve the railway mail terminal, a long, narrow building located between Harrison and Van Buren streets. One of these is a through track extending the full length of the passenger tracks and passing to the east of the concourse to a connection with the eastern track of the north station group. The other four are stub tracks, two at the south end and two at the north end of the mail building, the two south tracks connecting into the south approach and the two north tracks into the track connecting with the north group. This arrangement affords the necessary access to the mail terminal tracks for the handling of mail trains or cars entering or leaving the station via either approach.

The passenger tracks in the station have varying lengths so that they are capable of accommodating 7 to 18 car trains, with locomotives. The capacity of the passenger tracks is 191 cars at the south end and 141 cars at the north end.

Separate Baggage and Passenger Platforms

The distinctive feature of the track layout is the provision for a platform on each side of each track, alternate platforms being designed to serve exclusively as baggage and passenger platforms, respectively. The tracks are spaced 23 ft. 3 in. center to center across the passenger platforms, which are 13 ft. 9 in. wide, and 21 ft. 3 in. across the baggage platforms, which are 10 ft. 7 in. wide.

The separation of the passenger and baggage platforms has the advantage that it permits the establishment of independent levels for these platforms at a height most suitable for the particular purpose. The baggage platforms were given a height of 1 ft. 8 in. from the top of rail to afford a reasonable height of baggage trucks

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The main doorways at valves on each given by C. by an entablature of 47 ft. a tablature is ing vertical them. The crown 112 ft. 3 in. center to center across the passenger platforms, which are 13 ft. 9 in. wide, and 21 ft. 3 in. across the baggage platforms, which are 10 ft. 7 in. wide.

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constructed with their platforms at car floor level. In
the cases of passenger platforms consideration was given
to their construction to car floor level, but owing to
through car traffic movement involving the use of cars
from various connecting railroads in the west it was found
that high platforms would entail extended changes in equip-
ment by roads that do not use the station. Consequently
it was decided to adopt a low passenger platform but with
a type of construction that will readily permit of a change
to high platforms whenever it is found desirable. These
platforms are now constructed to a height of 7 3/4 in. above
the top of rail with ramps on an ascending grade of 7.12
per cent to connect with the concourse floor level. How-
ever, as this floor level is approximately five feet above
the track level a future change to car floor level will have
no other effect than to reduce the grade of the connecting
ramps.

By far the most advantageous feature of the separation
of passenger and baggage platforms is the opportunity
it affords for direct access to the baggage room in the
basement without the use of elevators, since this arrange-
ment made it possible to introduce ramps at the ends of
these platforms descending on a grade of 6.75 per cent
to the baggage room floor level. These ramps are 10 ft.
5 in. wide and can be used simultaneously by trains of
trucks moving in opposite directions.

The Headhouse Facilities in Detail
The main waiting room is a plain rectangle in plan with
doorways at each end and at three equally spaced inter-
vals on each side to which architectural emphasis has been
given by Corinthian columns and pilasters surmounted
by an entablature carried around the four walls at a height
of 47 ft. above the floor. The clerestory above this en-
tablature is broken up by segmental arch openings form-
ing vertical continuation of the doorways directly below
them. The ceiling comprises a flat barrel vault with its
crown 112 ft. above the floor. It consists entirely of sky-
lights with the exception of one row of coffers extending
around the sides and the ends. The central doorway in the
east wall opens into the ticket lobby or main passageway to
the passenger concourse and its coffered barrel vault ceil-
ing, extending to a height of 70 ft. is readily discernible
through the clerestory opening above the doorway. For
the sake of symmetry this coffer treatment is repeated in
a half dome niche behind the clerestory opening over the
central doorway of the west wall. The other six arch
openings in the clerestory serve as windows and are
screened by heavy grill work.
The floor of the waiting room is Tennessee marble.
The walls to the height of the belt course and the shafts
of the columns are of Italian travertine. The remainder
of the walls and the ceiling are of plaster, finished in a
warm buff tint, in keeping with the soft texture of the
travertine. The exact center of the waiting room is
occupied by an octagonal information counter with a
pedestal in the center affording a support for a four-face
clock. The counter and the clock standard are of travers-
nelle fleuris marble. Twenty double benches of American
walnut afford a seating capacity of 450.
The ticket lobby passage and the two main stairway
lobbies on either side of it are also finished with travertine
stone with the exception of the ceilings which are of cof-
fered plaster. Similar treatment is used in the north and
south entrance lobbies and in the office building entrance
lobbies directly above them. The stairways from Canal
street do not occupy the entire width of the stair lobbies
but afford space on either side for balconies 8 1/2 ft. wide
at the street level to permit access to concession spaces
reserved for shops.

A Unique Rest Room
Along the west side of the waiting room are three large
rooms facing on Clinton street, all of which have a height
of 40 ft. with large windows occupying the upper half
of the west or Clinton street wall. The north room is
54 ft. by 70 ft. 5 in. and serves as the women's waiting
or rest room. Special pains were taken to obtain a dec-

A Vertical Section Through the East and West Axis of the Headhouse and Concourse

rative treatment of subdued or restful characteristics.
The walls have been subjected to but little ornamentation
and are broken only by the high window opening on Clin-
ton street and relatively small door openings in the east
side. In fact, embellishment has been limited entirely to
the ceiling which is coffered with a Pompeian type of deco-
rination in blues, yellows and dark reds, and to two large
hangings of Belgian velvet in a deep red which occupy
about one-fourth of the upper half of the north and south
walls. These are entirely plain save for a small panel into
which the official seals of each of the four roads have been
tastefully worked. The furniture is American walnut up-
holstered with blue silk moiré. From the north side of
this room a stairway leads to a toilet room in the basement
affording both free and pay service. The free toilets pro-
vide 21 closets and 11 lavatories and the pay toilets, 9
closets, 18 combination closet-lavatories and four complete
bathrooms.
The toilet room for men in the basement of the south-
west corner of the building also provides free and pay
service. The free toilets contain 38 closets, 18 urinals,
16 lavatories and one Bradley wash fountain. The pay
toilets provide 26 closet lavatories, four of which are
supplemented by shower baths. All of the toilet rooms
have Tennessee marble walls and floors and plastered
ceiling. Standard Sanitary Manufacturing Company's
fixtures were used throughout. The barber shop, which
opens off the stair lobby to the men's toilets, is a room of
unusual decorative treatment. The floor is Welsh quarry
tile set with wide joints while a high wainscot is finished
The Headhouse Is a Monumental Structure

Upper Left, at the Information Counter; Upper Right, in the Ticket Lobby; Center, the Great Waiting Room; Lower Left, Looking Into the Waiting Rooms from One of the Canal Street Stair Lobbies; Lower Right, the Ticket Lobby Passage Affords a Broad Entrance Into the Waiting Room.
in Faience tile having a buff body and green trim with recesses for toilet cabinets and open shelves. The ceiling and the walls above the wainscot are plastered with a smooth but irregular surface tinted in light cream. Space is provided for 16 barber chairs, with individual pedestal lavatories and mirrors with black frames for each chair.

**A Restaurant of Unusual Character**

The largest room on the west side of the building is a lunch room 85 ft. by 111 ft., located symmetrically with respect to the east and west side of the building. It has a low American walnut wainscot with a marble base, plastered walls and a coffered ceiling. The entire west side of this room for a width of 22 ft. 8 in. and a height of 13 ft. is occupied by a service kitchen, the remaining floor space being occupied primarily by three U-shaped lunch counters with space adjacent to the north and south walls and on the mezzanine floor above the kitchen occupied by tables. The counter and stools are of table-chair height. The top of the counter is a thick slab of green Vermont marble while the base is of grey traverselle on the patrons' side and Tennessee marble on the serving side. The floor on the public side is Tennessee marble, and on the service side it is rubber tile, the service space floor being depressed a sufficient amount below the level of the public space floor to give the counter a convenient serving height.

To the south of the lunch room is a formal service dining room, 42 ft. 5 in. by 56 ft., which is decorated in a more subdued tone than the other rooms. It has a high wainscot of American walnut divided into small panels to offset the effect of the high ceiling. The walls are plastered and the ceiling is coffered in decorative plaster. Unusual pains have been taken by the concessionaire to give the room a dignified, distinguished air. Unusually rich furnishings have been provided in the form of tables, chairs and sideboards of antique Italian pattern. Access to this room is afforded by a corridor from the main waiting room as well as by a short corridor leading to the Clinton street entrance of the south arcade.

This dining room and the lunch room receive direct service from the service kitchen at the rear of the lunchroom, but the main kitchen, bakeries, stores, dishwashing facilities, refrigerators, etc., are in the basement. The basement space assigned to the concessionaire, Fred Harvey, also embodies a large cafeteria, entrance to which is had by a stairway leading from the south lobby of the waiting room. All kitchen space in the basement is finished with red quarry tile floors and white glazed tile walls.

**The Ticket Office**

The ticket lobby occupies the entire southeast corner of the headhouse east of the main waiting room and south of the ticket lobby passage. Of this space a rectangular area 58 ft. by 100 ft. is occupied by the ticket offices, affording 150 ft. of counter length on two sides with 29 ticket windows. The face of the counter is travertine, the top is Belgian black marble and is surmounted by a brass grill backed with clear glass, thus affording a clear view of the entire interior. There are no fixed ticket cases. Each ticket clerk is assigned an individual case mounted on castors which is rolled into place adjacent to his window when he goes on duty and is locked up and removed to permit its replacement by a case assigned to the clerk who relieves him when his tour of duty is completed. The only segregation of the business done at the various ticket windows is to assign six windows to the sale of communication and local tickets and assign all the rest of the windows to the sale of both railroad and sleeping car tickets. Each clerk is equipped to sell tickets for all roads using the station, his ticket case being stocked with tickets covering 95 per cent of the routes called for in the normal ticket sales. Tickets covering the remaining routes are
kept in a special case placed in the center of the ticket office where they are available to all clerks. The clerks are provided with telephones for communication with the reservation bureau on the third floor where clerks in the employ of the four railroads record reservations on the car diagrams. A few minutes before train leaving time, the diagrams are transmitted by pneumatic tube to the passenger agents of the individual railroads who occupy offices at the south end of the concourse lobby, whence they are delivered to the Pullman conductors.

Space is also provided on the third floor for an information bureau. In this room 20 trunk lines from a Chicago telephone exchange are carried to 12 operator positions, 6 on each side of a long table, divided lengthwise by a rack equipped with time tables and rate sheets for ready reference. Each operator can handle a call coming in on any trunk by moving the proper keys.

The concourse lobby under Canal street has a Terrazzo floor, terra cotta walls and a flat groined ceiling finished in light grey. The baggage and parcel counters are constructed of laminated maple and steel plates with vertical sliding windows of rough wire glass set in steel frames.

**A Spacious Concourse**

The interior of the passenger concourse is of a design somewhat similar to the concourse of the Pennsylvania station in New York, except that opportunities were afforded for a greater refinement of detail in the Chicago station. The roof consists of five flat barrel vaults with their axes east and west and is supported by steel arches carried on steel columns, all of the steel work being entirely exposed. The framing of the main central portion of the structure is divided into three longitudinal aisles with a central span of 84 ft. and two side spans of 20 ft., the ceiling at the crown of the central span being 90 ft. above the floor and that of the two side spans somewhat lower. Flanking this central portion are two side aisles of 68 ft. span with ceilings 43 ft. above the floor. In the transverse direction the ceiling is divided into bays 34 ft. wide which are spanned by longitudinal arches. The arches are all open box trusses and the columns comprise four angles laced on the inside, the framing being done in an unusually finished manner, especially at the junction of the four arch trusses at the tops of the main columns. The roof is covered for the most part with Federal pre-cast cement tile. In the main center span and in the two low side aisles these tile are exposed on the side wall, while in the two 20-ft. aisles a plastered ceiling of flat dome shape has been provided. The walls for the most part are grey mottled terra cotta with some of the upper portions of plaster finished in imitation of stone. The windows have steel frames and sash.

The floor is of reinforced concrete with large areas of vault lights for the purpose of affording some natural light to the baggage room in the basement. The floor of the concourse is entirely unoccupied except for an information counter of terra cotta in the center, over which is mounted a train bulletin divided into panels assigned to the various railroads. This bulletin board is surmounted by a two-face clock. At the east end of the building, flanking the stairway are two low projections from the east wall, the lower portions of which are devoted to concession space occupied by Fred Harvey as a grill room.

**Train Gates of Iron and Glass**

Access to the train concourses on either side of the passenger concourse is provided by continuous lines of vestibules 7 ft. 3 in. deep with sliding doors on the inside and swinging doors on the track side. These vestibules are arranged in groups serving two tracks for each 34 ft. bay, providing two exits to the trains 4 ft. 8 in. wide next to the columns with an entrance from the trains in the center 12 ft. wide. A "Hutchinson" train indicator for each track separates the entrance and exit doors. The vestibule construction is entirely of iron and steel with glass panels in the doors set in steel frames.

The train concourses, which correspond in detail and construction with the passenger concourse, are entirely open on the track side except for iron railings at the ends of the tracks which are carried partway down the sides of the passenger platform ramps.

The baggage room is 278 ft. wide, north and south, by 288 ft. long. Its width is expanded at the west end to provide a loading platform 400 ft. long, abutting on the space for street vehicles. Under the prevailing operating arrangement the bulk of the express is handled in facilities provided by each of the individual railroads, consequently a space 45 ft. by 85 ft., partitioned off at the south end of the loading platforms is adequate for the handling of such express matter as must be loaded or unloaded at the platform. The baggage room is provided with six Toledo scales, with automatic direct reading dials. Four of these are located along the loading dock (one in the express space) and the two others in the center of the room.

The South Train Concourse. Passenger Platforms Are Connected to the Train Concourse Floor by Means of Ramps. Enclosure for One of the Baggage Platform Ramps in Foreground.
How Baggage Is Handled

A pneumatic tube system comprises an important agency in the operation of the baggage room. This affords direct connection between weighing stations at the loading platform and the exchange cashier's office, which is located in the baggage room directly below the checking counter enclosure on the station floor, between the exchange cashier and the checking counter and between the exchange cashier and the baggage master's clerks' office. Every piece of outbound baggage unloaded at the platform is weighed by a receiving clerk on one of three automatic scales which makes out a weighing slip on which he records the weight and the number and name of the tracking company's check on the trunk. This weight slip is transmitted to the baggage counter for file until the passenger presents his duplicate check. When the duplicate of the tracking company's check is presented at the counter, it is taken up and dispatched to the exchange cashier with the duplicate of the railroad check presented to the passenger for identifying the trunk and attaching the new check.

Hand baggage checked at the counter is passed to the baggage room by means of a chute, while incoming hand baggage is delivered to the counter by an elevator and placed on compartment shelves until called for. The efficiency of this detail of the service is indicated by the fact that cases have been noted where hand baggage has been loaded out of baggage cars, trucked into the baggage room, elevated to the counter enclosure and stored before a passenger could alight from his train and walk the length of the platform and concourse to claim his baggage at the counter.

Well Designed Illumination

While natural lighting has been provided in abundance in the principal rooms of the station, careful study was given to insure that the artificial illumination would be equally effective. The lighting of the main waiting room is unique and embraces two independent systems. The ceiling and clerestory walls are lighted by two batteries of flood lights installed in balconies at the two ends of the room. Each bank contains thirty-five 500-watt X-ray reflectors and produces a well-diffused light. The lower portion of the walls, the columns and cornices of the belt course are effectively lighted by lamps installed on the tops of 16 massive bronze torches or floor standards mounted on green Vermont marble bases and placed at uniform intervals along the walls. The lighting fixture is a glass bowl ribbed with bronze which contains two 250-watt lamps mounted over a mirror reflector with four 100-watt lamps below the reflector to illuminate the sides of the bowl.

The covered vault of the ticket lobby passage is lighted by twenty-four 250-watt X-ray projectors on top of the cornice along the two sides of the room, while the walls are illuminated by four bronze brackets secured to the walls about 14 ft. above the floor. The dining rooms and the women's rest room are lighted by ceiling fixtures of artistic design, while the concourse lobby is lighted by simple bowls in the center of each panel of the groined ceiling.

In the passenger concourse the lighting fixtures are a simple rugged design in distinct keeping with the open steel work which supports the roof. They consist of 12 opal glass spherical globes suspended from a tubular ceiling ring supported by chains from the roof trusses, being provided with lowering devices to facilitate cleaning. The passenger platforms are provided with two 500-watt lighting fixtures in each longitudinal panel. As no standard lighting unit was found to give a satisfactory distribution of the light, a special fixture furnished by the A. B. Boettcher Manufacturing Company was designed for the installation. It consists of casting of special corrosion resisting metal with a polished interior to serve as a reflector with an acorn shaped rippled glass globe. The baggage platforms are lighted with standard R. L. M. reflectors fitted with clear glass covers.

Street lighting has been provided in the form of 40 ornamental street lighting standards each supporting two G. E. "Novalex" basket type street lighting units with 600 candle power series lamps. The boulevard along the river drive is ornamented with stone pylons each of which is equipped with four 100-candlepower series lamps while the office building entrances on Jackson Boulevard and Adams street are embellished by heavy bronze lighting standards of rugged design.

A New Type of Train Shed

One of the outstanding features in the design of the station is a new type of train shed which represents a development resulting from the unusual conditions imposed by the arrangement of the platforms and a sincere effort to effect an improvement over previous designs. It was desired to provide a low type of shed and because the open umbrella or butterfly sheds do not afford complete protection against rain or snow it was concluded that the shed must be of the enclosed type with smoke slots just clearing the locomotive stacks to obtain an immediate discharge of smoke into the open air. It was also felt desirable to provide more headroom over the passenger platforms than is usually obtained in low sheds. Another controlling consideration in the determination of the design was the width of the baggage platforms which is not sufficient to permit the placing of any columns in them. Consequently, the design had to be one in which the transverse roof span equals the distance between columns placed in the centers of the passenger platforms, or 49 ft. 9 in., a condition that at once introduced a serious problem to avoid excessively heavy and deep transverse girders to support the roof load.

These problems were solved by the development of a design which is not only ingenious from the standpoint of the structural engineer but is also unusually pleasing in appearance. The transverse load-carrying member comprises a flat arch girder affording a clearance of 17 ft. from top of rail, combined with two upward extending legs which are carried to a connection at the column at a height of 28 ft. above the platform. This arrangement provides a heart-shaped truss over each column which performs two important functions. It provides a monitor over the passenger platform affording the desired head-room, more effective lighting and better ventilation, and it effects a marked shortening of the effective span of the transverse girders.

For the purpose of reducing the obstruction in the passenger platform resulting from the presence of the shed columns, they were spaced as far apart as practical considerations would permit, 41 ft. 8 in. center to center.
The load between the transverse frames is carried very largely on the longitudinal girders forming the sides of the smoke slots, but supplemented by arch girders in the planes of the columns which frame into two struts connecting with the tops of the columns to form a ridge pole being the use of special sections of bulb beams for the curved rafters.

No less distinctive than the outline and framing of the shed is the roof covering which consists of Federal cement tile throughout, for the profile of the roof cross section

A Typical Cross Section of the Train Shed, Station Tracks and Platforms

for the monitors over the passenger platforms. These longitudinal members support five equally spaced rafters conforming to the contour of the roof outline to provide the primary support for the roof covering. Particular

is such as to call for the exercise of ingenuity as well as accurate workmanship to provide precast tile that would insure a perfect fit to the curves and angles of the steel frame. It imposed the necessity of providing 11 varieties

The station street except . The elevation by an establish under side possible elevations by the 0 and the max 0 crossing the was encounter condition was be raised at station of the on Madison street. This elevations for from minus tracks, respec tary to estab fixed by the street bridge of the oppor tracks in ord tions, but the line with gra in the sag a grades are re

New

The track the same loc ment has bee that of provi four, exclisively for the old layo for the freig entirely indep approach tr
The top of the high monitor over the passenger platform has a ventilating hood which is covered by two curved slabs 1 3/4 in. thick, 24 in. wide and 36 in. long measured on the curve of this hood, with a special cap unit covering the joint at the ridge. The sides of the monitor for a width of about nine feet serve as continuous skylights and are covered with three tiers of curved glass tile 1 3/8 in. thick, 24 in. wide and 36 in. long, each of which contains a pane of 3/4-in. rough wire glass, 20 in. by 30 in.

Over each baggage platform is a gable type skylight covered with interlocking tile 1 3/8 in. thick, 24 in. wide and 52 in. long, with a standard ridge cap at the ridge. Each third interlocking tile on both slopes is provided with a pane of glass 21 in. by 35 in. The remaining portion of the shed roof, namely, between the baggage platform skylights and the lower edge of the passenger monitor skylights exclusive of the smoke slot is covered with channel-section slabs approximately 18 in. wide by 8 ft. long. In addition to these units flashing tile is provided under the edges of the baggage skylight and under the hood over the passenger monitor.

The channel slabs form gutters which provide the drainage for the roof, emptying into down spouts at the low end of each block. The gutters are provided with Johns-Manville built-up roofing which is flashed up under the skylight and up the sides of the smoke slots. All the rest of the tile are uncovered, as water proof construction is insured by overlapping horizontal joints and filled vertical joints, together with the density of the concrete in the slabs themselves. The plastic joints are formed by projecting lips on the vertical edges of the slabs, so shaped as to provide a groove which is filled with a special oil-cement filler covered with a weather coating of elastic compound. The glass tiles of particular interest because the glass is concreted into the slabs in manufacture and is protected against stresses set up by changes in temperature, wind pressure and other strains by dipping the edges of the glass in a hot asphalt preparation before inserting it into the concrete.

Another difficulty imposed in the construction of the train sheds was introduced in the provision for covering the girders of the smoke slots to protect them from the corrosive locomotive gasses. Poured-in-place concrete was used for this purpose, the particular problem being to insure a high density in a concrete of such consistency that it would readily flow around the reinforcement and in an exceedingly narrow space between the forms and the sides of the girders. To obtain this the mixture was designed according to the Abrams method.

Tracks Embody Interesting Innovations

The station tracks are all tangent and parallel to Canal street except where they connect with the ladder tracks. The elevation and grades of the tracks were controlled by an established vertical clearance from base of rail to the under side of the viaducts of 17 ft. and the maximum possible elevation of the viaducts over the tracks, as limited by the elevation of the river bridges and Canal street and the maximum permissible grades on the street between these points of fixed elevation and the point of crossing the nearest track. The most severe condition was encountered at Madison street where the controlling condition was the grade of Canal street, which could not be raised materially because of established grades at the station of the Chicago & North Western, which fronts on Madison street between Canal station and Clinton street. This condition resulted in the establishment of elevations for the tracks under Madison street, ranging from minus 2.055 to minus 0.40 for the west and east tracks, respectively. At Van Buren street it was necessary to establish the grade of the tracks at plus 0.73 as fixed by the elevation of the roadway on the Van Buren street bridge. At all other points advantage was taken of the opportunity to establish higher elevations for the tracks in order to obtain more favorable drainage conditions, but this introduced a more or less undulating grade line with grades ranging from 0.0 to 0.4 per cent, except in the sag at Madison street where considerably heavier grades are required for short distances.

New Approaches Afford Greater Capacity

The track approaches to the station have substantially the same location as the old ones, except that the alignment has been improved. However, primary change was that of providing six tracks in the south approach instead of four, and four tracks in the north approach, used exclusively for passenger service instead of two which in the old layout were used both for passenger trains and for the freight transfer service now handled on two entirely independent tracks. The station company's south approach tracks terminate at Roosevelt road, where they join with four tracks owned jointly by the Pennsylvania and the Chicago & Alton and two tracks owned by the Burlington, and with passenger coach yards and engine terminals of the Pennsylvania and the Burlington to the east and west of the main tracks, respectively. The north approach terminates in the vicinity of Carroll avenue (vacated) on a curve connecting with a two-track main line owned jointly by the Pennsylvania and the Chicago, Milwaukee & St. Paul, extending to the west, and with a branch line of the Chicago, Milwaukee & St. Paul extending to the north.

In the case of both the north and the south approaches the axis of the approach tracks lies considerably to the east of the axis of the station tracks. Consequently, connection between the approaches and the platform tracks was made in each case by a single pair of ladder tracks fanning to the west. In most cases the platform tracks are arranged in pairs with a single connection to the two ladder tracks, the parent track of each pair crossing the inner ladder to a connection with the outer ladder and thus providing for simultaneous parallel movements in or out of any two of the platform tracks except the two tracks of any one pair. To permit direct connection between any approach track and any station track, double crossovers were provided in both directions at the throat of each yard as well as at the ends of the station company's tracks at Roosevelt road and at Fulton street, the throat at Fulton street being complicated by the fact that it is required to serve the two transfer tracks as well as the station approach tracks.

Heavy Construction

The track construction is designed for heavy service. All track on the approaches and through the crossovers and switches is laid with 130-lb. rail with 100-lb. rail in the tracks paralleling the platforms, all rails being of the P. S. section. The ties are 7 in. by 9 in. by 8 ft. 6 in. of creosoted red oak, placed 20 to the 33-ft. rail with 11-in. by 7-in. by 34-in. tie plates throughout. Through the diamond crossings the ties are 8 in. by 10 in. by 21 ft.
6 in. In the case of all tracks adjoining station platforms, the rails are supported on blocks, 6 in. by 8 in. by 2 ft. 6 in. long embedded in concrete and leaving a space about 2 ft. 6 in. wide between the inner ends of the two lines of blocks to facilitate drainage and the removal of rubbish. All rail joints are either of the continuous or 100 per cent type. The ballast for the approach tracks is broken stone, having a depth of 6 to 10 in. under the ties as is explained later.

In laying out the turnouts, slips and crossings special pains were taken to avoid special construction as far as possible and to avoid short radius curves, while making every effort to secure the maximum length of platform tracks. With the exception of five No. 7 frogs and two No. 6 frogs all frogs are either No. 8 or No. 9. The design and construction of the slip switches and crossings introduced many serious problems, particularly because of the use of 130-lb. rail and the necessity for providing effective insulation at the many points where this was required. However the construction is of a uniformly high grade and has rendered excellent service under heavy traffic.

**Tracks Supported on Concrete Blanket**

The most distinctive feature of the track construction is the special foundation provided in the form of a concrete blanket throughout a large part of the terminal area. This construction was applied not only to the station tracks, in which resort was had to the special construction referred to above, but also through most of the standard track construction and all of the turnouts, slips and diamond crossings, for which the concrete blanket or slab construction serves as the base upon which ordinary ballasted track is supported. It was described in detail in an article by J. D'Esposito in Railway Engineering and Maintenance for September, 1923, page 353. This unusual form of construction was adopted after a study of the unfavorable conditions imposed, which led to the conclusion that track maintenance would be exceedingly expensive and that it would be impossible to maintain the tracks in a satisfactory condition unless a more stable support was secured than that offered by the natural surface of the blue Chicago clay in a location so close to the Chicago river that it was constantly in a state of saturation and with the tracks at an elevation that would make satisfactory drainage impossible.

**Covers Large Area**

The total area of the concrete slab construction is 1,125,000 sq. ft., or approximately 25.6 acres. This area embraces all of the tracks from the north limits of the terminal property to Polk street and throughout the limits of the double crossovers between Taylor street and Roosevelt road. In addition the slabs were provided to support the two joint transfer tracks from the north end to Harrison street.

This construction consists throughout of 10-in. slabs of concrete reinforced in both faces with wire mesh or bars and divided in units of convenient size for construction. All of the slab construction was laid on a bed of 6 in. of cinders. Where the tracks are ballasted the slabs are generally 13 ft. wide, corresponding to the track spacing, and 21 ft. long. Under the platform tracks they are 14 ft. wide with a slab of plain concrete under the platform to fill out the space between adjoining track slabs. Superimposed on these platform track slabs is a second concrete slab of irregular section designed to hold and support the short blocks which carry the rails along either side of a curb wall to retain a fill of fine stone screenings which supports the slabs providing the surface for the platforms.

**Difficult Drainage Problem**

With a construction such as this, drainage is a matter of prime importance and entails special measures in that portion of the area between the north end of the terminal and Harrison street, where the track level was so low as to preclude gravity outflow into the city sewers. Throughout the length of the station platform the tracks are on a sufficient grade to insure adequate flow to catch basins, but under the approach tracks it was necessary to slope the slabs independently of the track grade so that the depth of ballast varies from 6 in. at the ridges to 10 in. in the valleys. The drainage system consists of a series of lateral or cross-drains of 8-in. cast iron pipe spaced approximately 80 ft. center to center with catch basins between the tracks in the ballasted construction and in the trough or center line gutters of the platform tracks. These cross-drains discharge into 12-in. cast iron longitudinal drains which, in the case of the area south of Harrison street, empty directly into the city sewers. North of Harrison street the mains discharge into two sumps, one just south of Van Buren street near the mail building, and the other at Madison street, from which the water is pumped into the river by means of two automatic centrifugal type bilge pumps. These two pumps are also connected by a by-pass with an independent drainage system for the down-sprouts of the train sheds, which discharges directly to the river, the only function of the suction connection being to insure that the train shed drainage system is thoroughly drained after each rainfall.

**Results Justify Added Expense**

A considerable portion of the track support has been in service for five years and the experience with it has fully justified the added expense for this construction. An unusual opportunity for a study of the results is af-
An Innovation in Mail Terminals*

With its development and construction period coincident with the decade during which the greatest impetus was given to the parcel post service, it became apparent early in the course of the project that the station facilities must include provision for the handling of mail far in excess of anything that had ever been considered necessary in the design of any other passenger station. Studies of the requirements made by the railroads and also by a committee representing the railway mail service led to the conclusion that the situation called for the development of a plant isolated as far as possible from the other station facilities and which would not only afford adequate capacity for the conduct of that portion of the mail handling which falls directly on the railways but which could be utilized in large part for a variety of postal operations definitely under the control of the postal department. In December, 1920, an agreement was drawn between the railway mail service and the Chicago Union Station Company under which the station company agreed to construct a large building comprising seven stories and a basement and to lease the upper six floors to the federal government, the track level and the basement to be re-

Five Views of the Railway Mail Terminal

Upper Left, the Spiral Chutes; Upper Right, One of the Felt Conveyor Separating Units; Lower Left, the Battery Charging Station for Electric Trucks; Lower Right, the Trolley Conveyor System for Delivering Mail Sacks to Cars

* A more complete description of the mail terminal appeared in the Railway Age of March 6, 1922, page 272.

The building is located just east of the station tracks, i.e., the south group and extends from Van Buren street to Harrison street. It is 796 ft. long and 75½ ft. wide,
contains 11 acres of floor area, has a cubical contents of 8,500,000 cu. ft. and is designed to handle 3,000 tons of mail matter each 24 hours. It is served on the second or street level floor by a driveway 33 ft. wide extending the full length of the building along its east side which affords 580 ft. of free tailboard space or enough to serve 63 vehicles at one time. Platforms serving the five tracks provided exclusively for mail service and the cashier passenger tracks have a length sufficiently adequate to accommodate 43 cars.

The building has a steel frame containing 7,000 tons cars and vice versa. However, the great bulk of the operations of the terminal consists of the receipt, classification and dispatch of all papers, catalogs and parcel post mail originating in Chicago, as well as mail of these three classes passing through the city.

All classes of mail made up in bags for mail cars on lines served by the union station are received on the street level at the north end of the building where 18 chutes are available for transmitting the sacks direct to the track or basement level to be sorted and loaded on platform trucks for hauling to mail cars and to various trains.

of structural steel, the most notable feature of which is a steel truss in the west wall 149 ft. 4½ in. long spanning a crossover between a track inside the building and one outside. This truss carries a load of 4,050 tons and is the heaviest truss ever used in building construction. It weighs 365 tons.

Adopt Details of an Industrial Structure

The building has brick walls faced with cream colored brick and reinforced concrete floors provided with a wearing surface of creosoted blocks. On the track level the building is open to the weather on the ends and along the west side. On the street level the open space along the delivery platform is provided with rolling doors. The windows afford large glass areas set in steel sash. The main entrance on Van Buren street and the minor entrance on Harrison street, as well as the cornices, belt courses, etc., have been finished in Indiana limestone.

While most mail handled is loaded and unloaded from cars spotted on the mail building tracks, provision is made for the handling of mail to and from cars and trains at points on the passenger tracks by means of tracks which deliver and receive mail in the basement, whence they are afforded access to the baggage platforms on the north and south passenger tracks by a tunnel extending from the mail building to the baggage room and thence via any one of the baggage platform ramps to the mail cars. More direct access to the south ends of the south station tracks is afforded by means of a tunnel leading west from the mail building to the power house, from which elevators communicate with the platform level.

Serves Many Purposes

This terminal has a variety of functions. From the standpoint of railway officers the feature of first interest is the handling of mail received from and delivered to trains at the union station. This portion of the work is handled by union station employees and consists primarily of the transfer of mail sacks from street vehicles to mail coming mail on trains entering the union station is sorted on the track or basement levels, loaded on trucks and delivered to the upper floors of the building by any one of 15 Otis freight elevators. Sacks of mail properly sorted for other railway stations or for Chicago city delivery are delivered to the street level floor and trucked to the driveway space near the south end of the building for transfer to street vehicles.

Elaborate Mechanical Installation

The mail terminal owes its greatest distinction to the enormous amount of mechanical equipment provided for the various operations of transporting, elevating, separating and chuting of mail matter in the operation of the plant under the direction of the postal service. This consists in large part of a system of 65 conveyor belts operated by independent electric motors and entailing the use of seven miles of belting. This equipment was designed and installed by the Lamson Company. It includes also five spiral chutes built by the Samuel Olson Company which delivered mail sacks either to the street level, the track level or the basement. One unique development in this connection is an overhead trolley conveyor system for the delivery of mail at the track level from the ends of the spiral chutes into the mail cars spotted along the various platforms. This consists of an overhead rail made of a cold rolled steel bar 1½ in. by ½ in. in section, supported from the canopy over the platform and extending to the handling platform located at the base of the spiral chutes.

This rail serves as a runway for a trolley which consists of a small bronze casting equipped at its upper end with a trolley wheel and at its lower end with a hook from which the mail sacks are hung by the tying cord. This hook is mounted on a pin so that it may be tripped to release the sack whenever a projecting finger on the side of the trolley frame meets with an obstruction in the course of its travel along the rail. This obstruction is introduced in the form of a portable tripping device which can be of any length. This bright-Nell Con...
which can be mounted on the trolley rail at any point in its length. This system, which was developed by the Allbright-Nell Company of Chicago, has effected a marked saving in labor since it does away with the loading of trucks at the chute, transporting them to the mail cars and unloading at the cars.

**Interlocking System Embraces New Features**

The signaling and interlocking system for the operation of trains is divided into two parts, one controlling the station and approach tracks at the north end, the other governing those at the south end. As explained previously, the switches in both the north and the south tracks are arranged in two distinct groups, one group embodying the ladders and crossovers at the entrance to the trainshed and the other embracing the crossovers at the ends of the station company's property.

The operation of the station requires that all passenger trains must be handled twice; outbound trains must first be backed in from the coach yards and incoming trains must be backed out after delivering passengers. This routine requires a close co-ordination in the operation of the two groups of switches to give a smooth and complete movement between the station and coach yards and at the same time retain clear tracks for the movement of outbound and inbound trains. Careful consideration of this operating feature led to the adoption of one central point at each end of the station for the control of all switches and signals.

**Extent of the Requirements**

The plant governing traffic at the south end controls 36 high signals, 70 dwarf signals, 38 movable point frogs, Switch & Signal Company. Electric power for the operation of the plant is supplied from the Union Station company's sub-station as 2300-volt current is distributed to the interlocking system over two power lines each having its own transformers where the voltage is changed to 110 volts to serve the interlocking system. Compressed air at 70 lb. pressure is furnished by the Union Station company's power plant.

**The Interlocking Towers**

The interlocking towers are of reinforced concrete and steel construction with brick facing and tile roofs. The south tower is located just south of the railroad mail building on columns set astride of one of the east stub tracks serving the mail terminal. The north tower is located east of the tracks a short distance north of Lake street. These towers are two stories high with relay motor generators and storage batteries on the lower floor and a Union Switch & Signal Company's Model 14 electro-pneumatic type interlocking machine on the upper floor. Each machine is equipped with two rows of lever lights which are used for providing a visual indication as to the condition of the section locking for the switches and the position of the signals. The track models are of the illuminated spot-light type.

Looking North at the Throat of the South Station Tracks, Signal Tower in the Right Foreground, Railway Mail Terminal Building in the Center Background

76 double slip ends and 42 single switches covering a length of 4,800 ft. The plant governing the traffic at the north end controls 2 high signals, 57 dwarf signals, 15 movable point frogs, 30 double slip ends and 41 single switches covering a length of 3,200 ft. Concentrating the control at one point eliminates the exchange of information necessary to co-ordinate train movements.

The interlocking plants are of the electro-pneumatic type with position light signals furnished by the Union

The south plant model has 194 spot-lights for track circuits, 2 for traffic direction between plants and 28 for train starting, a total of 224 spot-lights. The north plant model has 87 spot-lights for track circuits, 2 for traffic direction lights between plants and 20 for train starting, a total of 109 spot-lights. Spot-lights, placed as near the middle of each track circuit as possible, show a green light when the track circuit is clear and no light when the circuit is occupied. The lights for traffic direction also
show an arrow pointing to the direction in which the traffic is set up.

**Auxiliary Equipment**

Multiple unit-type tower instrument cabinets of steel construction with glass doors are placed back to back in rows at right angles to the interlocking machine, on the floor below. The switchboard, motor-generators and storage battery are all housed in the same room. Ironclad storage batteries of 500 ampere-hour capacity, consisting of two sets of 14 volts each, assembled in sets of 3 and 4 cells are mounted on a concrete platform 6 in. above the floor. These storage batteries are used to control the switch valve magnets, switch indications, signal control and route locking relays. The motor-generators and switchboard are of the General Electric Company's make, there being one motor generator for each set of batteries.

Switch movements are Union Switch & Signal Company's electro-pneumatic Type-AI. All of these switch movements are equipped with U. S. & S. separately mounted Style-C cut-off type valves to effect economy in air consumption.

**New Design of Position Light Signals**

Position light signals were adopted and a special design for the high light signals of a new type was developed after a careful study of the conditions imposed by the necessity for placing them on the fascias of the street viaducts crossing the tracks. Special pains have been taken to give these viaducts an attractive design and avoid the introduction of any features projecting above the top of an ornamental railing of uniform height. Consequently, it was highly desirable to develop a type of signals that could be supported against the outside of these railings without projecting above their tops. It was also desirable to provide signals for these tracks affording five indications, a requirement that would have required three arms in a semaphore type of signal, two units in a standard position light signal and three units in a color light signal.

The position light signal, as developed for the high signals, gives five aspects in a single unit. It consists of two horizontal rows of three lights each with a single light placed in the center and half-way between the two horizontal rows.

**Dwarf Signals Give Four Indications**

The dwarf signal is a standard position light dwarf signal with four lights that afford four indications. The significance of these aspects is explained in the diagram. The addition of the fourth indication to the dwarf signal is a new development in signaling and makes the dwarf signal particularly suited for signaling a busy terminal to allow trains to occupy tracks to full capacity and the addition of the fourth indication allows the connecting of the dwarf signals into a complete signal system, giving complete information for the governing of traffic at the maximum speed at which it is desired to operate in the terminal territory.

The dwarf signal at clear indicates that the next signal is at clear or caution. The dwarf signal at caution indicates that the next signal and at stop but the track is unoccupied to the next signal. The dwarf signal at permissive indicates that the track is occupied immediately ahead and that the movement should be made with caution, prepared to stop short of a train or obstruction. The dwarf signal at stop indicates that the route is not set. Use is made of the permissive signal in governing movements to stub end mail tracks and coal tracks at the power house.

**Diagram Showing the Indications Afforded by the High and Dwarf Signals.**

- **High Signal**: 
  - **Stop Signal**: 
    - **Stop**: 
  - **Caution Signal**: 
  - **Approach Next Signal Prepared to Stop**: 
  - **Clear Signal**: 
  - **Proceed at Authorized Speed**: 
  - **Permissive Signal**: 
  - **Proceed with Caution Prepared to Stop Short of Train or Obstruction**: 
  - **Slow Speed Signal**: 
  - **Track is Set to Divert Over Slow Speed Turnout**: 
  - **Track is Unoccupied to Next Signal or to End of Interlocking Limits**: 
  - **Proceed at Slow Speed Prepared to Stop at Next Signal or to End of Interlocking Limits**:

**How Trains are Started**

The system of intercommunication between conductors, gatemen and interlocking operators employs three indications: colored-light signals located adjacent to the station concourse, with one signal for each station track, two indication spot-lights at the entrance gate for each track and two indication spot-lights on the illuminated track model in the interlocking tower. Push button control switches are spaced approximately every 250 ft. on the train shed columns in the passenger platforms for the use of trainmen. The push buttons for gatemen are placed at the gates directly beneath the

spot-lights. The push buttons for tower operators are placed on the operator's desk in the interlocking tower. The manner of operation of the train starting system is as follows:

First—the conductor pushes the button nearest to his location on the platform, lighting the red spot-light on the illuminated track diagram in the interlocking tower which is placed at the end of the track corresponding to the track from which the train is leaving and if the information is received at the tower the red light is lighted in the color light signal suspended in the track shed adjacent to the station, the concourse and beside the tracks from which the train is leaving.

Second—if the tower operator is prepared to handle the track he pushes the button on the operator's desk, thus changing the color light signal near the concourse to yellow, changing the light on the illuminated track diagram to yellow and lighting the yellow spot-light at the gate.

Third—the gateman, after closing the gate, immediately pushes his button at the gate, changing the color light signal to green and the spot-light at the gate to green, thus permitting the train to leave, providing the proper indication of interlocking signals has been received.

Fourth—the train, immediately upon accepting the first interlocking signal, automatically puts out all train-starting lights.
Power Facilities Amply Provided For

The mechanical facilities in an establishment as large as the Chicago Union Station are necessarily of considerable magnitude and of a highly diversified character. The heating requirements are large and are complicated by the especial importance of thorough ventilation, particularly in the basements of both the station building and the mail building and in the office space of the headhouse to the level of the top of the waiting room, where effective window ventilation was not readily obtainable. Ventilation is also of great importance because of the fact that the extensive system of driveways under the headhouse is constantly being used by motor vehicles.

The heating system in the station proper, which is primarily one of direct radiation, is supplemented in large part by a tempering of the large volume of air driven through the ventilating system. The radiators are placed at points of exposure such as the vestibules of the various entrances, exposed outside walls and the skylights, where they serve the secondary purpose of preventing condensation on the glass.

A Million Cubic Feet of Air Per Minute

An idea of the magnitude of the ventilating system is afforded by the fact that the complete fan installation has an aggregate capacity of 1,220,000 cu. ft. of air per min. There are 35 fans in the station proper and 5 in the mail building, the largest of which has a capacity of 67,000 cu. ft. of air per min. In addition, 11 fans have been provided for exhausting smoke under the viaducts at Jackson Boulevard and Adams Street. The ventilation in the station structure embraces both plenum and exhaust systems. Fans in the basement take air from large shafts opening into the court above the waiting room and distribute it through a great network of ducts to the various rooms. A second set of fans in and soap powder after which they are re-oiled and replaced. Each fan is equipped with Vento heaters regulated by the Johnson Service Company’s thermostatic control system.

Hot Water Heat in Mail Building

The heating in the mail building is of a different character except for the basement which is heated and ventilated by tempered air in the same manner as in the main station. The upper six floors are heated by forced circulation hot water, this system being selected because of the fact that most of the street floor of the building is open to the air and unheated, which would have complicated the return of the condensate from a steam heating system because of the danger of freezing. The water for this heating system is heated in Sims heaters and circulated by two American Steam Pump Company’s centrifugal pumps driven by Terry steam turbines. Sims heaters are also used for heating domestic hot water supply in both the mail building and the headhouse.

Other equipment in the headhouse includes two American Carbonic refrigerator compressors with a capacity of 70 tons of ice per 24 hours for the restaurant service and one compressor of the same make having a capacity of 20 tons of ice for drinking water service. There are also three Worthington house pumps each with a capacity of 10,000 gal. per hour for building water supply, four International filters of the same unit capacity for filtering all water used in the building; a Dayton-Dowd motor-driven centrifugal fire pump with a capacity of 1500-gal. per min.; four Nash duplex centrifugal motor-driven pumps for the return of steam condensate to the power house; two 500-gal. Shone pneumatic sewage ejectors and two dry basin type centrifugal bilge pumps furnished by the Yeomans Brothers Company. Equipment of a substantially similar character is also provided in the mail building.

Power Plant for Heat Only

The supply of the energy required in the terminal, not only in the form of steam for heating but also the power for the operation of the pumps, fans, compressors, etc., is large and imposed an important problem with respect to the power supply, no small portion of which concerns the electric current for the lights, signals and the operation of the mechanical equipment. A careful in-
vestigation by the station company led to the conclusion that the greatest economy and reliability of service would be afforded by the purchase of electrical power from the local public utility, the Commonwealth Edison Company, rather than to construct and operate its own central station plant. Consequently the power plant provided by the station company is designed solely to provide steam for heating the various buildings, to supply hot water for domestic use, steam heat supplies for cars and for the operation of air compressors to supply compressed air for the operation of the switches in the interlocking system and for the charging of trains.

The steam plant is located on a small triangle of land fronting on Canal street a short distance north of Harrison street. It has a steel frame with brick walls and a radial brick chimney 227 ft. high by 12 ft. inside diameter supported on girders forming a part of the roof frame. The plant contains six Babcock & Wilcox Stirling type water-tube boilers of which four are 610 hp. and two are 326 hp. rated capacity each. They are fired by Green chain grate stokers. Coal and ashes are handled with equipment furnished by the Webster Manufacturing Co.

**Engine Room Equipment**

The engine room contains two Manistee rotary boiler feed pumps operated by Terry steam turbines; two Bury steam-operated air compressors with a capacity of 500 cu. ft. of free air per min. equipped with Reed air filters; two small Washington pumps, one for boiler feed during periods of small steam demand and another for boiler washing, and a Warren Webster open type feed water heater.

The steam delivery service is provided by two lines of 10-in. pipe and a 6-in. condensate return extending from the boiler house through the tunnels and basement of the mail building and concourse to the basement of the headhouse, one of the 10-in. lines being provided purely for reserve. In addition an 8-in. line is carried from boiler plant to the mail building with a 4-in. branch from the mail building to the headhouse for summertime low load service. Facilities for heating cars at the station tracks is afforded by steam lines along the ends of the tracks with outlets equipped with Barco flexible metallic couplings.

Electric power is supplied by the Commonwealth Edison Company at a sub-station in the sub-basement of the headhouse and another in the basement of the mail building, as three-phase, 60-cycle, 12,000-volt current. In the headhouse sub-station the current is brought in through three independent cables to insure continuity of service. This sub-station is provided with all necessary equipment for transforming and converting the current supplied to 115-230 volt alternating current for station and office lighting, 230-volt direct current for power uses and 2300-volt alternating current for the train shed and street lighting and for the interlocking plants as previously described. The transformers and converters were supplied by Allis-Chalmers. The station has a capacity of 3,900 kw. with provision for increasing it to 4,900 kw.

The sub-station also contains two special Allis-Chalmers motor-generator sets applying direct current at either 70 or 90 volts for train lighting and train battery charging. The current for this purpose is conducted to receptacles on each pumping post at the ends of the station tracks and is regulated by Allen Bradley rheostats.

The sub-station in the mail building has a capacity of 1,100 kw. and is similarly equipped. The general power service throughout the mail terminal is 230-volt direct current and in the power plant it is 440-volt alternating current. Charging equipment for the storage batteries of the trucks and tractors used in mail and baggage handling is located adjacent to the mail terminal sub-station.

A study of the speed requirements of the motors required for the various applications, such as the ventilating fans, pumps, refrigerating machinery, conveyors, elevators, etc., was responsible for the adoption of the direct current system. With few exceptions all motors in the main station are Westinghouse Type S. K. while those in the mail building are General Electric. The control equipment was furnished by the Sunde Electric Company and each control panel is equipped with a Urelioe enclosed externally operated circuit breaker.

### Problems of the Construction Program

The period of nearly 11 years which has elapsed between the completion of negotiations with the city in September, 1914, and the opening of the station appears longer than necessary to complete a project of this kind, but there are many reasons why the work could not be carried out in less time. As seen on the map of the old terminal layout, the site was hemmed in on the east and south by freight stations which could not be abandoned and razed until new freight terminals could be completed to replace them. Moreover, the acquisition of the property occupied by the station, as well as the purchase of sites for the new freight station facilities by the various railroads, involved protracted negotiations and it was not until 1916 that these had been carried to a stage that permitted of active prosecution of the construction work. Furthermore, there was much construction of a preliminary nature that had to precede work on the actual station facilities. Under the contract ordinance with the city new sewers had to be built, viaducts had to be reconstructed to accommodate new track grades and a wall had to be built along the river front. In addition, the approach to a street car tunnel under the Chicago river had to be lowered to accommodate the lower elevation of the tracks and buildings had to be wrecked and removed from the site of the headhouse and large areas to be occupied by the station tracks and approaches.

### The Freight Stations

The construction of new freight terminals for the Pennsylvania, Burlington and Alton comprised projects of large magnitude in themselves. The first of these to be completed and largest was that of the Pennsylvania and embodies a freight station 745 ft. by 420 ft. in plan, five stories high extending from Polk street to Taylor street on the east side of the Union Station tracks. It is supplemented by a team yard between Taylor street and Roosevelt road which is now under construction. The Alton terminal occupies an irregular shaped area north of the Pennsylvania terminal with a freight house fronting on both sides of Harrison street.

The Burlington’s new local freight facilities occupy all available space between the station tracks and Canal street from Harrison street to Roosevelt road as well as the track level space under Canal street within those limits. The new freight house occupies the space between Harrison street and Polk street with two small extensions south of Polk street, the remaining area being occupied.

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by team tracks. All of these freight stations are of the two-level type with tracks on the lower level and drive- ways on the upper level.

As the new Burlington freight house was built on ground largely occupied by old facilities, this road con- structed a temporary station south of Taylor street which was used while the old houses were removed and the new one was built. But in the case of the Alton and the Pennsylvania the old stations were kept in service until the new facilities were ready for service.

Other Obstacles Encountered

Other conditions which arose during the course of the work were responsible for a large part of the delays. President Wilson’s proclamation urging the cessation of all work unnecessary for the winning of the war led to a curtailment of activities in 1917 and a virtual cessation of operations from July, 1918, to the spring of 1919, but labor troubles caused the most serious obstruction to the conduct of the work. Strikes on the Pennsylvania’s new freight station, delayed the completion of that project fully 18 months and caused a like delay in the removal of the old freight facilities on the passenger station site. These delays together with labor difficulties on the station resulted in a loss of time that aggregated at least four years.

Because of the loss of time in clearing the site of the new terminal and the necessity for avoiding any interference with the operation of the old station, the construction work had to be carried out in piecemeal fashion. The first track work was done on the south approach between Polk and Taylor streets. This was later extended to Van Buren street and toward Roosevelt road, but was not completed to the south end of the station property until the present year on account of a delay on the part of the city in carrying out plans for the re- building of the Roosevelt road viaduct. Work on the north approach could not be started until much later because the site had to be cleared by the removal of two large warehouses.

Owing to the limited track capacity of the old station it was out of the question to take any of the old station tracks out of service until other tracks could be completed to replace them. In the south unit this was carried out by completing the three westerly station tracks as far north as Jackson boulevard and construct- ing a temporary station for the use of suburban pas- sengers. The new tracks were then opened over to the suburban service. Following this the tracks for the mail terminal were completed, after which new tracks were completed toward the center of the layout, gradually transferring the trains to the new tracks as the old ones were taken up.

Many Difficulties Involved

North of the concourse the first step was to provide three temporary tracks next to the river bank on ground vacated by the removal of the Pennsylvania freight house to permit the release of an equivalent trackage along the west side for the construction of new tracks, this work being carried progressively eastward until all the new tracks were in place, except those which are to occupy the site of the old station. All of this work entailed con- siderable difficulty in providing for a continuity of connections to the new and old tracks and in providing for passengers to reach trains on account of the differences in elevation of the new and old tracks, the new tracks being from 3 to 5 ft. lower than the old ones.

For an engineering standpoint the work also imposed considerable difficulty because of the piecemeal manner of construction. Many of the ship switches had to be installed in place when opportunity afforded, without connection to tracks on either end, which required that their location had to be so definitely established as to in- sure an accurate fit with track work carried out subsequently.

Started Work on Station Building in 1919

The work on the station building was started in 1919 with the excavation of the site and the sinking of caisson foundations and the construction of retaining walls on the site of the headhouse. It was originally planned that the headhouse would comprise a structure used only for station purposes, its height being limited to that required for a waiting room with a high ceiling. The foundations for a structure so designed required 268 caissons containing 13,500 cu. yd. of concrete. However, shortly after this foundation work had been completed it was concluded that the air rights on the site occupied by this structure were so valuable that it would be unwise to con- struct a building which would not permit of their full development. Accordingly, it was decided to construct a building which would not only house the main waiting room and auxiliary facilities but would serve also as an office building, with an ultimate height of 22 stories. This decision at once introduced a new problem because the loads to be imposed by a 22 story building were so much greater than those of the structure for which the foundations had been constructed that the piers already in place were entirely inadequate to carry the taller structure.

An Unusual Foundation Problem

A further complication was introduced by the fact that the new design of building embodied an extensive re- location of columns so that the position of many of the columns did not correspond to the location of the founda- tion piers. Under these circumstances an extensive rein- forcement of the foundation was imperative.

Before undertaking this, careful consideration was given to the possibility of applying greater loads to the piers already in place than those for which they had been designed on the basis of the unit bearing pressure allowed by the building department of the city of Chicago for caissons supported on hardpan, namely six tons per square foot. This led to the construction and loading of an experimental caisson four feet in diameter by 71 ft. deep which had the support removed from beneath its base by digging a tunnel from a shaft sunk nearby so that the loads imposed on its top were supported entirely by the skin friction of the sides. The test made on this caisson showed that no movement occurred under loads producing a skin friction of 350 tons per sq. ft. of cylind-rical surface and on the basis of these findings the city building commissioner authorized the increase in the allowable load on the caissons to 10 tons per sq. ft. The exact manner of making this test is explained in an article in the Railway Age for March 11, 1922, page 561.

Rebuild Foundation

However, in spite of this concession the work of strengthening the foundation was both difficult and ex- pensive. It required the sinking of 192 additional piers from 4 to 10 ft. in diameter, some of them so close to the old ones as to introduce serious complications in excavation. In addition a large number of reinforced concrete girders had to be constructed to span across two or more of the piers for the support of columns in new locations. In such cases cantilever construction had to be resorted to as a means of relieving some of the old piers of a portion of the load applied.

This work was followed by the erection of the super-
structure of the headhouse and the completion of the Canal street structure, after which work proceeded on the excavation and foundation work for the concourse. To permit the concourse work to proceed it was necessary to provide a temporary passageway for the passengers between the old station and trains entering the station from the south, which at this time were using the new south group tracks. This arrangement, which entailed a walk of about one block from the station to the head of the passenger tracks, was probably the most serious inconvenience to which passengers were subjected as a consequence of the construction work. Practically no delays to trains were attributable to the construction work, in fact, after the old freight stations had been removed there were more tracks available for passenger station use than were embraced in the old station facilities. As soon as the roof, walls and a portion of the floor of the new concourse were completed the passengers were provided with a passageway through this structure to the south train sheds.

Work Still to be Done

With the opening of the new station on May 15, opportunity was afforded for the wrecking of the old station and the excavation of the site for the construction of the tracks, platforms and train sheds in the north group, upon which work could not proceed until the old station is removed. The work is now in progress. With this exception, the framework of the new train sheds is all in place and the concrete tile roof and skylights are being erected, temporary umbrella sheds being removed as fast as the new roof is completed.

The removal of the old station also makes it possible to proceed with the work of raising Canal street to the new level and widening it to 100 ft. in the block between Monroe street and Adams street, the only portion of the improvement of Canal street which has not been completed.

All of the various viaducts across the tracks are now complete with the exception of Adams street, upon which work will be undertaken shortly in connection with the construction of a new bridge across the Chicago river by the city. The conduct of these additional items of construction work will, however, result in little interference in the operation of the station.

Accessory Facilities

Among the supplemental facilities which have been provided to make the Chicago Union Station as complete as possible from the standpoint of service to the passengers, and which were not referred to in the earlier part of this article, are a hospital, a cell room and immigrant quarters. The cell room and immigrant quarters are in the basement, access to them being provided by a corridor leading from a stairway in the west platform of the south section track a short distance south of the train concourse. The former contains two cells, a toilet room and accommodations for police officers. The latter provides a small waiting room and toilets and lobbies for men and women. The hospital is located on the mezzanine floor at the northeast corner of the headhouse. It provides wards for both men and women, a nurses’ room, receiving room and operating room.

The requirements of those trainmen for whom Chicago is an away from home terminal have also been considered in providing recreation, rest and locker rooms on the third floor. A lantern room where trainmen’s lanterns are stored, cleaned and refilled, is provided in the basement.

Organizations

During the course of negotiations with the city of Chicago in 1912, the Chicago Union Station Company was organized and J. J. Turner, first vice-president, Pennsylvania Lines West, was elected president. Thomas Rodd, chief engineer of the Pennsylvania Lines West, was also made chief engineer of the Chicago Union Station Company, with Joshua D’Esposito as assistant chief engineer in direct charge at Chicago. Graham, Anderson, Probst and White, Chicago, were retained as architects. In addition, an advisory board of engineers was organized which consisted of the chief engineers of the proprietary railroads, this board remaining in active service during the entire construction period. In 1919, upon the retirement of Thomas Rodd from the active railroad service and his appointment as consulting engineer, Mr. D’Esposito was made chief engineer. The staff which assisted him in the design of the various facilities and the conduct of the work included A. J. Hammond, principal assistant engineer; and A. S. Holmes, assistant to the chief engineer; C. E. Cox, engineer of contracts and estimates; C. J. Noland, office engineer; E. Brock, mechanical engineer; Thomas Holt, signal engineer; C. C. Turner, electrical engineer, and C. L. Swanson, chief clerk. Following the retirement of Mr. Turner in 1922, Samuel Rea was elected president of the Union Station Company.

The principal construction contractors on the project were as follows: John Griffiths & Son Company, general contractors for the headhouse and concourse; R. C. Wieboldt Company, general contractors for the mail building and foundation and steel erection contractors on the headhouse; W. J. Newman Company, contractors for excavation, wrecking, sewer construction and concrete track slab construction; Robert Gordon, Inc., heating and ventilating; Callaghano Brothers, plumbing; A. E. Coleman Company, ornamental iron work; Edward Moore Roofing Company, roofing; McNulty Brothers Company, plastering; Alfred Olson Company, painting; Hatfield Electric Company, electrical installation; Kelly-Atkinson Construction Company, Berkeley Elliott Construction Company and Overland Construction Company, structural steel erection; and the Underground Construction Company, foundation work.

The presence of a water supply in the basement, the construction of a sewer system, the installation of a heating plant and the provision of a complete electrical system were among the important tasks of the work. The basement has a capacity of about 100,000,000 gallons and is served by a pump, turbine and main with a capacity of 100,000 gallons per hour. The heating plant is of the district type and is controlled by a central station. The electrical system consists of a 5000-kilowatt generator and a 2500-kilowatt generator, both driven by steam turbines. The basement is also served by a complete fire-protecting system, including automatic sprinklers and fire hydrants.

Banquet Car Originated by President Budd of the Great Northern