Dec. 4, 1923. 1,476,062

W. ECCLES

MEANS FOR SUPPORTING AND FOR CONNECTING BODIES, MACHINES, OR OTHER APPARATUS

Filed March 2, 1921 4 Sheets-Sheet 1

Fig. 1.

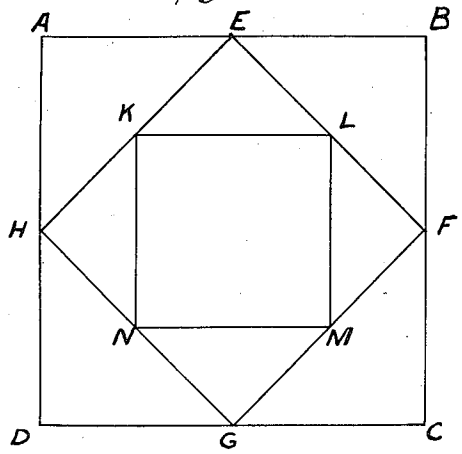
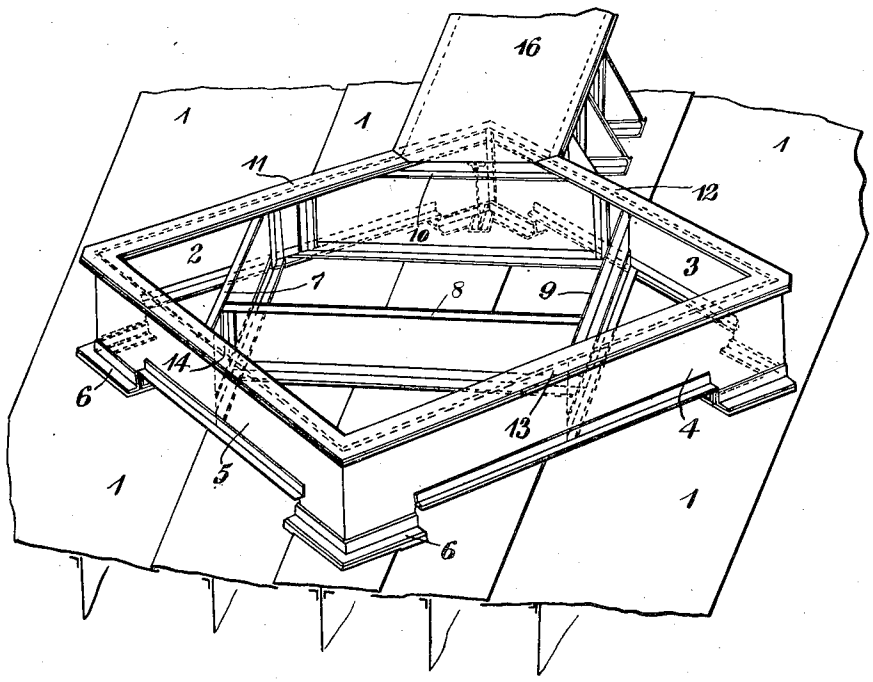


Fig. 4.



William Eccles
INVENTOR

BY A. C. Davis
ATTORNEY

Dec. 4, 1923. 1,476,062

W. ECCLES

MEANS FOR SUPPORTING AND FOR CONNECTING BODIES, MACHINES, OR OTHER APPARATUS

Filed March 2, 1921 4 Sheets-Sheet 2

Fig. 2.

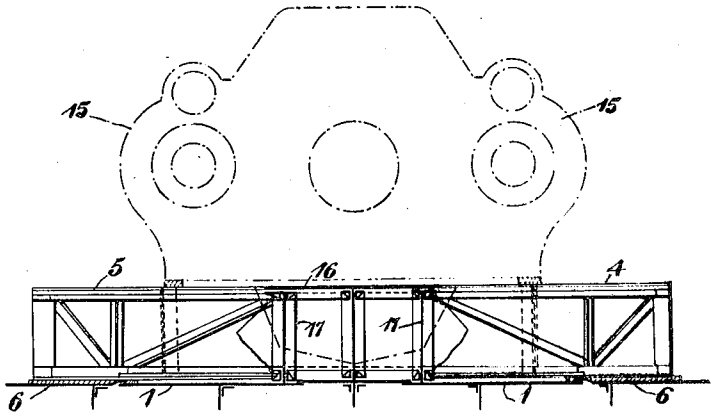
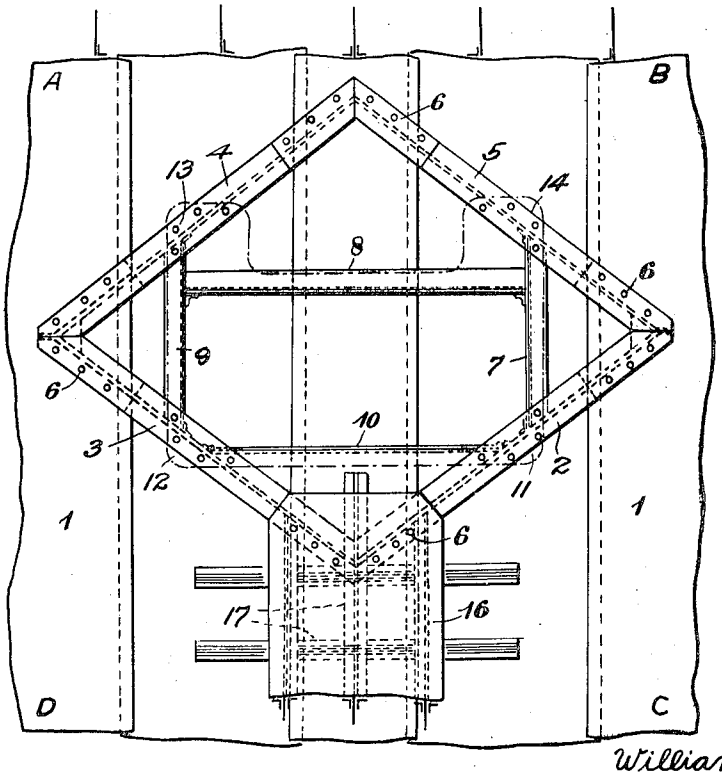


Fig. 3.



William Eccles
INVENTOR

BY O C Davis
ATTORNEY

Dec. 4, 1923. 1,476,062

W. ECCLES

MEANS FOR SUPPORTING AND FOR CONNECTING BODIES, MACHINES, OR OTHER APPARATUS

Filed March 2, 1921 4 Sheets-Sheet 3

Fig. 5.

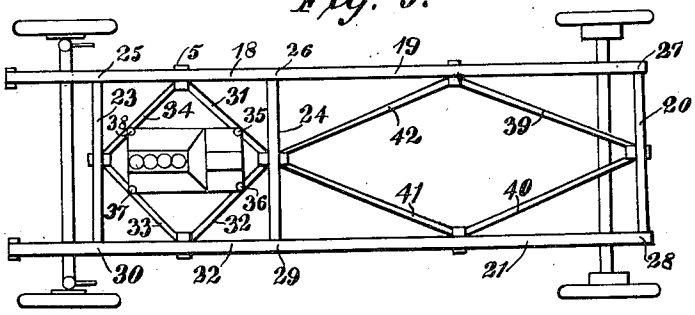


Fig. 6.

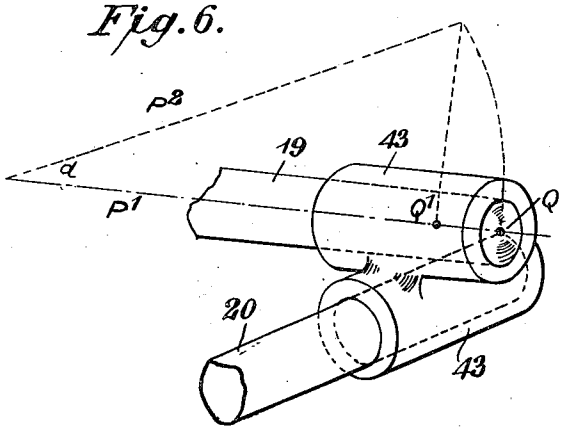


Fig. 7

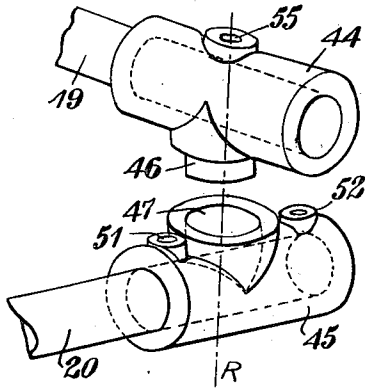
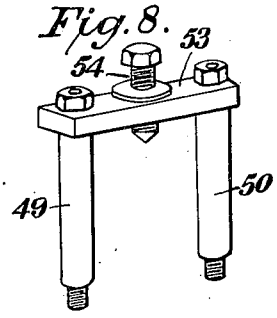


Fig. 8.



William Eccles
INVENTOR

BY D C Davis
ATTORNEY

Dec. 4, 1923. 1,476,062

W. ECCLES

MEANS FOR SUPPORTING AND FOR CONNECTING BODIES, MACHINES, OR OTHER APPARATUS

Filed March 2, 1921 4 Sheets-Sheet 4

Fig. 9.

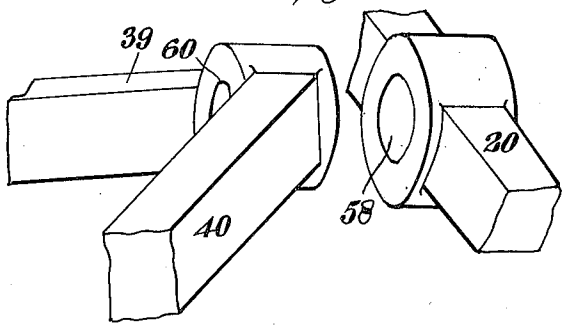


Fig. 10.

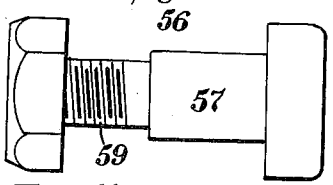


Fig. 11.

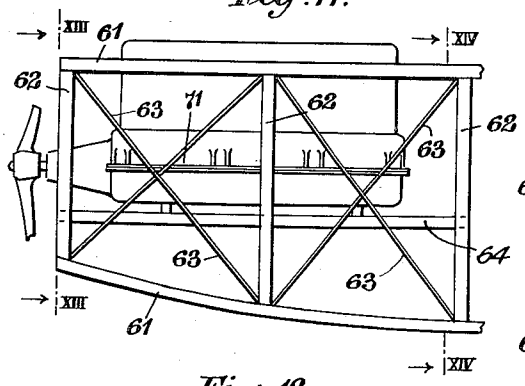


Fig. 13.

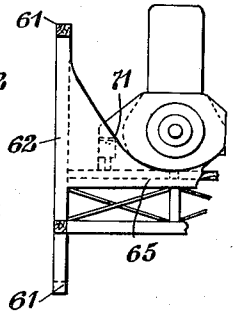


Fig. 12.

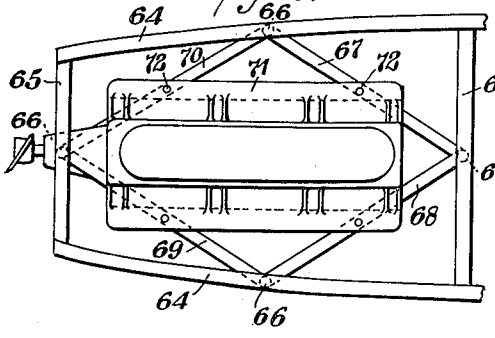
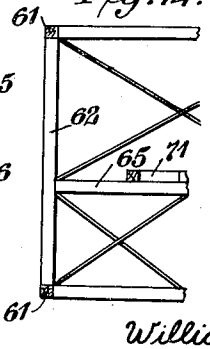


Fig. 14.



William Eccles
INVENTOR

BY D. C. Davis

ATTORNEY

Patented Dec. 4, 1923. 1,476,062

UNITED STATES PATENT OFFICE.

WILLIAM ECCLES, OF CHORLTON-CUM-HARDY, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

MEANS FOR SUPPORTING AND FOR CONNECTING BODIES, MACHINES, OR OTHER APPARATUS.

Application filed March 2, 1921. Serial No. 449,204.

To all whom it may concern:

Be it known that I, WILLIAM ECCLES, a subject of the King of Great Britain, and a resident of Chorlton-cum-Hardy, in the county of Lancaster, England, have invented a new and useful Improvement Relating to Means for Supporting and for Connecting Bodies, Machines, or Other Apparatus, of which the following is a specification.

This invention relates to means whereby a body, machine or apparatus may be supported from, and/or connected to, a second body, machine, or apparatus at or by four points not necessarily in one plane in cases where these points are liable to relative movement in a direction perpendicular to the plane nearest containing the points.

As three points determine a plane surface it will be clear that where a body is supported by or connected to a second body at three points in the supporting or connecting base of the first body such base will remain plane notwithstanding relative movements of the three supporting points in directions perpendicular to the plane of the three points. Consequently deformations of the second body resulting in movements of the supporting points of the nature referred to will not subject the first body to bending or twisting stresses. Where, however, the supporting or connecting points are greater in number than three and are subjected to movement as above described, they may not remain in the same plane and the first body may consequently be subjected to bending or twisting stresses.

The object of the invention is to provide improved means for supporting one body from, or connecting one body to, a second body by four points in said second body in such a manner that bending or twisting stresses will not be transmitted to the first body by reason of movements or deformations of the second body.

According to the invention the four supporting or connecting points of the second or supporting body hereinafter termed the primary support points are connected by links or beams joined to the supporting body at said points so as to form a substantially quadrilaterial frame which may or may not be a plane figure according to the relative position of the points. In each connecting link or beam a point is chosen, these points being collectively termed the secondary support points and these points are also connected by links or beams which form a second frame. If the connecting joints at the various points are flexible or the links or beams have torsional flexibility relative to a longitudinal axis then by properly choosing the secondary support points the second frame will be a plane figure and will remain plane notwithstanding relative movement of the primary support points.

The second frame can therefore form the base of a body which it is desired to support free from stresses which might arise by reason of deformation of the supporting body.

In order that the nature of the invention may be clearly understood, it will now be described with reference to the accompanying drawings in which Fig. 1 is a geometrical diagram hereinafter explained for the purpose of enabling the principles underlying the invention to be more clearly understood. Fig. 2 is an end elevation, partly sectional, and Fig. 3 is a plan of a seating for the gear case of a marine steam turbine constructed in accordance with the invention. Fig. 4 is a perspective view of the same viewed from the top of Fig. 3. Fig. 5 is a plan view illustrating the invention applied to a motorcar for the purpose of supporting the engine and the body. Figs. 6 to 10 are detail views of joints hereinafter explained. Fig. 11 is a side elevation of a portion of an aeroplane body showing how the engine may be supported in accordance with the present invention. Fig. 12 is a plan of the same, Fig. 13 is a sectional view on the line XIII—XIII, Fig. 11, looking in the direction of the arrow, and Fig. 14 is a similar view on the line XIV—XIV, Fig. 11, looking in the direction of the arrow.

Referring now to Fig. 1, the diagram illustrates a link structure made up of three squares ABCD, EFGH, KLMN, each formed of four straight links connected together at the various points indicated in the diagram by flexible connections or universal joints. The points E, F, G, H are

what have been hereinbefore termed the primary support points, EFGH the primary framework, K, L, M, N the secondary support points and KLMN the second frame. Under these conditions, if the square ABCD is subject to a twisting couple whereby for example the points A and C are moved in one direction perpendicular to the plane of the paper while the points B and D are moved in the contrary direction, it is clear that E, F, G, H, which are the middle points of the links ABCD, will retain their position and that the square EFGH will remain plane and will not be distorted. Furthermore, if the movement of the points A, B, C, D is relatively small compared with the sides AB, BC, etc., the square EFGH will not be materially altered in size, that is to say no substantial strain will arise in the members EFGH. If, on the other hand, the twisting of the square ABCD is comparatively great then the links forming the square EFGH will be subjected to compressive stresses but the square itself will not be twisted. If the links EFGH are made stiff in a direction perpendicular to the plane of the paper, if for example they are made of plates the plane of which is perpendicular to the plane of the paper, any bending action of the links EFGH due to the compression stresses will be in the plane of the paper and the points K, L, M, N will therefore be moved in the plane of the paper but the square KLMN will retain its plane form.

If the links EFGH are constituted by beams which are stiff in a direction perpendicular to the plane of the paper but are torsionally flexible about a longitudinal axis, then if the square ABCD is deformed by a displacement of the sides AD and BC in the same direction perpendicular to the plane of the paper while the points E and G remain stationary which is equivalent to a bending of the square ABCD about a line joining EG, then the links or beams forming the square EFGH will each be twisted about a longitudinal axis but the points K, L, M, N, will still remain in one plane.

The square ABCD, which, as before stated, is assumed to be formed of links flexibly connected at their ends so as to make a readily deformable structure, corresponds to and exemplifies the second or supporting body which is liable to deformation, the square KLMN corresponds to the base of the body which is to be supported, the two bodies being connected at the points E, F, G, H through the medium of the primary framework EFGH. In practice the square KLMN would generally be a frame forming part of the body to be supported or to which said body is firmly connected.

The diagram, Fig. 1, exemplifies the arrangement with square frameworks. If, however, the framework EFGH is quadrilateral but not square, the above conclusions will still hold provided the following relationship between the various points is fulfilled.

$$\frac{HK}{KE}\times\frac{EL}{LF}\times\frac{FM}{MG}\times\frac{GN}{NH}=1$$

Figs. 2, 3 and 4 illustrate how the principles above enunciated may be applied according to the present invention for the purpose of supporting a gear case from a ship's floor. In these Figures the floor is formed by plates 1 which constitute the tops of the tanks forming for example the double bottom of the ship and the primary framework 2, 3, 4, 5 is formed of four beams which are firmly connected to the plates 1 at their ends 6 by means of the usual rivets or bolts for example. It will be observed that the intermediate portions of the beams are not connected to the floor and in fact are quite free of the same, as is very clearly seen in Fig. 4. These beams are stiff in a direction perpendicular to the plane of the floor but under stress they will bend in a plane parallel with the floor or will twist about a longitudinal axis. The mid points approximately of said beams are connected to the framework formed by the beams 7, 8, 9, 10 as shewn and it will be clear that bending of the beams 2, 3, 4, 5 in a plane parallel with the plane of the floor 1 or twisting of said beams, 2, 3, 4, 5 will not communicate any twist to the frame formed by the beams 7, 8, 9, 10. Consequently these beams may form the base or bed plate of a gear case such as indicated at 15 in broken lines in Fig. 2. It will be observed that the beams 7, 9, 10 are only connected at or near their ends to the seating beams 2, 3, 4, 5 and the beam 8 is connected at its ends to the beams 7 and 9, said beams being sufficiently stiff in a vertical plane to support the weight of the gear case without bending.

It will be evident that the floor 1 corresponds to the square ABCD of Fig. 1, the seating beams 2, 3, 4, 5 correspond to the framework EFGH of Fig. 1 and the frame 7, 8, 9, 10 corresponds to the framework KLMN and from what has already been stated it will be clear that any twisting movements of the floor plates 1 of the ship, which twisting will owing to the manner in which the ship's frame is constructed always take place either about a fore and aft line or about a transverse line of the ship, that is in the direction AD, Fig. 3, or in the direction AB, Fig. 3, will not be transmitted to the frame 7, 8, 9, 10 and consequently the said frame will remain plane and there will be no tendency for twisting strains to be transmitted to the gear

case by which the parallelism of the gear shafts would be affected. Moreover, bending of the floor 1 either about a fore and aft line or about a transverse line resulting in a displacement of diagonally opposite pairs of supporting points 6 in the same direction will cause only twisting of the several beams 2, 3, 4, 5 about their respective longitudinal axes and will not cause any twisting or bending of the frame 7, 8, 9, 10.

The part indicated at 16 in the figures is a seating for the thrust block of the propeller shaft which is firmly connected to the floor plates 1 by vertical plates 17 and may be connected to the adjacent ends of the beams 2 and 3. It is shewn merely for the purpose of indicating the general position of the propeller shaft and the present invention is not intended to be applied to this thrust block seating.

Referring now to Fig. 5, the chassis of the car is formed of seven members indicated at 18, 19, 20, 21, 22, 23, 24. These are connected together at the points 25, 26, 27, 28, 29, 30, respectively, by horizontal pivots which permit the chassis to adapt itself to the road and so reduce shocks on the springs. The middle points of the members 18, 24, 22 and 23 respectively are connected by beams 31, 32, 33 and 34 which support the engine bedplate on which may also be mounted if desired the gear case framework. Said bedplate is connectetd to the beams 31 to 34 at the points 35, 36, 37, 38. The car body is supported from the beams 39, 40, 41 and 42 which are connected by horizontal pivots to the members 19, 20, 21, 24 of the chassis. It will be readily seen that any twisting of the chassis framework due to inequalities in the road for example will not be transmitted to the engine bedplate or to the car body. The joints of the framework of the chassis at the points 25 to 30 must be arranged, as the movements of the various points are comparatively large, to permit both sliding and rocking motion.

An example of a joint such as is necessary at the points 25, 27, 28 and 30 is shewn in Fig. 6 where the two frame members 19 and 20 indicated as cylindrical rods or shafts are connected at right angles through a connecting piece 43. The members 19 and 20 are arranged to both rotate and slide in said connecting piece. If for example the member 19 is caused to move through the angle α, shewn in the figure as very much exaggerated, from the position P^1 to the position P^2, the point Q on the member 19 will move through a distance Q, Q^1 which is proportional to the versed sine of the angle α and consequently the member 19 must slide in the connecting piece 43 to this amount. It will be understood that the amount of sliding movement which takes place will be very much less than that indicated in the figures and collars or stops will be provided to prevent the sliding exceeding a certain amount and to prevent the joint from parting asunder. Suitable provision should also be made for lubricating the joint.

It will be evident that the chassis 18, 19, 20, 21, 22, 23, corresponds to the frame ABCD of Fig. 1, the frame 34, 35, 36, 37 or 39, 40, 41, 42 to the frame EFGH and the points 35, 36, 37, 38 or the points at which the body is connected to the frame 39, 40, 41, 42 to the points K, L, M, N of Fig. 1.

It is sometimes desirable to arrange that the angle between two members of the chassis framework such as 19 and 20 for example shall be capable of variation as viewed in plan and in this case the form of joint indicated in Figs. 7 and 8 may be adopted. The connecting piece between the two members 19 and 20 for example will then be made in two parts 44 and 45, the part 19 being capable of rotation and sliding in the part 44 and the part 20 being capable of rotation and sliding in the part 45. Said parts are united through a spigot and socket joint 46, 47 which permit of angular movement on the axis R and the parts 44 and 45 are prevented from moving apart by means of the brace shewn in Fig. 8, the two portions 49 and 50 of which are screwed into bosses 51 and 52 on the part 45 and are connected by a cross-piece 53 through which is screwed a pin 54 adaptetd to engage with a seating 55 in the part 44.

In Figs. 9 and 10 a method of joining the members 39 and 40 to the member 20 is shewn. A bolt 56 shewn in Fig. 10 is employed, the part 57 of said bolt being a loose fit in the orifice 58 provided in the member 20 and the part 59 of the bolt being an easy fit in the orifice 60 at the junction of the members 39 and 40. The part 57 should be a little longer than the depth of the orifice 58 to ensure a perfectly free movement between the various parts. It will be understood that the various joints shewn in Figs. 6 to 10 are illustrated only by way of example and other methods of obtaining the requisite flexibility between the various points of connection of the chassis framework and the supporting framework of the engine and of the car body respectively may be employed.

Referring now to Figs. 11 to 14, an aeroplane body is indicated made up of various beams 61 and frames 62 with tie rods 63 in any usual manner. Longitudinal beams 64 and transverse beams 65 are provided for supporting the engine, these beams forming a frame corresponding to the frame ABCD of Fig. 1. Pivoted to said beams at approximately the mid points 66 which form the primary supporting points, is the primary

framework formed of the rods 67, 68, 69 and 70 corresponding to the frame EFGH of Fig. 1, and the bedplate 71 of the engine is connected at its four corners to points 72 which form the secondary support points. It will be clear from what has already been stated with reference to the previous figures that twisting movements of the frame formed by the beams 64 and 65 will not be transmitted through the frame 67, 68, 69, 70 to the engine bed plate.

The invention is applicable for many different purposes and it will be understood that the special applications shewn in the drawings are only given as examples to illustrate how the invention may be carried into practical effect for supporting a machine or other element or body from, or connecting the same to, another machine or other element or body, and that the invention is in nowise limited to the special applications shewn.

From the foregoing, it will be seen that I have provided a supporting structure which comprises an intermediate frame having connecting means between four points thereof and one body to permit relative angular movement and connecting means between four other points of said frame and a second body to permit relative angular movement.

What I claim is:—

1. An arrangement for supporting a gear casing or other element which it is desired should not be subjected to twisting strains, comprising a plurality of members constituting first and second substantially rectangular frames, the members constituting the first frame being connected at or near their ends to substantially the middle points of the members constituting the second frame, the members constituting the second frame being comparatively flexible in a direction parallel with or in the plane of the first frame but being relatively stiff in a direction perpendicular to said plane, and the members constituting the second frame being connected at their ends to a floor or framework which is or may be subjected to twisting strains, substantially as described.

2. A device for connecting two bodies comprising a frame, flexible connections between one body and four points of said frame, and flexible connections between four other points of said frame and the second body.

3. A device for connecting two bodies comprising a quadrilateral frame, flexible connections between one body and the four angular points of said frame, and flexible connections between four other points of said frame and the second body.

4. A device for connecting two bodies comprising a quadrilateral frame, flexible connections between the four angular points of said frame and one of the bodies, and flexible connections at points in the frame substantially midway of the angular points to the other of the bodies.

5. A device for connecting two bodies comprising a rectangular frame, flexible connections between the four angular points of said frame and one of the bodies, and flexible connections at points in the frame substantially midway of the angular points to the other of the bodies.

6. A device for connecting two bodies comprising a quadrilateral frame formed of members which are comparatively flexible in the direction of the plane of said frame but are relatively stiff in a direction perpendicular to said plane, connections between the ends of said members and one of bodies, and connections at substantially the middle points of said members to the other body.

7. A device for connecting two bodies comprising a substantially rectangular frame to which one of the bodies is secured, a second rectangular frame flexible connections between the angular points of the first-mentioned frame and substantially the middle points of the members forming the second frame, and flexible connections between the angular points of said second frame and the other body

8. A device for supporting a machine element comprising a quadrilateral frame, flexible connections between the machine element and substantially the middle points of the members of said frame, and flexible connections between the angular points of said frame and a supporting framework.

9. A device for supporting a machine element comprising two substantially rectangular frames to one of which the machine element is firmly secured, flexible connections between the angular points of the latter frame and the middle points of the members of the second frame, and flexible connections between the angular points of the second frame and a supporting framework.

10. A device for supporting a machine element comprising a substantially rectangular frame to which the machine element is firmly secured, a second rectangular frame formed of members which are comparatively flexible in the direction of the plane of said frame but are relatively stiff in a direction perpendicular to said plane, connections between the angular points of the first-mentioned frame and substantially the middle points of the members forming the second-mentioned frame, and flexible connections between the ends of the members of the second frame and a supporting framework.

11. A device for supporting a machine element comprising a quadrilateral frame,

pivotal and sliding connections between the members forming said frame, a second quadrilateral frame to which the machine element is firmly connected, and pivotal connections having their axes in the plane of said frame between the angular points of the second frame and substantially the middle points of the members of the first frame.

12. A device for supporting a machine element from a framework, which may be subjected to a twisting couple, comprising a quadrilateral frame flexibly connected at its angular points to said framework and flexible connections between substantially the middle points of the members of the quadrilateral frame and said machine element.

13. A device for supporting a machine element from a framework, which may be subjected to a twisting couple, comprising a quadrilateral frame formed of members which are comparatively flexible in a direction parallel with the plane of said frame but are relatively stiff in a direction perpendicular to said frame, said frame being connected at its angular points to the framework and arranged so that one diagonal is parallel with the axis of the twisting couple, and connections between the machine element to be supported and substantially the middle points of the members of the frame.

14. A device for connecting two bodies comprising a frame, connecting means providing for relative angular movement between one body and four points of said frame, and connecting means providing for relative angular movement between four other points of said frame and a second body.

15. A supporting device comprising a body, a quadrilateral frame, connecting means providing for angular movement between the four corners of the quadrilateral frame and said body, a second body, and connecting means providing for angular movement between the second body and an intermediate point on each side member of the quadrilateral frame.

In testimony whereof I have hereunto subscribed my name this 31st day of January, 1921.

WILLIAM ECCLES.