THESIS.

PLANS AND SPECIFICATIONS

FOR A

STEAM HEATING, WATER SUPPLY,

AND ELECTRIC LIGHT AND POWER STATION,

BY

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FOR THE DEGREE OF BACHELOR OF SCIENCE IN THE SCHOOL OF MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

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SPECIFICATIONS FOR A CENTRAL STATION
FOR
STEAM HEATING, WATER SUPPLY,
AND
ELECTRIC LIGHT AND POWER
FOR
THE UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS.
A Station consisting of the following equipment:

An Electric Light Plant with a capacity of one-thousand-seven-hundred-and-fifty (1750), sixteen candle power incandescent lights, and forty (40), two-thousand candle power arc lamps, with equipments complete to switch board.

- A Fire Pump and Water-supply Pump, with water mains and piping.

Boilers, with a total rated capacity of one-thousand-two-hundred-and-forty (1240) horse power; equipped with feed pumps, stokers, ash handling machinery, fuel economizer, draught apparatus, and steam mains complete to tunnel.

A Coal Bin having a capacity of three-thousand tons, to have machinery for handling coal from wagons to bin and from bin to stokers.

To be built and installed according to the following specifications:

The complete station to be included in one building of three rooms.

The building to be located between Engineering Hall and the Machinery Building. The north and south centre line to be fifty-two feet west of the east boundary line of the arboretum as now existing, and the east and west centre line of the Boneyard tunnel to be two feet south of the centre line of the Machinery Building. The floor line to be contour ninety-five referred to the University bench mark, and the bank line outside to be contour ninety-four.
Building

The design and construction of building to conform to the accompanying plans as nearly as possible. All dimensions to be as given in drawings. In dimensioning the drawings, eight inches was assumed to be the length of a brick, four inches as the width, and two inches as the thickness, hence horizontal dimensions of three feet or less are to be reduced to the nearest brick, or half brick; and vertical dimensions to the nearest quarter brick. For example, the thickness of wall will be nearly twenty-six inches instead of twenty-four.

The walls to be of brick. All brick showing on the surface; outside, inside, around windows, doors, etc., above a line two feet below the floor line on the outside, and four inches below the floor line inside to be terra-cotta pressed brick, excepting that part of the wall on the east side and north end which will be covered by the walls of the coal bin. The brick to be laid finished on all surfaces above a line two feet below the floor line outside, and four inches below the floor line inside. All brick other than pressed brick used in or about the building to be good hard burned brick of uniform size and good form.

All brick work to be laid in good cement mortar excepting the boiler settings and smoke flue which are to be laid in lime and sand mortar. All mortar showing on surface between the pressed brick, to be colored to match the brick.

The partition walls between the boiler room and coal room, and between these two rooms and the engine room to be eight inches thick, the surfaces showing in the boiler room and the engine room being pressed brick of the same color as the outside walls.
The foundations to be as deep as shown in drawings, and if at any place good ground is not found at that depth, it is to be extended down to good ground or excavated and filled in a manner which shall be approved by the inspector representing the University.

The windows to conform in general design to drawings. The semi-circular part at top to be fixed in the frame and the rectangular portion to be in two frames each being free to revolve ninety degrees about a vertical axis through the middle of the frame.

The south door to be double, swinging on hinges, opening outward. The door between engine and boiler rooms to be a sliding door of two sections, hung on the engine-room side of the wall, each section to move from the middle in opening. The north door to be a sliding door of two sections, hung on the inside, both sections moving to the west in opening.

All window sashes and frames, and doors and door frames set in, or surrounded by brick work, to be painted a color one shade darker than the brick work.

The floor of the engine and boiler rooms to be composed of two courses of brick, the first course laid on edge and the second course on side and covered with a course of smooth, pressed tile. Color of the tile to be dark brown. The floor of the coal room to be of two courses of brick laid as in the other rooms, and covered with cement one inch deep.

The roof to be supported by steel trusses sixteen feet apart resting on buttresses of the wall. The trusses to be furnished by contract. The bids to be accompanied by drawings and specifications to be examined and considered by the building committee who shall have power to select any, or reject all offers.
The pitch of the roof to be sixty degrees.

The purlins to be five inch beams weighing twelve pounds per foot. To be not more than seven feet apart or less than six feet. To be riveted to the upper element of trusses with two three-eighths inch rivets at each truss.

Rafters to be two inch by four inch pine lumber, clear, straight, and dressed. To be fastened to the purlins by iron hooks screwed to the rafters and engaging the flange of the beams. A sheathing of one inch matched lumber to be put on over the rafters. The lumber to be clear white pine, dressed on one side. The sheathing to be covered with the best quality building paper tacked on.

The weather covering of the roof to be slate, to be laid to the weather an amount one inch less than half the length of the slab.

The sides of the clear story to consist entirely of windows and frame work. The window sashes to be hung to swing seventy-five degrees about a horizontal axis through the middle of the frame, opening out at the bottom. Windows to be opened and closed by means of four sets of shafting carrying bell cranks. Each set of shafting to swing each alternate frame on one side. Each set of shafting to be in three independent sections, and each section to be operated by suitable mechanism from the floor.

All wood work in the roof above the bottom of trusses to be painted cream color on the inside. The sashes and frames of the sides of the clear story to be painted slate color.
outside to match the roof. All iron work in the roof to be painted a pinkish orange color of a tint mid-way between the terracotta of the brick work and the cream of the wood work.

Coal Bin

The coal bin to have walls which will sustain the weight of the coal independent of the brick walls surrounding it; to be built as follows:

Two strings of six inch beams weighing twenty pounds per foot to pass round the walls of the coal room, the lower one six feet from the floor and the upper one sixteen feet from the floor, stayed across with one and one-fourth inch stay rods eight feet apart, the beams across the ends being stayed to those along the sides by diagonal stays of same size, six feet apart. Standing vertically against these strings are four inch beams weighing eight pounds per foot, four feet apart. On this studding is put a sheathing of two inch planking.

A four by six inch tee rail to be built in the wall between the coal bin and boiler room on which the coal hoppers are to rest.

Six coal hoppers for feeding stokers to be erected above the brick partition wall. To be twelve feet long eight feet wide and twelve feet high, made of one fourth inch sheet steel or iron. The hoppers to be supported on the brick partition wall and held in position by means of two angle bars riveted to the trusses. The chutes to lead from the bottom of hoppers on the west side of partition wall. To be twelve inches in diameter and dust tight. Lower end to be enlarged to conform to the hopper of the stoker.

A dust proof partition wall to be constructed, extending from the top of the brick
partition out under the hoppers, and up in front of them, and joining the roof at bottom of clear story. The lumber used for sheathing in the partition to be the same as used for the roof and painted the same color.

A "C. W. Hunt Swing Bucket" coal conveyor to be installed for storing coal in the bin and for elevating coal from the bin to the hopper. To be located as shown in drawings of the building. To move north at the bottom and up at the north end; the driving mechanism being that regularly used for this form of conveyor, located on the upper run between the north wall and the first truss; the pulley shaft extending through the partition wall and receiving the rope drive to be used for power purposes in the station.

A "Spout Filler" to be used in the trench for filling the buckets, the frame being so made that it can be moved and used at any point in the length of the building.

The bottom of the conveyor passage to be four inches of brick cemented and drained into the catch basin. The covering of the passage to be strong wood framework planked, and having openings in the side for the filling spout. A door three feet wide and four feet six inches high to be made in the partition wall near each end of the boiler room, opening into the conveyor passage.

Trenches and Tunnels.

A trench for feed pipes, two feet deep and two feet six inches wide to be made passing along the front of the boilers to the pumps in the pump and engine room as shown in drawings. The bottom of trench to be bricked and to have a drain ditch along one side, opening
into the Boneyard tunnel. The trench to be covered with cast iron plates resting three inches on each wall. The plates to be cast webbed for strength and weighing fifty pounds per square foot.

A trench for the ash conveyor to be made according to drawings of boiler settings and building. The bottom of this trench to be four inches of brick, cemented and covered with cement, and drained into the catch basin. All that part of the trench outside of the boiler settings to be covered with webbed cast iron plates weighing forty pounds per square foot. At the north wall the trench is to be enlarged into a pit five feet long, three feet wide, and five feet deep, to contain the elevator boot.

A smoke flue built according to drawings to be of hard burned bricks laid in good mortar; the bottom to be six inches of brick well covered with mortar. The construction to be as near water tight as possible, and well drained into the catch basin. The top to be brick supported by cast iron tee rails and covered with the same flooring as the remainder of boiler room.

A tunnel for the passage of Boneyard to be constructed, passing through the building under the floor of the engine room according to drawings. The walls to be two feet thick and fourteen feet deep from the floor line. The top of tunnel to be arched with a radius of three feet, the arch to be sixteen inches thick. The openings in the walls for the entrance and departure of the tunnel to have an arch at the top, and an inverted arch at the bottom sixteen
inches deep. The bottom of the tunnel to be semi-circular in section to conform to the inverted arch in the wall; to be brick eight inches deep laid in cement mortar. An approach and a departure to be built to the ends of the tunnel. The approach to be sixteen feet long from the west wall of the building, consisting of a bottom and two retaining walls. To start at the entrance to tunnel six feet wide and twelve feet deep from the floor line, and diverge from the building to a section eight feet wide at the bottom, the walls having a slope of forty-five degrees, and the bottom being at the natural depth of the stream. The departure to be a continuation of the tunnel to the boundary line where it ends in a wall. The whole construction to be water tight from the beginning of the approach to the end of the departure.

Boilers.

The boiler plant to consist of the following boilers: Nos. 1, 2, 5, 6, 7, 8, and 9, are boilers now in possession of the University and are to be moved and reset. Nos. 1, 2, 5, and 9 are Nos. 5, 6, 4, and 3, respectively in the old heating plant. Nos. 6, 7, and 8 are Nos. 3, 2, and 1 in the old Machinery Building. Nos. 3 and 4 to be new Babcock & Wilcox Co's. boilers, rated at two hundred and forty (240) horse power each, to carry one hundred and fifty (150) pounds of steam.

All boilers to be equipped with Roney Mechanical Stokers, set according to drawings and specifications furnished by Westinghouse, Church, Kerr & Co.

Boilers No. 1, 2, 3, and 4 to be set according to drawings and specifications used and furnished by Babcock Wilcox & Co. changed only to accommodate the stokers, ash conveyors,
and flue. Setting of boiler No. 9 to be same as is regularly used by the Sterling Co. combined with the Roney Stoker. All walls of settings exposed to the fire on one side and to the external air on the other to be sixteen inches or more in thickness.

The settings for the four horizontal tubular boilers, Nos. 5, 6, 7, and 8, to be according to accompanying drawings; No. 5 to be furnished with an iron extension smoke box twenty-two inches long and same diameter as the boiler, and secured to it by means of angle irons and studs. To have two cleaning doors in front and a flue connection in the top with an area of six square feet. Boilers No. 6, 7, and 8 have iron smoke boxes attached. The back arch to be cast iron angle bars carrying brick work.

The setting to be stayed by four sets of cross stays and two sets of longitudinal stays as per drawings, the longitudinal stays fastening to the stoker front and supporting it.

The boilers are provided with side brackets for supporting the boiler on the setting. The brackets are to rest on cast iron plates one inch thick, twenty inches wide, and two feet long, built in the walls of the setting; the front brackets resting directly on the plates, and the rear brackets resting on half inch rollers on the plates. Pieces of six inch by four inch tee rail six feet long to be built in the middle of the wall longitudinally for the plates to bear on and to distribute the load on the walls. The boilers to be set with the back end one inch lower than the front end.

A sheet iron ash funnel to be provided and placed in the ash pit floor over the conveyor trench, for the purpose of dropping the ashes in the conveyor.
The blow-off pipe to lead from the boiler down nearly to the floor line, then out through the setting wall and down under the floor to the blow-off main. A cast iron, asbestos packed cock to be fitted in the pipe where it comes out of the setting. That part of the blow-off pipe exposed to the fire to be surrounded by a piece of four inch cast iron pipe. The blow-off main to be a four inch pipe, laid under the floor about five and one half feet east of the flue, and leading from boiler No. 1 to the Boneyard tunnel, turning east, and ending about the east end of the tunnel.

The feed pipe to enter the boiler at front end and lead to a point in the middle of the boiler about two feet from the rear head. To be fitted with a cock near the setting, a gate regulating valve at hand height, and a check valve between the cock and gate valve.

The connection to smoke flue to be provided with a good tight butter-fly damper.

Each boiler to be fitted with the same water column as in the old setting, the hand wheel guage cocks being replaced by "Jenkens' Packed" ball gauge cocks with lifting rods ending on a level at hand height. The connections to boiler to be without valve or cock. Blow-off pipes with cocks to be connected to bottom of gauge glass and bottom connections of water column and lead to drain passing along under boiler fronts.

Each boiler to have a Crosby, eight inch, brass case steam gauge, to register two hundred pounds, and placed above, and in front of the water column.

Boilers No. 6, 7, and 8 each to be fitted with one, two and one half inch, "Consolidated Co's." nickle seated safety valve, and boiler No. 5 with a three and one half valve of
the same kind.

All external brick work in the boiler settings to be deep red pressed brick laid in mortar of the same color.

All iron work exposed to view to be painted black.

All surfaces of boilers, domes, and steam drums exposed to radiation to be covered with magnesia lagging two inches thick. All steam pipes and feed pipes to be jacketed with magnesia pipe covering one inch or more in thickness. All magnesia jacketing to have smooth canvass covering, to be heavily painted with white enamel paint, and be bound on with polished brass bands.

The gases from boilers No. 5, 6, 7, and 8 to discharge into a rectangular flue passing across above the boiler fronts and leading to the main flue. The flue to be made of No. 10 Gauge sheet iron or steel; to begin at boiler No. 8 with an area of four square feet and terminate between Nos. 5 and 6, with an area of eight square feet. A flue from No. 5, with an area of six square feet to join the flue from Nos. 6, 7, and 8, forming a flue of fourteen square feet area and passing back behind the settings to the underground flue. The flue from No. 9 to pass down at back of setting and enter the main flue under the floor line. Economizer.

A "Green" fuel economizer of four hundred (400) tubes, ten (10) tubes wide to be installed and set as per drawings above the flue and behind boilers No. 1, 2, and 3. The casing
to be No. 8 sheet iron or steel. The housing to communicate with flue by an opening at each end; the south opening being closed by two butterfly dampers, and the north opening closed by a drop swing damper which closes the flue when dropped, and the opening to economizer when raised. The dampers to be cast iron ribbed for strength. The economizer to be supported on the walls of the flue built up to the height of the bottom manifolds. Ends of soot chamber to be closed by cast iron plates not fastened.

Fan.

An exhaust fan for the production of draught to be installed as shown in accompanying drawings. To be a "Sturtevant, 7 X 10\(\frac{1}{2}\)", the fan being seven feet in diameter and four feet long and the housing ten and one half feet high. To have full plate housing, top horizontal discharge. To be driven by a direct connected Sturtevant engine, of the "single valve double enclosed upright" type; cylinders six inches diameter by five inches stroke. Fan to be overhung, (that is, without bearing at inlet end of shaft). Connections to flue to be made of No. 10 sheet steel; to be of same area as openings in the housing, and fitted with slide gate dampers. A butterfly damper to be placed in the main flue at inner wall line; to be made of cast iron, and turn about a vertical axis.

Ash Handling Machinery.

Ash handling machinery consisting of a horizontal conveyor, an elevator, and a hopper with chute, to be entirely of metal construction.

A trough conveyor with roller chains, riding on rails at the sides, to be installed
in the trench made for that purpose under the boiler furnaces, running from within two feet of the south end of trench to the pit at the north wall where it delivers the ashes to the elevator boot. Width of trough to be twelve or fourteen inches.

An elevator to be erected near the north wall, the foot being in a boot placed in the pit made for that purpose, and which receives the ashes from the conveyor; and the top being at such a height that it will deliver the ashes into the hopper. The conveyor is to be driven by sprocket wheels and chain from the head shaft of the elevator which is to be driven by the rope drive used in the station. The hopper, six feet by six feet by ten feet high, to be made of No. 8 or No. 10 sheet iron or steel, and supported on four columns made of six inch iron pipe, to be located against the north wall and the bottom twenty-four feet above the floor. A chute to lead from the bottom of the hopper out through the wall to carry the ashes out to the wagons. The top of the hopper to be covered tight, and the elevator head and elevator to be enclosed in dust proof housing to the floor line, and making a fit with the hopper cover, and with the cover of pit at the bottom.

Return Tank.

A surge tank, four feet in diameter by fourteen feet long, made of one fourth inch tank steel, for receiving the return water from the heating system and the drain from the pipes, to be set up in the south end of boiler room, four feet from the floor and four feet from the wall as per drawings.
Pumps

Pumps for water supply and boiler feeding located as shown in drawings.

No. 1 to be a "Dean Bros." duplex underwriters fire pump; steam cylinders twenty (20) inches diameter and water cylinders twelve (12) inches diameter by sixteen inches stroke, rated at fifteen hundred (1500) gallons per minute underwriters rating. To be set steam end north and set on a good foundation with special care to prevent lateral motion when running at high speed. To take water from the twelve inch main leading from the storage reservoir and discharging into the eight inch main going to the buildings. Suction and discharge mains each to be fitted with water gates. Steam pipe to have a gate throttle valve. A large lubricating oil pump to be fitted to steam pipe below the throttle valve. Exhaust pipe to pass down into Boneyard tunnel and east nearly to the end.

Pump No. 2 is the water supply pump. To be a "Marsh" low service pump, catalogued as size TI - 10" & 7½" X 12". To be connected to the twelve inch suction main and discharge into the eight inch supply main. Nos. 3, 4, and 5 are boiler feed pumps. To be "Marsh" feed pumps of sizes catalogued as follows: No. 3 - size L - 10" & 6" X 12"; No. 4 - size I - 8" & 5" X 10"; No. 5 - size E - 5" & 3" X 6". The pumps to be set on brick piers of sufficient weight to prevent vibration; with centre of pumps three feet above the floor. Each pump to be fitted with one valve in each suction and discharge pipe, one throttle valve, one sight feed lubricator, and one pump governor of approved manufacture.
Electric Light Plant.

The electric light and power plant to consist of the following elements:

No. 1: An "A. L. Ide & Son" Ideal Engine, and a "Brush Electric Co's" arc light machine connected by what is known as the Ideal Rigid Transmitter. Size of engine cylinder, eight by ten inches (8" X 10"); of pulley eight and one half by fifty four inches (8½" X 54"). Dynamos to have a capacity of forty (40), two-thousand candle power arc lights. To be equipped with all trimmings and attachments required for running and regulation, complete to switchboard. To be set on, and bolted down solid to, a brick foundation built solid with the foundation of the engine. The belt to be a good double leather belt eight inches wide.

Nos. 2, 3, and 4: General Electric Co's. multipolar dynamos, and A. L. Ide & Son's Ideal engines direct connected.

No. 2: a twelve (12) kilowatt dynamo, and a seven by ten inch (7"X 10") engine.
No. 3: a twenty-five (25) kilowatt dynamo and a nine by ten inch (9"X 10") engine.
No. 4: a fifty (50) kilowatt dynamo and a twelve by twelve inch (12"X 12") engine.
Dynamos to be equipped with rheostat and all other attachments necessary or convenient for running and regulation, complete to switchboard.

Engines to have cast iron sub-base, and set on foundations built according to drawings and specifications furnished by A. L. Ide & Son. Each engine to be furnished with one quick opening lever throttle valve, one large sight feed lubricator, and one lubricator oil pump.
All parts of engines, dynamos, and pumps not polished, and all iron work in the engine room not jacketed (excepting the roof trusses), to be painted with white enamel paint.
PLANS FOR A CENTRAL STATION
FOR
STEAM HEATING, WATER SUPPLY,
AND
ELECTRIC LIGHT AND POWER
FOR
THE UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS.
Plan of Building with Location of Equipment

Central Heating, Light & Water Supply Station

for

The University of Illinois

Scale: 1/4 = 1'

Signed: [signature]
South End Elevation of Building
for a
Central Heating, Lighting & Water Supply Station
for
The University of Illinois
Scale 1" = 1'
Side Elevation of Building for a Central Heating, Lighting & Water Supply Station for The University of Illinois.
Scale 1/6" = 1'
Sectional Elevation of Building
for a
Central Heating, Lighting & Water Supply Station
for
The University of Illinois
Scale 4" = 1'