Oct. 11, 1960 R. HICKS 2,955,689

SUPPORTING MEANS

Filed Sept. 25, 1957 2 Sheets-Sheet 1

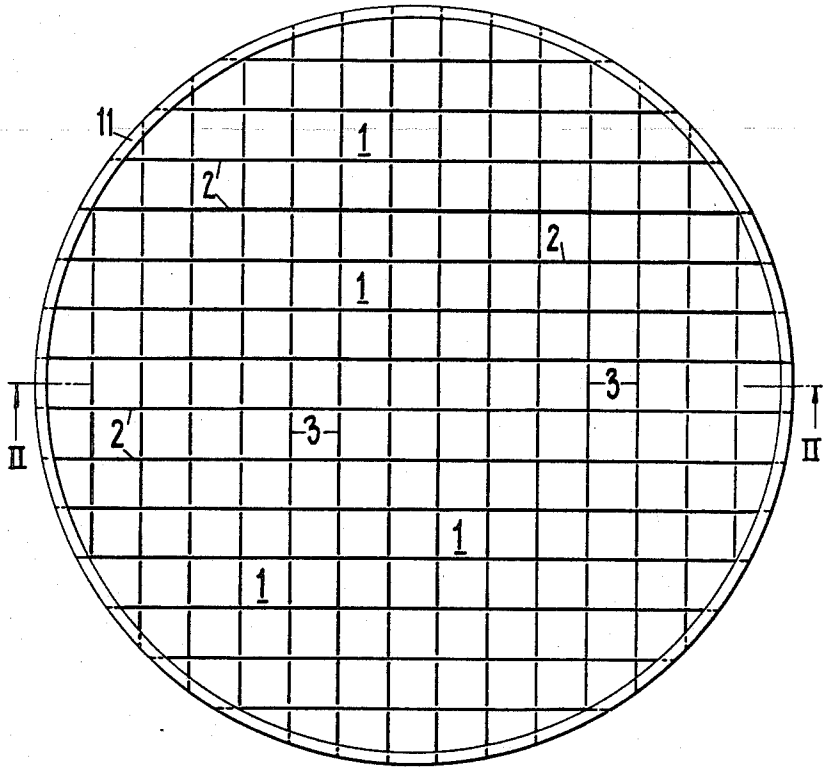


Fig. 1.

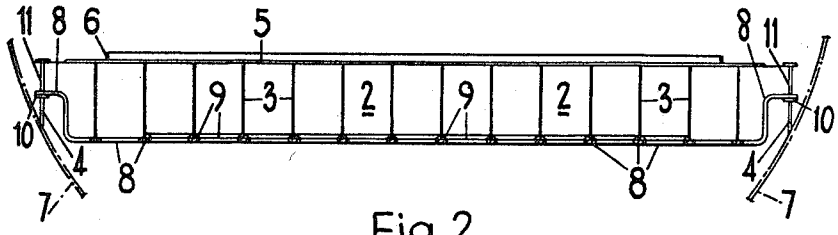


Fig. 2.

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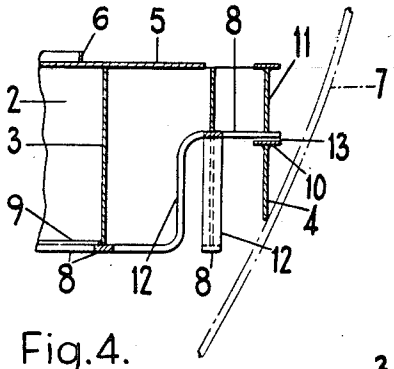


Fig. 4.

Fig. 3.

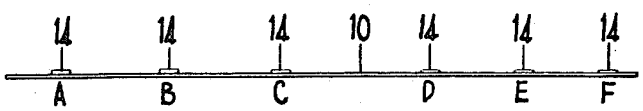


Fig. 5.

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SUPPORTING MEANS

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1 Claim. (Cl. 189—82)

This invention relates to supporting means, and particularly to supporting means of the kind comprising a grillage, the grillage members of which rest or are arranged to rest on an annular foundation.

It is clearly desirable in such circumstances that any load which has to be supported by the grillage, should be distributed as far as possible evenly around the annular foundation so that the supporting means is not unduly strained in localized points. The present invention is applicable where the imposition of such a load may cause distortion of the members of the grillage, such distortion taking the form of a generally vertical displacement at least in the vicinity of the annular foundation, and an object of the invention is the provision of such supporting means in which the reactive forces on the grillage in the vicinity of the annular foundation caused by a load placed substantially symmetrically on the grillage are as far as possible evenly distributed around the periphery of the foundation.

According to the present invention, in supporting means of the kind referred to, some of the grillage members are arranged, in the absence of a predetermined load upon the supporting means, not to touch the annular foundation where they pass over it, gaps being provided between such members and the foundation which gaps serve to control the reactive forces acting on the grillage members when the predetermined load is subsequently applied, so that the loading is substantially uniformly distributed around the periphery of the foundation.

Thus, supposing the supporting means to consist for example of a grillage with square units of "egg-box" form, this grillage resting on a circular upstanding ring-like skirt or foundation, in the normal construction of grillage each member thereof would be contingent with the skirt where it passed over it. If the load were to be arranged on this grillage there would be a reaction at each point of contact of a grillage member and the skirt, but the reactive forces would depend upon the characteristics of the various members and would not normally be such as to give uniform loading on the skirt around its periphery. In the design stage, however, it can be assumed that this loading on the skirt is in fact to be uniform, and it can be established what the particular reactive force should be at each said point of contact to give such uniform loading. Should all these reactive forces be taken as being applied simultaneously to the appropriate points of the grillage members, their total sum being equal in magnitude to the total load, then, in effect, the load on the grillage could be considered as being fixed in space, but the displacements of the various grillage members would vary around the periphery by amounts which can be calculated. If therefore it could be arranged that, in actual use, the support is adapted so that, when supporting the required load, the grillage assumes a status wherein the displacements of its members vary in substantially the same way as the calculated displacements, then it would follow that uniformity of loading would result. By arranging for

gaps, corresponding to the differences between these calculated displacements, to be present between the unloaded grillage and the skirt during construction of the supporting means, this desired effect will be achieved when the load is applied. In other words, the distribution of loading on the foundation by reason of engagement of the grillage members therewith can be controlled by controlling the displacements of the various grillage members under load.

The grillage may itself be constructed in a regular fashion so as to be capable of resting upon the annular foundation with its members contingent thereto, the present invention including the provision of packing pieces between the regular grillage and the foundation in order to give the required gaps.

In order that the invention may be clearly understood, a supporting means in accordance with the present invention will now be described by way of example with reference to the five figures of the accompanying drawings, in which:

Figure 1 shows a diagrammatic plan view of the means,

Figure 2 shows a section on the line II—II of Figure 1 with a top plate in place,

Figure 3 shows a fragmentary plan view of the grillage,

Figure 4 shows a section on the line IV—IV in Figure 3, and

Figure 5 shows a developed view of the top flange of a half quadrant of the skirt foundation showing the relative thickness of the packing pieces.

Referring to Figure 1, a grillage is composed of a plurality of square grillage units **1**, these units being formed from a number of long transverse grillage members **2** and short spacing grillage members **3** which are arranged in a rectangular formation forming an egg-box pattern. The grillage is arranged to rest on a ring-like annular skirt foundation **4** as shown in Figure 2. In this particular example, the grillage is provided with a top plate **5** having a circular flange **6** and the whole supporting means is intended for use with the core of a nuclear reactor, which is to be considered as supported by the means upon the top plate **5** and substantially within the area bounded by the flange **6**. The core may be composed mainly or wholly of moderating material with ducts or channels in which cooling medium under pressure is arranged to flow past fuel elements, so that the core and its supporting means are contained within a pressure vessel **7** which is generally spherical in shape; in practice, the skirt foundation **4**, though attached to the pressure vessel **7**, will itself be supported by massive struts (not shown) situated vertically beneath the skirt **4** and embedded in a concrete base, so that the load transmitted through the skirt **4** falls on these struts and not primarily on the pressure vessel **7** itself.

The grillage members **2**, **3**, though formed into an egg-box pattern in which each unit **1** is open top and bottom, have flanges **8** welded along their bottom edges so that the bottom aperture of each unit **1** in effect takes the form of a square whose area is less than that of the top aperture by an amount represented by the overlap of the flanges bordering the square. The flanges also have thin facing plates **9** welded in strut fashion between them and their associate members **2**, **3**. As will be seen from Figure 2, each grillage member such as the member **2** shown is reduced in height as it approaches the skirt **4**, the corresponding bottom flange **8** following the edge of the member upwards before extending to rest upon or just above the horizontal top **10** of the skirt foundation **4**. A circular ring **11** (Figures 1, 2) extends round the circumference of the grillage; it has a generally vertical form with top horizontal

flange and is similar in shape to the skirt 4 with its top 10.

Figures 3 and 4 show in more detail the construction of the grillage in the region of its circumference where it rests upon the skirt 4. The dotted parts 12 in Figure 3 indicate those regions where the members 2 or 3 have their lower flanges 8 turned upwards with corresponding reduction in height of the members; the resulting arrangement where the members cross near the circumference is best shown in Figure 4, in which a gap 13 is also indicated between a bottom flange 8 of a member 2 as it passes over the skirt 4, and the top 10 of this skirt. Into this gap is placed a packing piece; these packing pieces are given the general reference 14 in Figure 5, where a half quadrant of the skirt top flange 10—from 15 to 16 or 17 to 16 in Figure 3—is shown developed or laid out flat with the packing pieces 14 upon it. It will be seen that these packing pieces diminish in height from the end 15 or 17 to 16; the actual location of each packing piece has been given a letter reference which is intended to correspond with similar letter references A to F on Figure 3. Denoting each packing piece by its intended location, in a particular case the packing pieces had the following heights; A:¾", B:⅝", C:17/32", D:13/32", E:5/16", F:¼". The grillage being quite regular in form, in the absence of the packing piece 14 there would be no gap 13 in Figure 4 and each member 2, 3 would rest on the skirt top 10 where the flange 8 of the member passed over it. The packing pieces 14 may be considered to fit into a gap 13 between grillage and skirt top 10 equal in height to the highest packing piece; in the particular case above-mentioned, this gap would be ¾" and would be totally filled by a packing piece 14 at the point A only. Figure 4, being actually a section on the line IV—IV of Figure 3, would show a ¾" gap 13 partially filled by a packing piece at E of 5/16" height, leaving an actual gap of 7/16".

It will be clear, therefore, that the actual gaps remaining between grillage and skirt will vary from a zero value at point A to a maximum value at point F after the packing pieces 14 have been inserted. It will also be observed from Figure 3 that, whereas at points A a member 2 or 3 has not encountered a crossing member for some distance before reaching the periphery of the grillage, at points as E, F such encounter has been made much closer to the grillage periphery; in addition, the two parts F are very close together. In the absence of any gaps 13 or packing pieces 14, with grillage and skirt contingent, it is clear that a heavy predetermined load applied at the centre of the grillage would be borne largely at points E, F, which are stronger, rather than at A. The reactive forces would thus be very uneven. With the packing pieces in position, however, the reactive forces are at first greater at contingent points A, which distort under the transferred weight of the predetermined load until the vertical displacement is sufficient to make grillage and skirt contingent at points such as E, F. When all the predetermined load has been applied, the reactive forces are arranged so that the loading on the skirt is evenly distributed around the circumference of the support. In making the calculations which determine the actual gaps which are to remain after packing pieces 14 have been inserted in the gaps 13, the predetermined load is considered to give rise to an applied load round the periphery of the grillage of equal magnitude and opposite sign. The displacements produced by this applied reactive load are calculated; they will evidently be considerably greater at A than, say, at F. The variation of these displacements gives the magnitude of the actual gaps which should be provided after insertion of the packing pieces 14 in order that the reactions to the loaded grillage should be uniformly distributed; if the calculated displacement at F, say, is subtracted from that at A the magnitude of the actual gap which should be provided at F is obtained.

I claim:

A supporting means comprising a grillage including two sets of girder members mutually crossing one another at right angles, and a substantially annularly shaped member located beneath the grillage and engaged thereby and supporting the grillage, one girder member of one set being disposed substantially on a diameter of said annular member and one girder member of the other set being substantially on another diameter of said annular member so that the two diameters on which said girder members of each set are disposed are at right angles to one another, said two diameter girder members being in contact with the annular member under no load conditions, the remaining girder members of each set being variably spaced from said annular member under no load conditions, such spacing for each said remaining girder member being the difference between the full load displacement of the portions of the diameter girder members immediately above the annular member under full load conditions in the absence of said spacing and the full load displacement of that portion of each such girder member immediately above the annular member under full load conditions in the absence of said spacing, so as upon the application of full load substantially to equalize the distribution of the consequent loading around the annular member.

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