Massachusetts
Institute of Technology.

Thesis.

Design for a Town Hall.

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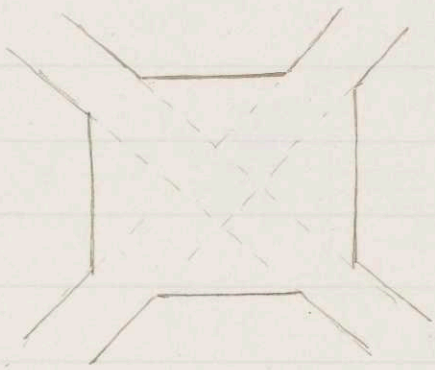
The Subject of this Thesis, is a Town Hall, with which are connected a Public Library and Offices for the Selectmen, Town Clerk, School Committee and others: to be built in a town about the size of Milton.

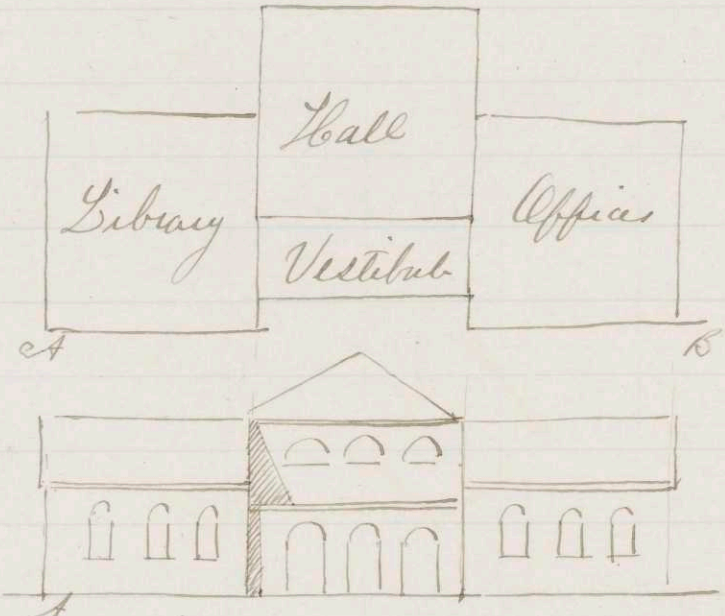
It is to be situated at the corner of two streets, which intersect at right angles and are enlarged into a public square, as shown below:



The principal conditions imposed are 1st The building shall be in one story. 2nd There must be easy access to one or more of the largest rooms from the hall, so that the former may serve as refreshment rooms, in case that a party is given at the building.

Assuming these conditions, it is desired to make a design as complete as possible

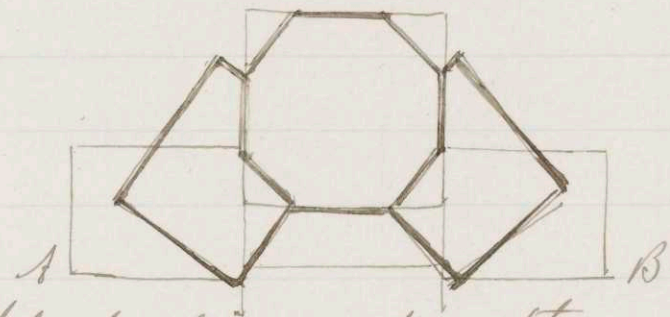
The first scheme that suggested itself was the following, it being desired to have a composition of three features.



Upon making an elevation for this plan, it was seen that the principal feature was too much retired and concealed in a great measure in perspective by the projecting Corners A & B.

This fault might have been corrected by bringing the Central building forward over the vestibule, but unless the vestibule were made excessively high, there would be a second story which was not desirable.

Wishing to have the central feature assert itself, the corners A & B were cut off, and then of the hall in like manner so that after a little consideration the following plan was arrived at which although somewhat unusual is believed to be justified by the conditions of the problem.



The black lines show the resulting plan.

In making an elevation for this plan, the roofs of the library and office buildings have been run back almost to the corner of the octagon, so that the hall may not be hidden by them: for the same reason, and also to give variety, a flat roof has been used to cover the vestibule. The hall is also brought into notice by the engaged belfry and the ventilator.

which crowns the roof.

It is thought that the arrangement of the roof, taken in connection with the plan of having the sides of the wings parallel to that of the main hall, make it impossible that the latter should be concealed from any point of sight.

The Hall.

The windows of the hall have not been brought below the ridges of the roofs of the side buildings, and the points of their intersection with the cornice of the hall have been recognized by carrying a band of cut stone around the building.

The roof has been made steeper than those of the wings on account of the better effect that is thereby obtained in perspective and it seems quite allowable to do so in this case, since the roofs are so broken up.

There being no windows over the stage

in the rear of the hall, it has been thought best to have none in front or either side of the belfry, as they are not required for lighting purposes.

The entrances provided on either (Open.) side of the octagon, it is thought would be useful in case of an exhibition being held in the summer time, when it would be desirable to have as many openings into the hall as possible.

The Belfry.

This has been kept as small as possible so that it may serve the purpose for which it is designed, that of holding a clock and bell, and not detract from the size of the hall.

The Vestibule

In the centre appears the Inscription Tablet rising above the balustrade, and

projecting slightly forward by means of brackets. Under it is a drinking fountain. On either side is a wide entrance, and an office window; care has been taken to place the piers so that the window coming midway between them shall yet be on the axis of the office.

The corners of the vestibule are cut off, thus removing an undesirable solid angle.

Library and Offices

These buildings are alike upon the exterior. The height is proportioned to the size of the library; the windows being kept low and, having the upper part of stained glass, the ceiling may be lowered in the offices as far as desired.

Between the windows on the library is a tablet, and there is a corresponding one for the offices.

The roof being extremely flat, to serve the purpose of bringing the hall forward

the ventilators that have been added, serve to mark them more distinctly.

The chimneys keep their places and do not interfere with the general design.

Stage and Dressing Rooms.

There is nothing about these that calls for remark, except that by mouldings the different heights of floor have been shown.

The stone used in building might be as shown in the perspective, Conglomerate with light stone trimmings.

Plan.

Entering on the right of the drinking fountain, there is found a primary vestibule which in winter would be provided with exterior doors; passing through a doorway, the main vestibule is entered which extends under the belfry from the office to the library, there being a heavy semi circular vault to support the belfry whose exterior wall comes nearly on the crown of the vault.

Each half of the vestibule is five sided each side containing an opening as shown on the plan, which gives easy access from this point to all parts of the building except the stage.

Four sides are treated alike, the opening under the belfry being the odd one.

Tax Collector's Office.

This room opens out of the vestibule as shown on the plan, and is conveniently situated for tax payers; it contains a small

fire place and wash bowl.

Room of Selectmen & Town Clerk.

Passing along the corridor which one of these openings leads to, on the right, is found the above room: the opening comes exactly opposite an opening into the hall, so that one of the principal conditions of the problem is thus attended to.

This room contains a closet and vault separated by a passage into the next room so that both may be made available upon occasion: this room has a fire place.

School Committee's Room.

The next room on the right of the corridor is the above room, which contains a closet.

At the end of the corridor is a small room, separated from it by a glazed partition, so that by this means the corridor is lighted, and also by glazed doors in

the Selectmen's and School Committee's rooms.

Constables Room.

This room contains a fire-place

Water Closet.

This is of triangular shape which answers very well for this purpose a seat and wash bowl being provided.

It is ventilated as are the offices by a flue into the ventilator shown on the outside of the building.

Main Hall

Next comes the entrance to the Hall which may be used at any time although the corresponding one from the library would usually be closed.

The hall is octagonal having a side of 29 feet and is 44 feet in height. The ceiling is panelled as shown below

the chandelier being suspended from the corners of the central square, which is perforated in

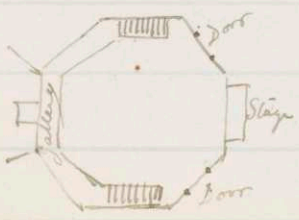
the centre to serve for ventilation

The windows are high in the walls, as necessitated by the exterior arrangements, but this is not considered a fault as there are many instances of this method of lighting, which are very successful.

The light is more evenly distributed in this way, and a disagreeable glare is avoided; but in order to obtain this point without making the hall appear unnecessarily high, the windows have been made to appear longer by the use of a long bevelled face.

The decoration of the walls has been made as much as possible of a horizontal movement, the most marked portion of it being a wide band on seven sides consisting of paintings of famous events in the history of the town.

A gallery arranged as below might take the place of all but two of these paintings, and probably this would make the acoustic effects better. (See accomp. fig.)



The doors have been arranged in a symmetrical manner.

The Stage projects 10 feet from the main wall and is recessed 8 feet so that in case of theatricals being given there may be room for a few flies; it is reached by a flight of steps upon each side and in the drawings is raised four feet, but it had better be only three feet high.

The main floor cannot be made to slope toward the stage as that would unfit it for many uses.

The Dressing Rooms

are in the rear of the stage and separated by a corridor which opens onto the stage and leads to the rear entrance.

The Library

is reached from the Hall as shown on the plan: it is divided by an ornamental wooden screen in the centre of which is the desk into two equal parts, a reading room, and storage room for books: the former is provided with a fire place and large reading table, and the latter with racks arranged as shown on the plan.

The Librarians' room leads from the storage room, and corresponds with that of the Constable: Some care was taken to make these rooms symmetrical.

A stair case leads from the Storage room to a similar room in the basement.

Stair ways.

Between the piers of the belfry and the front wall of the vestibule are the stairs which lead to the belfry and to the basement. Descending a corridor is reached which leads on the right to two rooms intended to serve as kitch-

en accommodations when refreshments are required above, there being a dumb waiter which opens into the Closet in the Selectmen's room.

On the left of the Corridor is a storage room for the library.

Also from the Corridor there are two entrances to the main cellar, where there are four furnaces so arranged that all may be used for the hall, or one for the library and one for the offices. A large rear entrance is provided.

The Belfry is reached by a stairway which passes over the arch that supports the belfry wall, and is covered by a roof that runs from the pediment over the tablet.

The flat roof over the vestibule is

reached from the belfry and ladders lead to the clock above

The air space under the roof of the hall is reached from the clock deck.

From the Belfry there are doors opening onto the roof of the vestibule

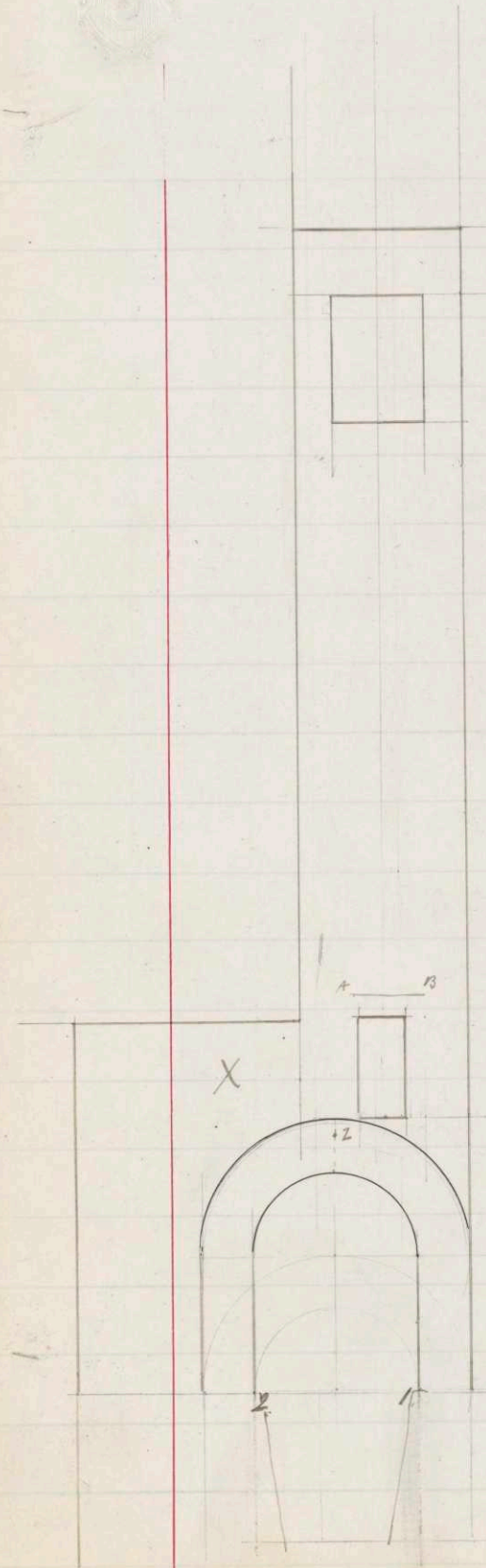
Not much attention has been paid in the drawings to detail, but it has been the endeavor to get the best general arrangement.

Support of Belfry.

The walls of the Belfry are 1ft in thickness and rest upon a barrel vault 4 feet thick, the front wall coming 1ft from the crown of the vault. There being an opening in the front wall for the stairway, the weight of the wall is thrown to the ends of the vault, therefore it will be necessary to see that these portions of it are of the requisite strength.

On the next page is a drawing of the main masses of the belfry and its supports from which its is very evident that there is no chance for the arch to give way, one pier being backed by the wall of the hall and the other by the wall enclosing the stair way.

The lintel A. B throws one half the weight above it on each side, and as the load on the right comes so nearly over the pier, and that on the left comes almost on the crown



of the arch, the whole load might be treated as an isolated load at the crown, without being much out of the way as the portion X may be made so thin as not to interfere with the result thus obtained.

The most accurate way however is to find the moment of the right hand half of the load about the point 1 and that of the left hand half about the point 2; then if the former be the less as it plainly will be, the difference of the moments will be the moment of the force that tends to make the right hand pier rotate outwards; this moment divided by the height of the point of application of the force (1/3 the thickness of the arch from the crown) above the point

1, will give the force Q_1 which must be added to Q_{11} the force acting at this point due to the weight of the right hand half. Then the line of resistance may be drawn and if it pass within the middle third of the foot of the pier, the arch is stable.

In the same manner the other line of resistance may be drawn using the same force Q_1 and combining it with force due to the weight on the other half.

Expressing this in algebraic form we have $Q_{11} = \frac{aP}{b}$ where a = horizontal dist. of centre of grav. of semi arch and load from point of springing, P = total weight of semi-arch and load, and b = vert. ht. of pt. of application of Q_{11} above springing.—

$Q_1 = \frac{M'' - M'}{h}$ explained above

Then Q_1 the force to be combined with the individual voussoir weights, to draw the line of resistance $= Q_{11} + Q_{11} = \frac{aP}{b} + \frac{M'' - M'}{h}$

Roof of Hall.

is supported by four trusses like the one shown in fig 3 on the next page; these are stiffened by lateral braces 12. 23. 34 &c shown in fig 1, which support the ceiling of the hall, ties being fastened at the points 5 & 6

As it is desirable to have the cross bars fit into the trusses at a joint the strut is put in at this point, making each half of the truss unsymmetrical.

To find the loads coming upon the joints of the truss: there being eight triangles of roofing, and four trusses, each semi-truss will have to bear the weight of one triangle, as A.B.C, but the amount borne by different parts decreases uniformly from A to C where it is nothing.

It is necessary to find what loads are supported at A, 2, & C respectively.

fig 1

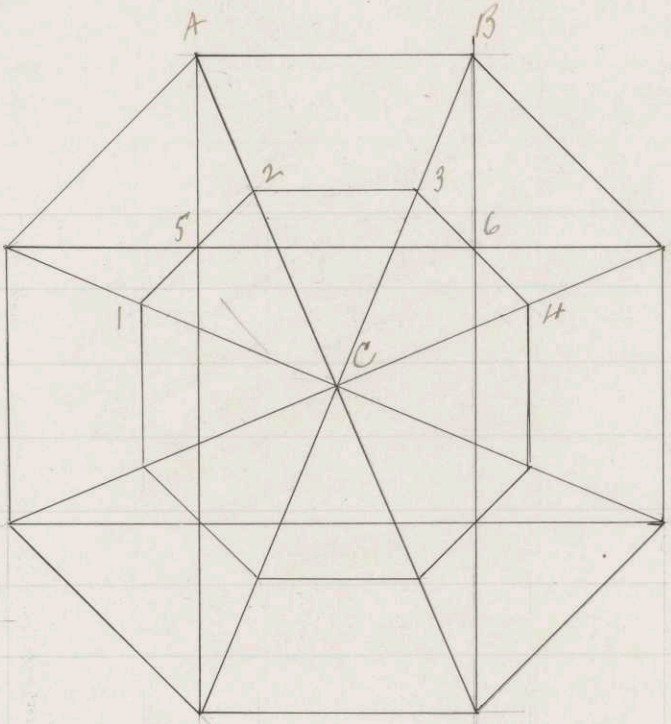
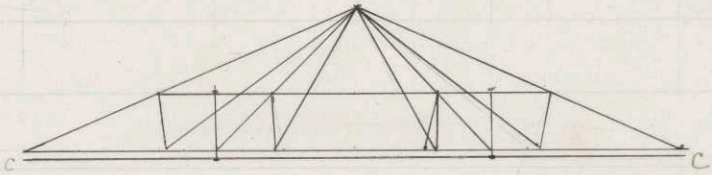
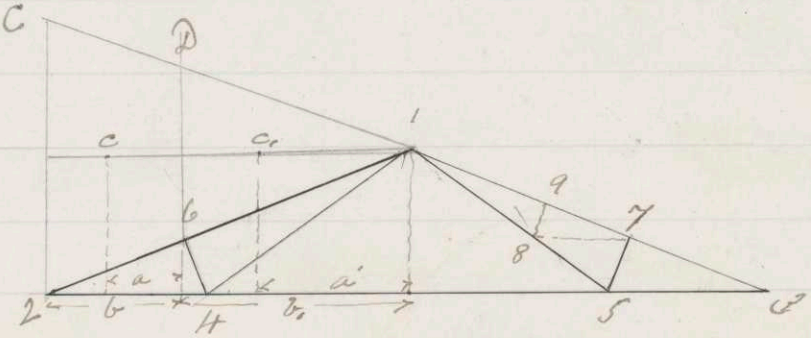


fig 2



cc. ceiling

fig 3



To do this, in fig. 3, a triangle is laid off, 2 C 1, representing the load on one side of the bars; then finding the centres of gravity of the trapezoid and triangle representing the weights below and above the strut; then dropping ~~a perpen~~ vertical lines we have the points of application of the resultant forces upon the bars 2 6 & 6 1.

From this we obtain the amounts of load acting at 2, 6, & 1 by taking moments about 6 & 1.

Thus: if we have W acting through C, then S the supporting force at 2 due to this load, or the amount of load supported $= \frac{Wa}{b}$ and the amount supported at 6 from this load is $W - \frac{Wa}{b}$; in like manner from the weight W_1 represented by the triangle 6 D 1, we have supported at 6 $\frac{W_1 a_1}{b_1}$ and at 1 $W_1 - \frac{W_1 a_1}{b_1}$

Summing up we have for loads:
at 2, $\frac{Wa}{b}$; at 6, $W - \frac{Wa}{b} + \frac{W_1 a_1}{b_1}$;
and at 1 $W_1 - \frac{W_1 a_1}{b_1}$

This accounts for the loads at the joints due to the weight of the roof, but in addition there is supported at 6 (fig 3) $\frac{1}{8}$ the weight of the ceiling of the hall as shown on fig. 1 at the point 5.

Having determined the loads coming upon each joint of the truss, the stress coming upon each member may be readily determined by the graphical method of laying off a load line whose segments are the loads coming at the various joints, and drawing a polygon of forces whose sides taken in order are parallel to the bars of the truss.

Knowing the stress to which each member is subjected, its size is to be calculated if a tie, by means of the formula $f = \frac{p}{bh}$ where f = working strength, p = stress obtained, and b = breadth and h = height of cross section;

if a strut, which is prevented from buckling the same formula is used:

if however the strut is not laterally braced it is necessary to use the formula

$P. S = \frac{f A}{1 + a \frac{l^2}{k^2}}$, where P = stress obtained;

S = factor of safety;

$f = 7200$; $a = \frac{1}{250}$ (for rectangular struts)
A = cross section in inches; h = least external diameter in inches (assumed).
l = length in inches.

The stress due to bending moment must also be considered; in finding the section of the bar, the stress due to this cause being added to that due to direct stress.

To find this stress due to Bending moment use the formula

$M = \frac{PJ}{y}$ M = bend. mom. P = stress
J = mom of inertia y = dist of most stressed fibre from neutral ax.

There might be a tertiary stress 187 introduced as shown in fig 3, when it would be necessary to determine the load coming upon 1, 9 & 7 as shown before.

Girder over Stage.

It is necessary to have a girder to support the wall coming over the stage, for as the opening must occupy nearly the entire width of the side of the octagon, there is no wall left to resist the thrust of an arch, and it seems undesirable to construct a buttress for this purpose. Besides there is a band of ornamentation running around the hall at the point at which the girder is to come so that a continuous horizontal movement is obtained in this manner which with an arch would be lost.

To calculate the size of this girder we have the formula $f = \frac{Mc}{I}$, explained previously. There being a uniform load W. the greatest bending moment $= \frac{wc^2}{2}$ w being the load per unit of length c. the half span of the girder.

If f comes inside the working strength. The girder

of the size assumed is safe.

Charles M. Baker
Boston
May 18. 1878.