To all whom it may concern:

Be it known that I, HEINRICH HOLLAND, a citizen of the German Empire, residing at Charlottenburg, in the Kingdom of Prussia, German Empire, have invented and useful Improvements in Methods of Erecting Large Halls and the Like, of which the following is a specification.

My invention relates to improvements in constructing large halls and the method of mounting and dismounting the parts of the same.

It is particularly adapted for use in the construction of large halls such as are used for keeping air ships and other air machines. And the object of the improvements is to provide a construction and a method of erecting the same which permits to mount or dismount the construction without using a scaffold.

With this and other objects in view my invention consists in the matters to be described hereinafter and particularly pointed out in the appended claims.

For the purpose of explaining the invention an example embodying the same has been shown in the accompanying drawings, which example consists of an elongated hall of large dimensions which is adapted to receive an airship of the construction suggested by Zeppelin. According to the dimensions of the air ship the hall requires an inner circular cross-section of a diameter of about 25 meters and a length of about 160 meters.

In the said drawings—Figure 1, is a cross-section of about one half of the hall showing a front view of one half of a truss in its simple form, Fig. 3, is a similar cross-section showing the other half of the truss, Fig. 2, is a side view of the truss showing the method of erecting the same, Fig. 9, is a perspective view on an enlarged scale of one of the angle plates on which the partly mounted trusses are supported when being tilted, Fig. 3, is a plan of Fig. 2, Fig. 4, is a plan on a reduced scale of a larger part of the hall showing the bearing plates for the bottom joints and the tilting lines which are of importance in mounting the structure, which lines have been indicated in the right and left hand halves of the truss by the characters 1–1, 2–2, etc., to 7–7, Fig. 5, is a diagrammatical view of a pair of simultaneously erected binders and their longitudinal connection, Fig. 6, is a diagrammatical view illustrating the manner of constructing the longitudinal connection between two adjacent complete sections of the hall and of applying the roof covering between the sections of the hall, Fig. 7, is a front view on an enlarged scale of the lower part of the truss as it appears while the partly completed truss is being tilted upward, Fig. 8, is a side view of the longitudinal connection between two trusses forming a pair of cooperating trusses and of the longitudinal connection between two adjacent sections of the hall, and Fig. 9, is a plan of Fig. 8.

In the example shown in the drawings a hall is illustrated in which the trusses consist of two arched halves which are jointed at their tops. The trusses are arranged at a distance of about 5 meters, and the first and second ones, the third and fourth ones, the fifth and sixth ones, etc., are combined into cooperating pairs of trusses which pairs are provided apart from their longitudinal connections with diagonal braces, while the second and third, the fourth and fifth, the sixth and seventh trusses are respectively connected only by longitudinal braces which permit a certain longitudinal displacement of the trusses relatively to each other as is required by reason of changes in the temperature. In order to distribute the pressure of the wind which acts on the front faces of the hall on a larger number of the trusses, the pairs of trusses which are near the front faces are preferably braced with each other.

In the preferred form of the invention the trusses consist of a number of complete sections of substantially the same length. Several trusses, for example six or three pairs thereof, are constructed at the same time, and the manner of construction is such that the sections of each truss which are jointed at the top are at first connected with each other. The longitudinal and diagonal connections of the pairs of trusses, and the longitudinal connections between consecutive pairs of trusses are constructed, whereupon the outer faces are covered with canvas or the like. Now the roof which is thus constructed is tilted upward on one of its ends, for example on the ends of the right hand side, so that at the opposite side, that is at the left hand side, the following section can in each truss be placed beneath the 110
elevated roof section and secured thereto. Thereupon the said sections which have been secured to the roof section are braced, the covering is applied thereto, and the body which has thus been produced is tilted about its left hand ends, so that the next section can be secured thereto. In the same way the construction is continued, until the whole section of the hall which is formed by the six trusses is completed. In the same way the adjacent section of the hall is erected. Finally the complete hall sections are braced by longitudinal connections, and the spaces between adjacent sections of the hall are covered with canvas or the like.

Referring now more particularly to the example illustrated in the drawings, a complete truss consists of two symmetrical arched halves a and b provided with foot joints c and d and with a top joint e. Each half of the truss is constructed of sections a₁, a₂, a₃, . . . aₙ and b₁, b₂, . . . bₙ, which have substantially the same length. Near their lower ends the sections a and b are connected by a tension element f₁. To the lower end of the lower girders of the truss sections a₁, a₂, aₙ and b₁, b₂, . . . bₙ eyes g₁, g₂, . . . and h₁, h₂, . . . are secured which in the construction of the truss can successively be connected by tension elements f₂, fₙ . . . The tension element f₁ which is connected to the eyes g₁ and h₁ remains in place, until the truss or the section of the hall has been completed, whereupon it is removed. In the example illustrated the tension element f₁ consists of two sections which are connected with each other at their middle. After completing the construction of the truss or the section of the hall, the said sections of the tension element are disconnected, and the sections of the tension element are placed on a path provided below the top of the whole hall, as is indicated in dotted lines. The bearings s for the bottom joints are preferably supported on a grating constructed of ties or the like.

Before the construction of the hall is begun the ground is carefully planned, and the bottom plates or bearings s for the bottom joints are exactly adjusted as to their alignment and height, as is shown in Fig. 4. Now the sections of the hall are successively erected. The breadth of the sections of the hall, or the number of the adjacent trusses forming such a section, and which are simultaneously erected depends on various conditions, and particularly on the number of workmen engaged in the construction of the hall, and the machinery which is available in the construction, particularly the hoisting machines.

In the position of the parts illustrated in Fig. 4, the section which consists of the seventh to twelfth trusses is about to be erected. For this purpose, within the planes of the said trusses the sections a₁ and b₁ of each truss are mounted, and in each truss the eyes g₁ and h₁ are connected by the tension element f₁. In the present example the seventh and the eighth, the ninth and the tenth, and the eleventh and the twelfth trusses respectively provide a pair of braced trusses. Now the longitudinal and diagonal braces are mounted in each pair of trusses, and the longitudinal braces between adjacent pairs of trusses and the elements which are afterward used for connecting adjacent sections of the hall are secured in place. Thereupon the body which is thus produced is covered with a roofing material, such for example as canvas. Thereafter the body is tilted upward about its right hand ends, at the left of the body the truss sections a₁ are mounted and secured in position, and finally the portion of the hall section which has thus been enlarged is covered with canvas. Thereupon the body is tilted about its left hand end, and the truss sections b₁ are secured to the right hand end of the trusses etc.

The hall sections or the trusses which are gradually completed are tilted about tilting lines which are different in each tilting operation. For various reasons it is important that in each tilting operation the tilting axes of all the trusses which are combined into a hall section, and which are simultaneously tilted upward are disposed within the same straight, horizontal line which is parallel to the longitudinal axis of the hall, and that the tilting lines about which the successive tilting operations are performed have exactly the prescribed position. If, for example, the point of support of a partly completed truss is disposed nearer the median line of the hall, or higher than the points of support of the other trusses, the strain exerted on the said truss and the adjacent longitudinal braces caused by tilting the partly completed truss would be considerably increased. Furthermore, if the tilting lines are not exactly maintained over the whole length of the hall, the hall section would easily be turned or laterally displaced, when gradually tilting the same upward. The errors made in each section are under circumstances summarized, so that the complete hall has no continuous longitudinal axis, and the hall sections are not in alignment with one another. To make the tilting operation more easy, and to fix and maintain the tilting line with accuracy the inner ends of the partly completed trusses are supported on angular plates k of cast steel or the like which are provided with lateral trunnions k₁ and k₂ and a notch k₃ through which the eyes b₁ and h₁ of each truss are inserted, as is shown in Figs. 2 and 2. Each of the said angle plates k is supported with
its trunnions \( k^2 \) and \( k^2 \) within a suitable bearing \( l \). To secure the exact and uniform height and the exact horizontal position of all the tilting lines about which in the successive tilting operations each truss is tilted, to enable the truss sections which are being secured in place to be easily and speedily brought in place, and to transmit the load which comes into action when tilting the trusses on a broad surface, each bearing \( l \) is mounted on a low truck \( m \), and below each truck a track is arranged the axis of which is within the perpendicular median plane of the truss. The said track extends a certain distance beyond the plan of the construction and at both sides thereof, so that the truss sections can be loaded on the said tracks \( m \) outside the plan of the construction, and two adjacent truss sections can be connected to a pair of truss sections on two adjacent tracks and can simultaneously be moved into position to be tilted.

In the plan illustrated in Fig. 4, in which the hall section formed by the seventh to twelfth binder is about to be erected the rails disposed below the trusses have been indicated by the letter \( n \). If the said rails have been carefully leveled, and if the tracks \( m \) have no springs, the geometrical axis of all the

planes of the truss sections which are being secured in place to be easily and speedily which the trusses forming a pair, and the longitudinal braces between consecutive pairs of

trusses have been mounted, as far as the trusses or pairs of trusses have been built, and the connecting elements which prepare the longitudinal connection between consecutive hall sections have likewise been secured in place. The roof covering has been applied to the hall section which has so far been erected. Preferably the roof covering consists of canvas, a separate strip being provided on each side of the hall for each field between two consecutive trusses. The strip \( w \) for a field of the left side of the hall is suspended from the right of the top of the hall along the line \( w^1 \), and the strip \( w \) for the right hand side of the hall is suspended from the left of the top along the line \( w^2 \). The canvas is brought on the hall in the form of rolls, which are gradually unwound and secured to the binders and the longitudinal braces as the construction of the truss proceeds. The hall section which has so far been completed must now be tilted about the right hand bearing points. For this purpose the last truss sections \( b^7 \) of the right hand truss halves are each supported on one of the previously described angle plates \( k \) provided with lateral trunnions. All the trunnions of the angle plates \( k \) are exactly adjusted within the line 2--3--6 of the right hand half of the hall.

The left hand side of the hall section which has so far been constructed is now uniformly elevated into the position shown in Fig. 2. For consecutively lifting the sides of the hall sections hoisting frames \( o \) are disposed on either side of the hall sections, which frames preferably extend over two tracks, and more particularly over those tracks which belong to a pair of trusses. To the ends of the trusses which must be lifted, and more particularly to the outer section of each truss, and in the present case to the outer end of the truss sections \( a^7 \) an angle piece \( q \) is secured which is embraced by the forked end of a block carrying a pulley \( g \). About the rollers \( g \) which belong to a pair of trusses a chain \( q^3 \) is laid. The free ends of the said chain are suspended from the lower pulley blocks of two differential tackles \( r \) which are attached above the trusses to a hoisting frame \( o \) extending over the pair of trusses. By thus suspending the trusses the load of the latter is uniformly distributed to both tackles, even if one of the tackles is operated a little in advance of the other one. A pair of each pair are braced against each other, the unequal distribution of the load is of importance, because otherwise the strain on the construction or the load of one of the tackles would be unduly increased. Notwithstanding the
arrangement described, it will still be advisable to operate the six tackles as uniformly as possible, though small inaccuracies are unavoidable. The arrangement of the tackles and the chain lead to the conclusion that the two tackles of a pair will still be advisable to operate as uniformly as possible, though slight inaccuracies are unavoidable in the operation of lifting the different pairs of trusses are not injurious, because the connection between the pairs of trusses allows of a slight displacement.

While the left hand side of the hall section is lifted, the truss sections \( a \) have been placed on the trucks \( m \) located at the left hand side of the construction. Furthermore for each pair of trusses two parts \( a \) have been connected with each other, and the trucks have been so advanced, that the tilting axes are exactly in line. In this position the trucks are braked. If necessary, the trucks can be further secured in place by means of suitable claws which embraces the heads of the rails. After the left side of the hall section has been lifted into the position shown in Fig. 2, the truss sections \( a \), or the connected sections \( a \) of the pairs of trusses, are tilted into the position shown in dotted lines in which they have the correct position for being secured to the trusses by means of screws, wedges, and the like, and the longitudinal connections are secured to the adjacent pairs of trusses. Furthermore to both ends of the hall section brackets are secured, to which afterward the longitudinal connections with the adjacent hall sections are secured.

The intermediate connections \( s \) for connecting the trusses of a pair of trusses, and also the intermediate connections \( s \) for connecting adjacent pairs of trusses, and the brackets \( a \) at both ends of the hall section are secured to the trusses by means of angle irons \( t \). Furthermore the brackets \( a \) are held by braces \( w \). The brackets \( a \) of two adjacent hall sections project beyond their trusses so far that the space left between the same is just sufficient to enable the hall sections to be erected, as is clearly shown in Fig. 6. After completing the hall this small space is filled up by short pieces \( z \) which are secured to the said brackets by means of plates \( y \). Now the covering material is unwound from its roll, and the surface of the hall section is covered as far as possible. The pieces \( y \) by means of which adjacent hall sections are united may in advance be secured at one side to the brackets \( w \) by means of plates \( y \), so that they are gradually worked together with the hall section. After the sections \( a \) and \( a \) have been connected with each other, the angle pieces \( p \) can be removed from the trusses \( a \) and secured to the lower ends of the trusses \( a \), and the hoisting frame \( e \) at the left of the construction can be shifted toward the left, until the tackles \( r \) are again above the angle pieces \( o \) of the pulleys \( q \). Now the bearings \( l \) at the left of the hall are used as tilting bearings. But before the right hand side of the hall sections is lifted, the tension element \( f \) is disconnected from the eye \( p \), and the said tension element, which for the purpose of avoiding bending of the same is preferably suspended from ropes, is lowered, until it is in line with the eye \( k \) and \( g \), whereupon the left hand end of the said element a further piece is secured, so that the eyes \( k \) and \( g \) can be connected by the said tension element. Now the hall section can be lifted at its right hand end. Immediately after lifting has begun the trucks \( m \) are free of the load of the construction, so that they can be moved backward into the position shown in Fig. 2 in dotted lines, in which the truss sections \( b \) can be mounted thereon. Before the hall section has been elevated into its end position, the trucks \( m \) with the trusses or truss sections or pairs of truss sections mounted thereon are again moved to the left, where they are exactly adjusted in position, so that all the trunnions are exactly within the line. The truss sections or sections of pairs of trusses \( b \) are now secured to the sections \( b \). The longitudinal connections are made, the roofing is applied thereto, the tension element is disconnected from the eye \( k \), the tension element is lowered, and, after being enlarged by a suitable extension, secured to the eye \( k \), so that now the eyes \( g \) and \( k \) are connected with each other.

After two adjacent hall sections have been erected, the brackets \( a \) are connected to the other hall section by means of the plates \( y \). If desired the said brackets have been been jointed with one of their ends to the outside of one of the hall sections. Now a covering of roofing material is brought on the space between consecutive hall sections beginning from the top of the said sections, which covering has the breadth of the distance between the said hall sections. The said covering is secured in place so that the intermediate space is covered. If, for the purpose of taking up the pressure of the wind on the end faces of the hall, the pairs of trusses are braced against each other by diagonal braces, the latter are preferably elevated with the construction of the hall section. But the said braces are but loosely held in place and are rigidly secured at the end of the construction, in order to avoid excessive strains caused by inaccuracies in the lifting operation of the different trusses.

It will readily be understood, that the whole hall can be built in a comparatively...
short time without any scaffolding. The last part of the work, which consists in securing the connections between the hall sections and in covering the spaces between the said sections, can be done by one man who descends from the top of the hall on the outer face thereof. This part of the work does not require the lifting of parts of any considerable weight.

When building a hall in the manner described a number of trusses is erected at a time. When lifting one side of a hall section the truss sections to be secured thereto are already complete and placed on the trucks and combined into pairs and set in the correct position. The tilting axes are adjusted on the ground, and not at a height. The tilting lines can easily be adjusted and fixed parallel with the longitudinal axis of the hall by sighting the same as described and by moving the trucks. For these reasons the erection of the hall requires a minimum of time.

As the hall sections are always tilted from the correct tilting lines, the complete hall sections assume the correct positions in alliment with each other, and in the course of construction the sections are always adjusted anew, so that within the construction of the individual trusses and of the hall sections errors of the construction are not summarized and departures from the desired form of the hall sections cannot occur. Therefore it is not necessary to adjust the hall after the construction is completed, and the work connected therewith and the increase in the strain on the construction are avoided. The hall is dismounted in the same way and with the same machinery.

At first the narrow pieces of covering material which cover the spaces intermediate the hall sections are wound up, and by dismounting the intermediate pieces the whole hall is divided into hall sections.

Each hall section is dismounted by being slightly lifted at one side or tilted about the foot joints at the opposite side. Thereafter the lowermost truss sections are removed and this side of the hall is lowered.

In the tilting bearings after the same have been brought into the correct position. Now the right hand side is slightly lifted, the lowermost trusses at the right hand side are removed, and the right hand side is lowered on the tilting bearings after the same have been set in the correct position, etc.

I claim herein as my invention:

1. The herein described method of erecting trusses, which comprises the tilting of a truss section successively on opposite ends, and successively securing a truss section under each elevated end.

2. The herein described method of mounting arched trusses, which comprises the elevation of a truss section at its ends successively, and securing under each elevated end a truss section of substantially the same length.

3. The herein described method of erecting constructions comprising a plurality of arched trusses each composed of sections, which includes bracing a plurality of corresponding sections of adjacent trusses against each other, elevating the said braced sections at one end, and securing further truss sections to each of the braced sections under the elevated ends thereof.

4. The herein described method of erecting constructions comprising a plurality of arched trusses each composed of sections, which includes bracing a plurality of corresponding sections of adjacent trusses against each other, elevating the said braced sections successively at opposite ends, and securing further braced truss sections under each of the braced sections at the elevated ends thereof.

5. The herein described method of erecting arched trusses, composed of sections, which includes elevating a sectional truss successively at opposite ends, and securing a further section under the end being elevated, the outer ends of the sectional truss being connected by a tension element while being elevated.

6. The herein described method of erecting arched trusses, composed of sections, which comprises elevating a sectional truss successively at opposite ends, successively mounting truss sections on tilting bearings, one section for each end of the sectional truss which is being elevated, moving the same below the elevated end of the sectional truss, adjusting and fixing the said bearing as to height and horizontal position along a sighting line, and securing the truss section under the sectional truss.

7. The herein described method of erecting arched trusses composed of sections, which comprises elevating a sectional truss successively at opposite ends, successively mounting truss sections on tilting bearings disposed on springless trucks, one section for each end of the sectional truss which is being elevated, moving the same below the elevated end of the sectional truss, adjusting and fixing the said bearing as to height and horizontal position along a sighting line, and securing the truss section under the sectional truss.

8. The herein described method of erecting constructions comprising a plurality of arched trusses each composed of sections, which includes bracing a plurality of corresponding sections of adjacent trusses against each other, elevating the said braced sections at one end, mounting braced truss sections on trucks, moving said truss sections on their trucks below the elevated ends of said elevated sections of adjacent trusses.
securing thereto the braced sections mounted on the trucks.

9. The herein described method of erecting constructions comprising a plurality of arched trusses each composed of sections, which includes bracing a plurality of corresponding sections of adjacent trusses against each other, elevating the said braced sections at one end by means of hoisting devices the frame work of which extends over all the braced truss sections, mounting other braced truss sections on trucks, moving said truss sections on their trucks below the elevated ends of said elevated sections of adjacent trusses, and securing thereto the braced sections mounted on the trucks.

10. The herein described method of erecting arched trusses composed of sections, which includes bracing adjacent sectional trusses against each other, securing a draft evening apparatus to the ends of said sectional trusses at one side thereof, connecting said evening apparatus to a hoisting device, elevating the ends of said sectional trusses by means of said draft evening apparatus and hoisting device, and securing other truss sections under the elevated ends of the sectional trusses.

11. The herein described method of erecting trusses composed of sections, which includes securing eyes to the ends of said sections, tilting a sectional truss successively upon opposite ends, successively connecting the eyes provided at the free ends of the sectional truss to be tilted by a tension element, and securing further sections under the ends being elevated.

12. The herein described method of erecting arched trusses composed of sections, which includes elevating a sectional truss successively at opposite ends, successively connecting the ends of the sectional truss to be elevated by a tension element, securing a further section under the end being elevated, disconnecting said tension element from the side of the sectional truss which has thus been extended, attaching an extension to said tension element, and securing the same to the outer end of the section which has been secured to the sectional truss.

13. The herein described method of erecting hulls built up of arched trusses consisting of sections which includes elevating sectional trusses successively at opposite ends, securing truss sections successively to the ends of the sectional trusses being elevated, and unwinding a roll of covering material from the top of the sectional truss gradually over the sides in the course of the elevation of said sectional trusses.

14. The herein described method of dismounting trusses built up of sections, which includes supporting the truss above the lowermost section at one side, removing the said lowermost section, and lowering the remaining sectional truss with its supported end.

In witness whereof I have hereunto set my hand in presence of two witnesses.

HEINRICH HOLLAND.

Witnesses:

HENRY HASPER,

WOLODEMAR HAUPT.