6. S. PALADINO. — A simple rotary shaker.

Summary. — An improved type of rotary shaker suitable for submerged culture work has been described in which the board carrying the shake flasks is made to move eccentrically on four steel balls. The advantages of this method of suspension of the board over the conventional methods employing universal joints are discussed.

Riassunto. — E' descritto un agitatore animato di moto piano-rotatorio adatto per fermentazioni sommerse effettuate in beute. Il piano porta-beute è sopportato da quattro sfere di acciaio alloggiate in apposita sede. Vengono illustrate le caratteristiche di questo apparecchio ed i vantaggi del suo uso.

Résumé. — Les A. font la description d'un modèle perfectionné d'agitateur rotatoire destiné aux études des fermentations en culture submergée. La suspension du plateau porteur des flacons par quatre billes d'acier en mouvement excentrique est discutée et comparée aux suspensions habituelles réalisées par des joints universels.

Zusammenfassung. — Eine verbesserte Schüttelmaschine mit Rotationsbewegung für Arbeiten mit Schüttelkulturen wird beschrieben, in der die die Schüttelkolben tragende Platte sich excentrisch auf vier Stahlkugeln bewegt. Die Vorzüge dieser Methode der Schüttelbewegung gegenüber den üblichen Methoden, bei denen Universalkupplungen verwendet werden, werden erörtert.

In the following a rotary shaker of simple construction suitable for submerged culture work is described.

Principle of construction.

A wooden board P_1, carrying the shake flasks is made to move on four steel balls by means of an eccentric. It is held to a stand by means of four steel springs (figs 1, 2 and 3). If the springs are properly dimensioned and the size of the board approaches that of the stand each point on the board will describe a regular circular movement the radius of which is determined by the eccentric throw.

CONSTRUCTIONAL DETAILS.

Stand. The stand is made of angle iron and iron pipe welded together. Constructional details are given in fig. 4 and 5. It is not necessary to make the stand more robust and heavier than indicated, as the rotary agitation causes practically no vibration. It is, however, preferable to fix the feet of the stand to the floor, particularly in the case of the larger model, as otherwise it tends to move.

To the transverse elements of the stand four circular metal bearings are welded on which four steel balls can freely move (G, fig. 4 and 5). The surface of these bearings is polished and slightly concave so as to prevent the metal balls from escaping.

On each of the four corners a pin holds a metal pulley (E fig. 5) to take a metal spring (F fig. 5) connecting the stand with the board.

Eccentric. The eccentric consisting of a short metal rod (C fig. 5, for details see fig. 5a) is fixed to a metal plate fastened by means of a bolt to a large pulley which rotates on a bearing in the centre of the frame. Its throw is variable from 19 to 45 mm; it can be adjusted within these limits by sliding it in a slot on the pulley to the desired position. Its normal amplitude is 22 mm. A ball bearing fits tightly around the eccentric pin in order to reduce friction and wear on the pin caused by small irregularities in the movement of the board.

Transmission. The eccentric is moved by a 1/3 h.p. electric motor fastened to the frame as shown in fig. 4 and 4a. Transmission is effected through two pulleys of appropriate size; the normal speed is 240 r.p.m. The larger pulley carries a counterweight equal to about half the weight of the fully loaded board.

Board. The board is made of wood (fig. 6) with a metal frame (fig. 7 and 7a). To each of the four corners of the frame a pin carrying a small pulley is welded for the springs connecting the board with the stand. It is important that the springs be correctly dimensioned (F fig. 7a); on this the regularity of the movement of the shaker depends. In choosing the proper dimensions of the springs, the size of the board in relation to that of the frame of the stand, its total weight and the friction of the moving parts against each other has to be taken into consideration. Underneath the metal frame four polished circular pieces of metal (G fig. 5 and 7a) are welded, against which the four steel balls move. The eccentric moves the board through a central hole (D fig. 7)

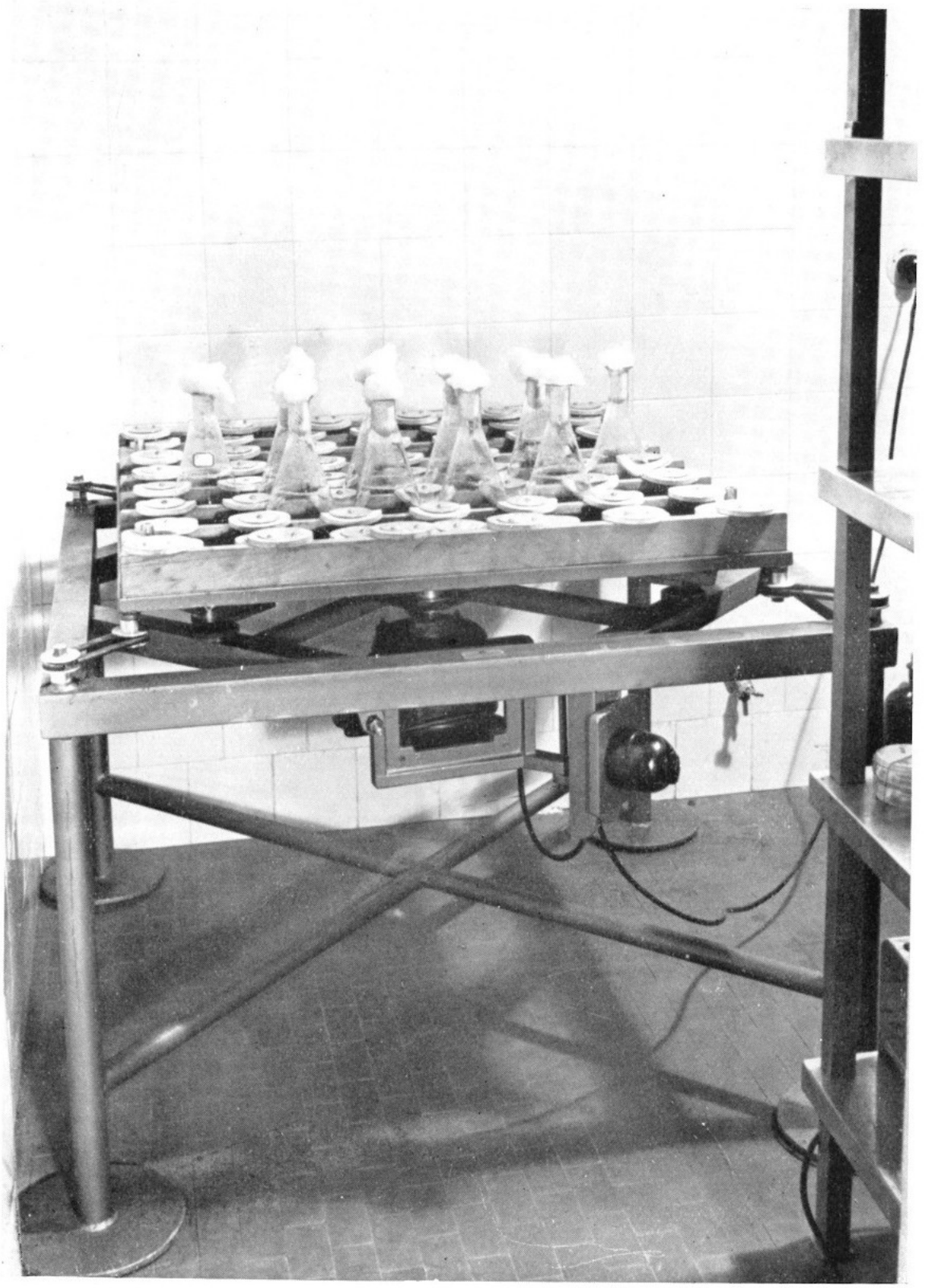

Fig. 1. - Rotary Shaker, general view.

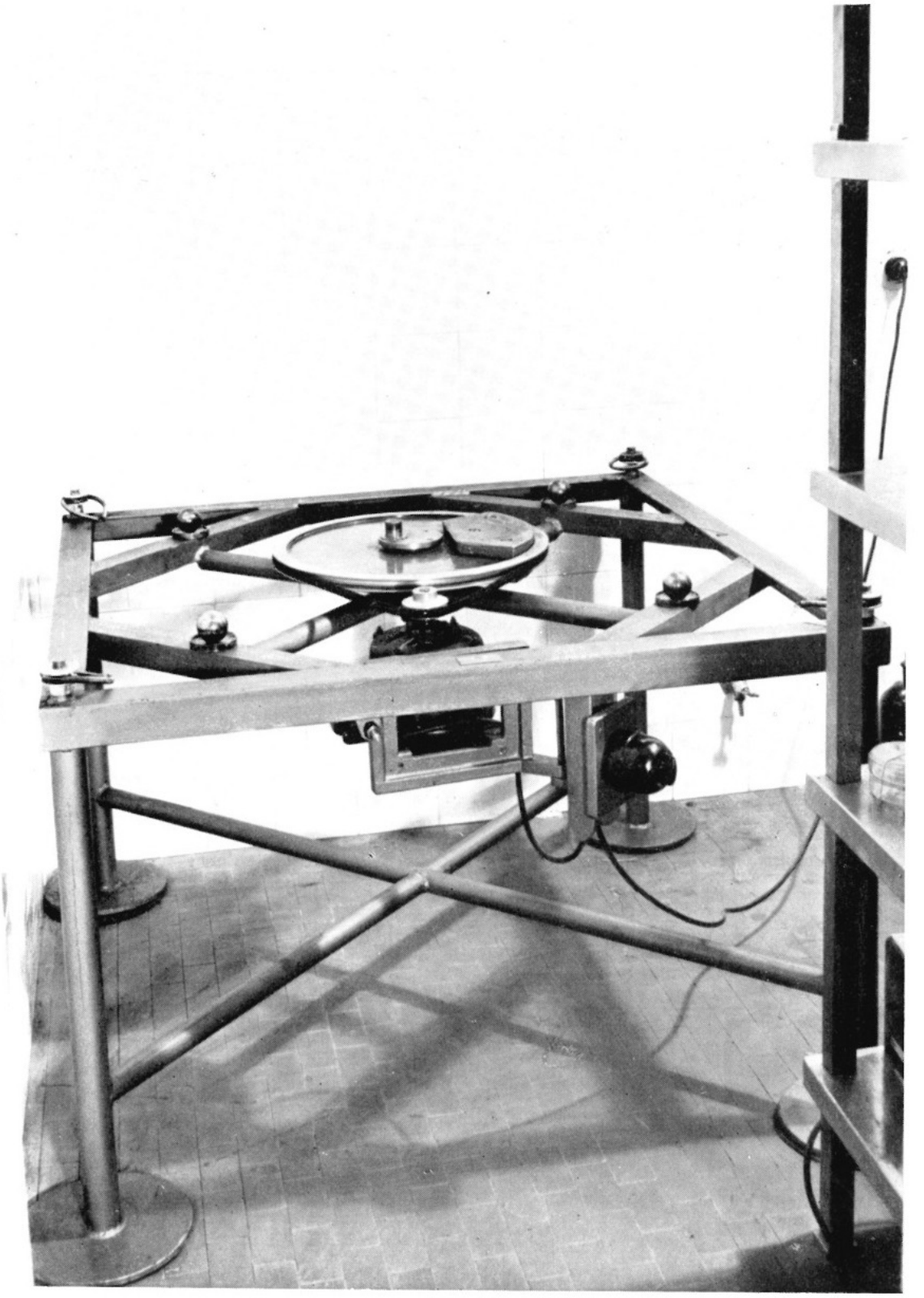

Fig. 2 - Stand of Rotary Shaker, showing eccentric and steel spheres on which board rests.

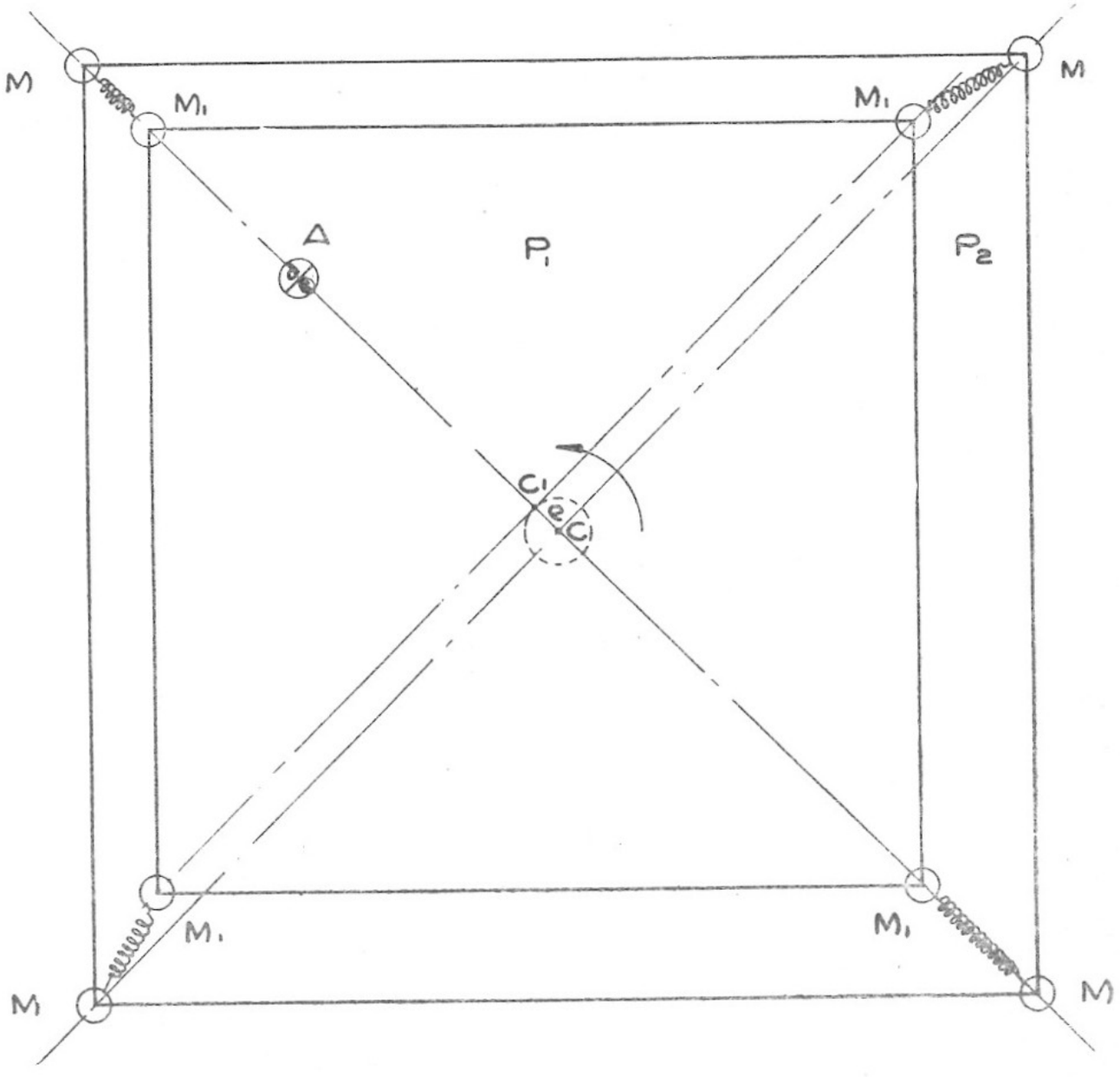

Fig. 3 - Diagram illustrating movement of board P_1 against frame M to which it is fixed by springs.

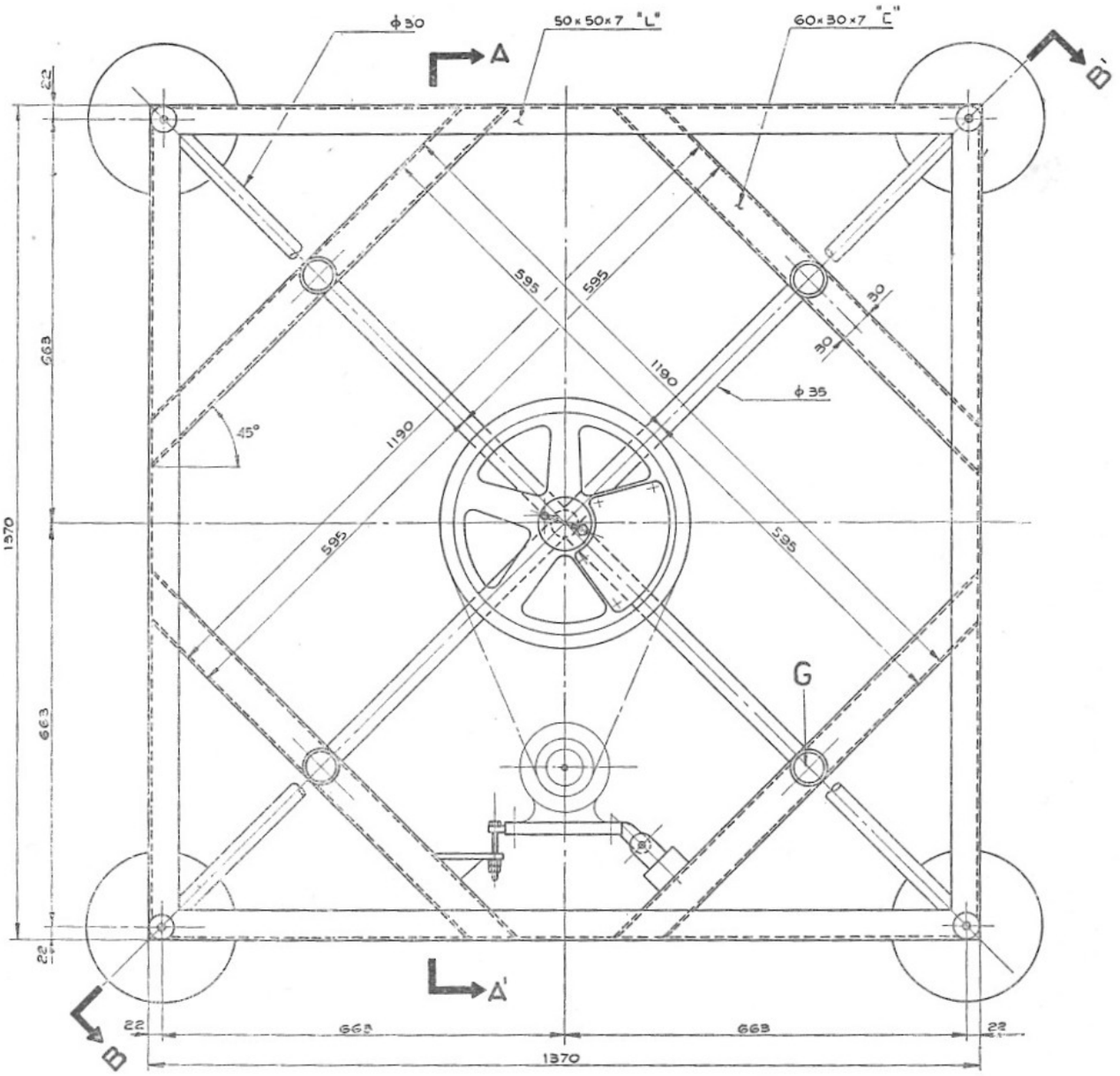

Fig. 4 - Stand, upper part seen from above showing cups for steel balls (G) and drive.

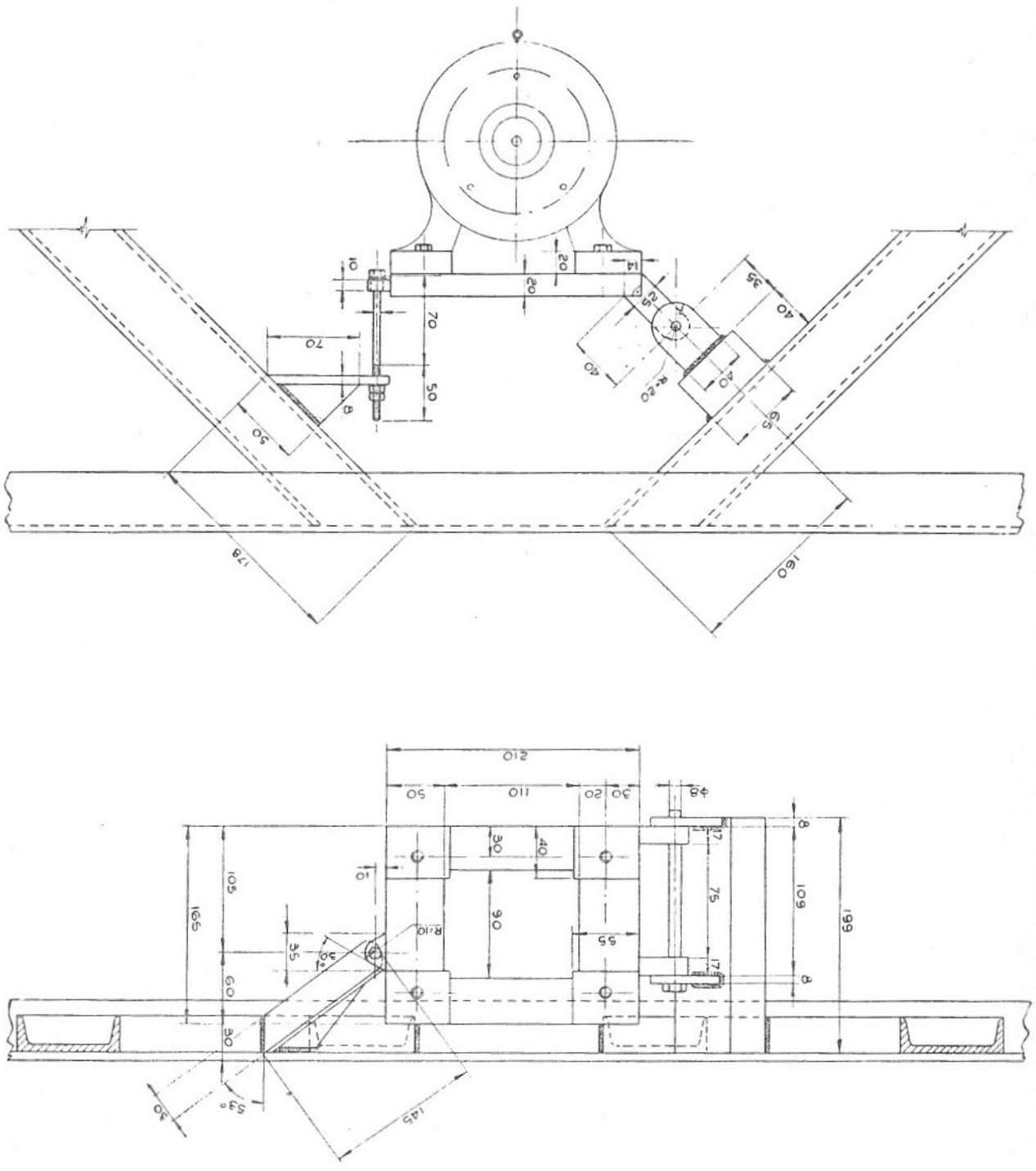

Fig. 4-a. - Constructional detail of 4 - Supension of motor.

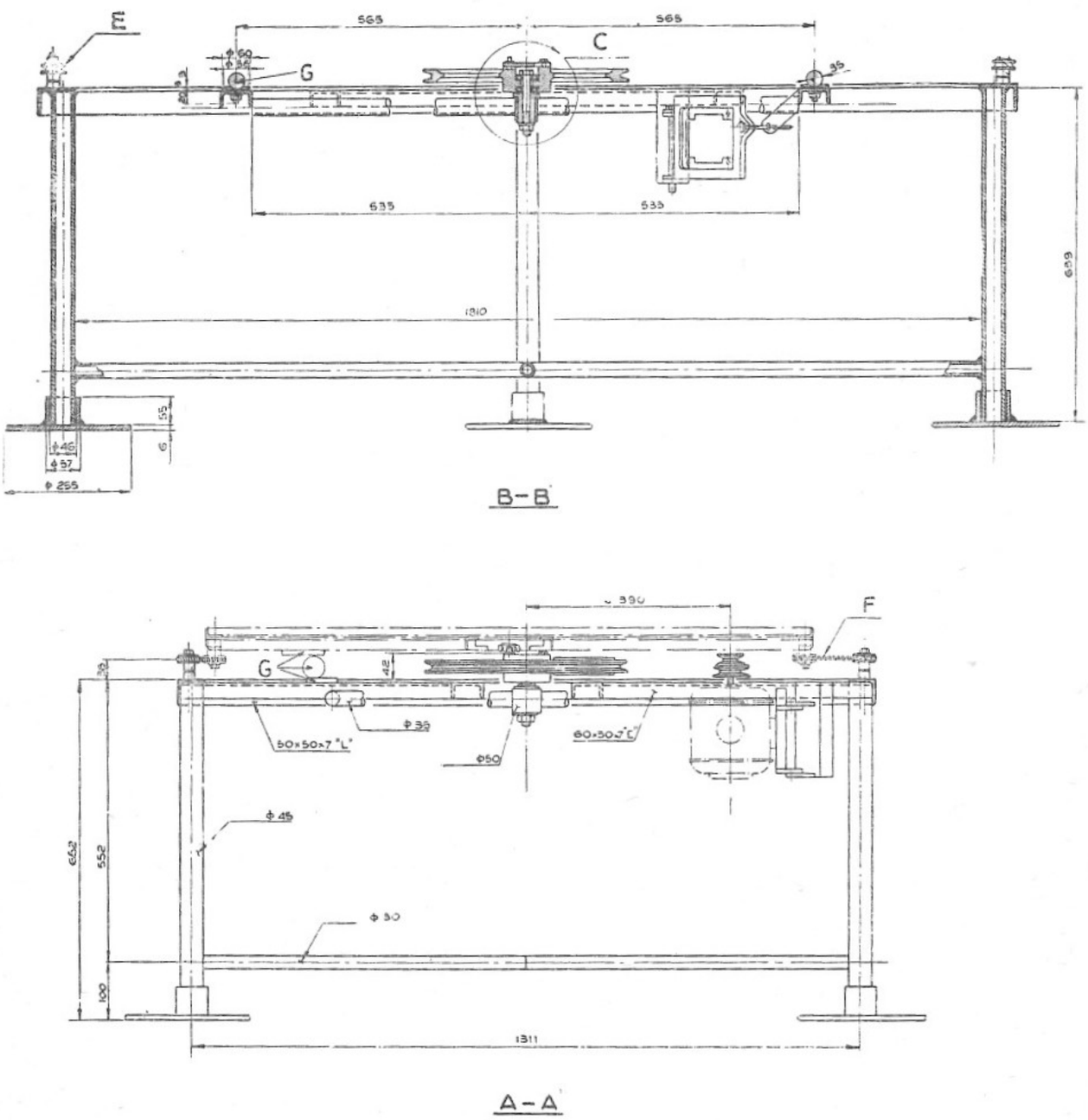

Fig. 5 - Stand, diagonal and lateral cross sections.

C Eccentric
E Pulley
F Metal Spring
G Steel balls and cups

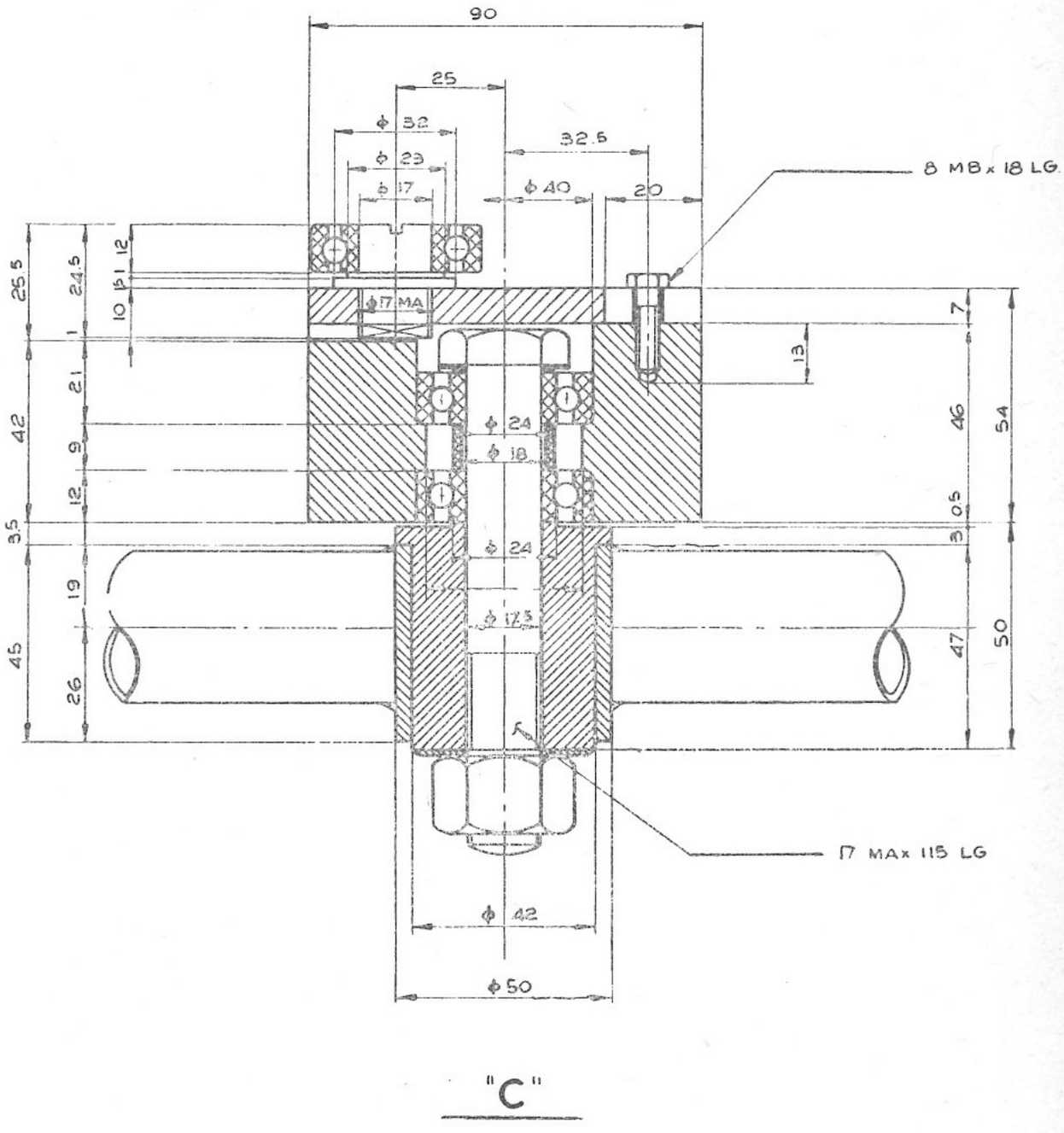

Fig. 5-a - Eccentric, constructional details.

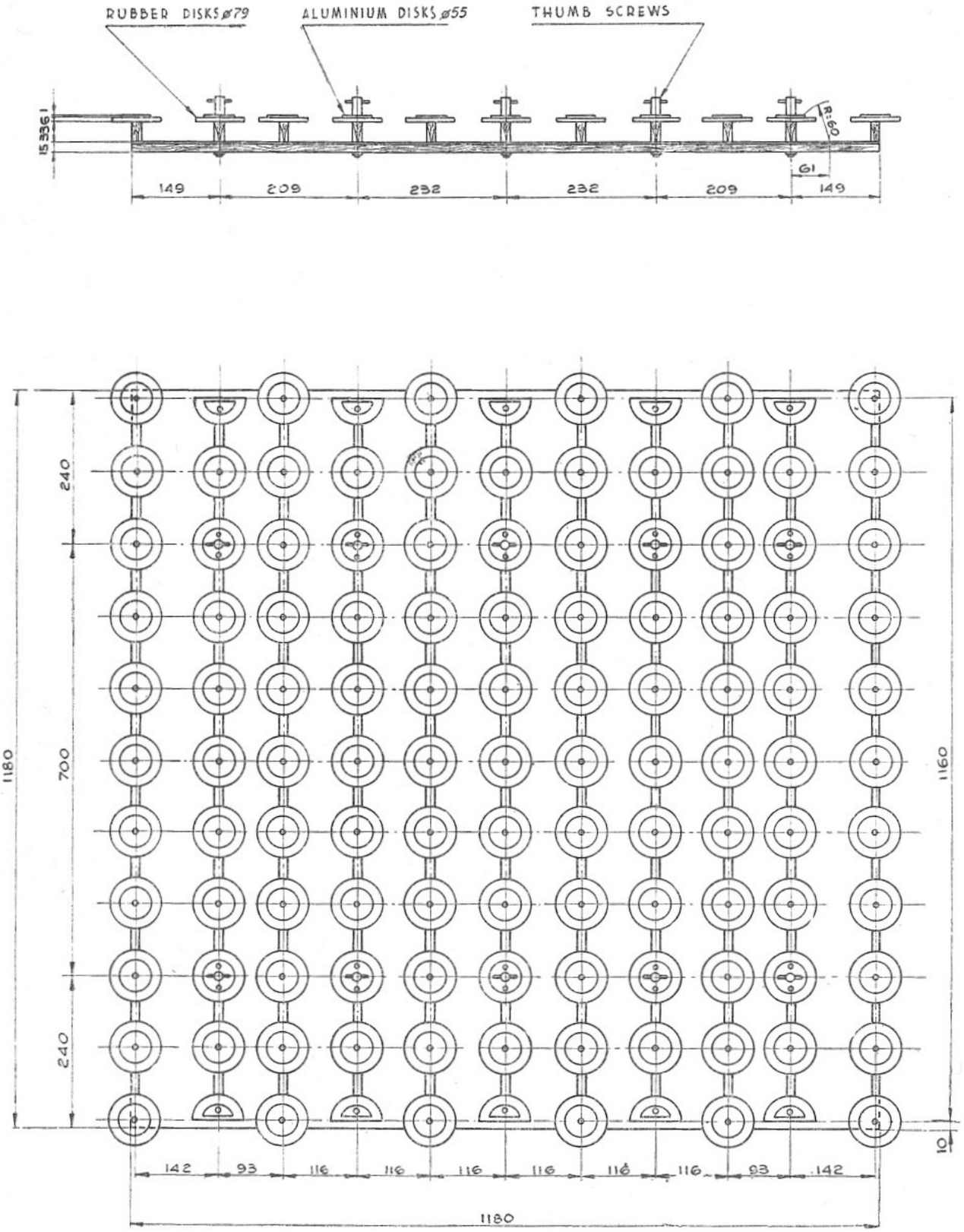

Fig. 6. - Wooden board with rubber disks for holding shake flasks.

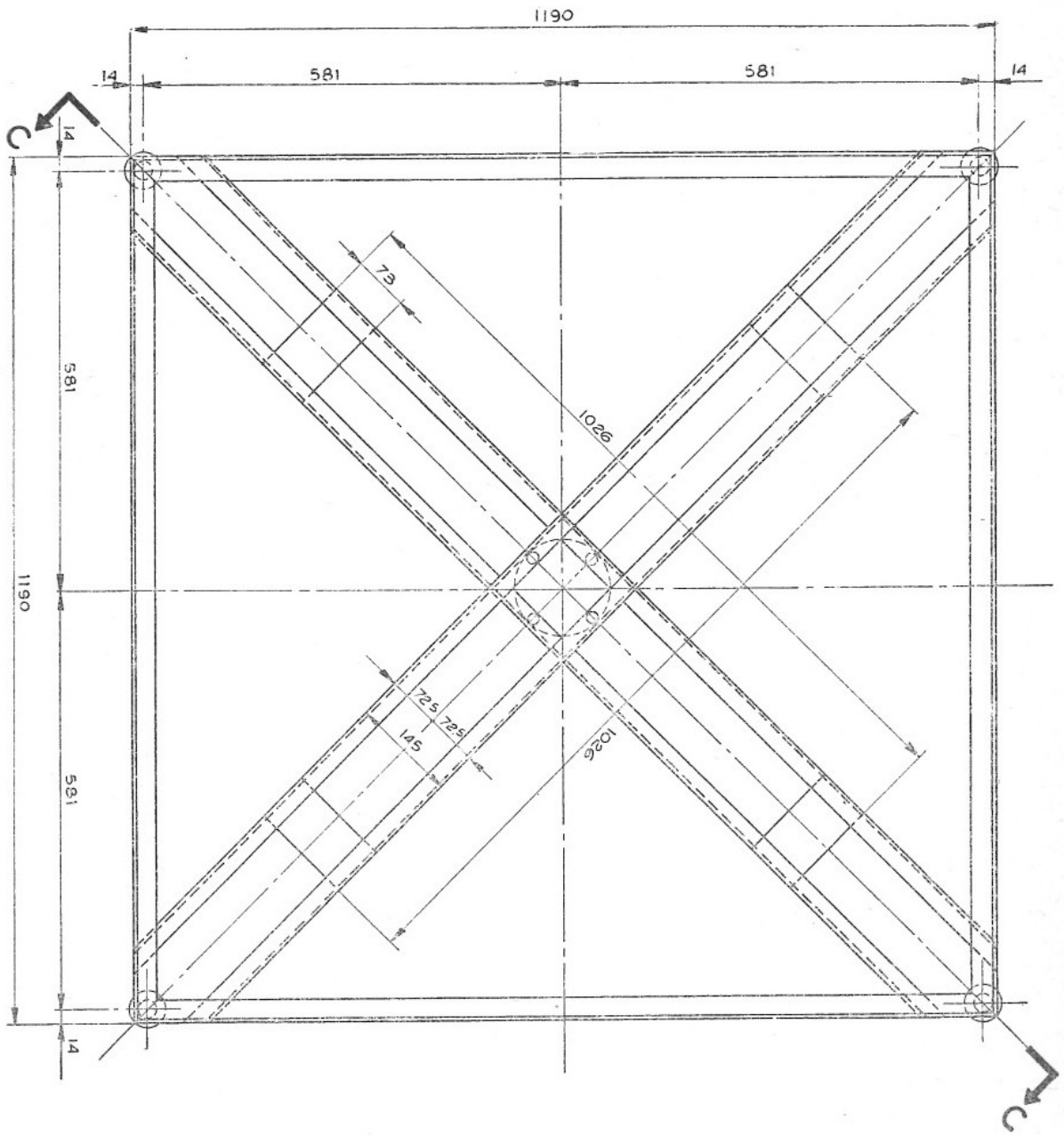

Fig. 7. - Movable metal frame carrying board for shake flasks.

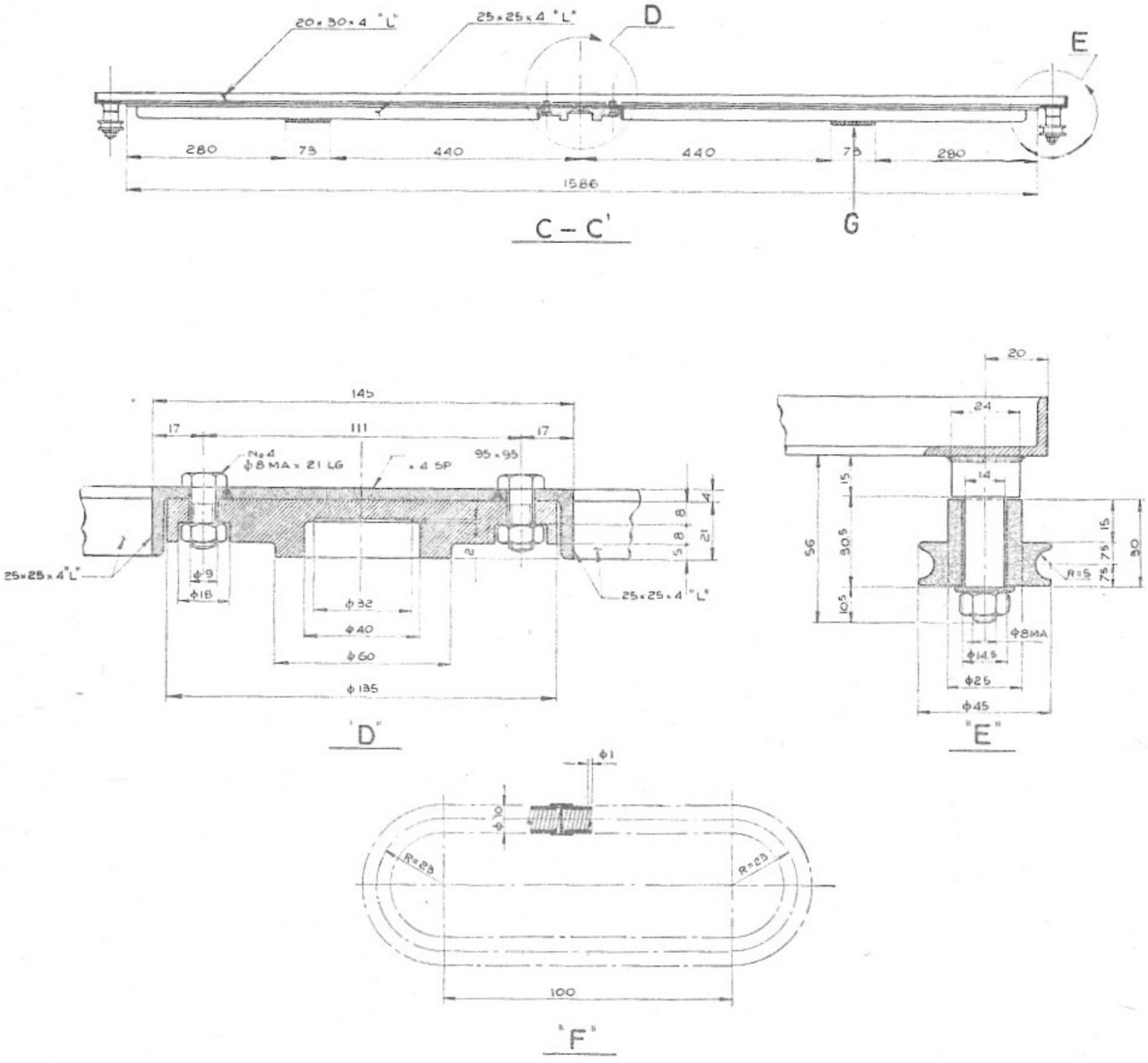

Fig. 7-a. - Movable frame, constructional details.
(D) Socket for eccentric, other letters as in Fig. 5.

into which fits tightly the outer race of the ball bearing by which the eccentric is surrounded.

For fastening the shake flasks to the board a system using rubber disks has been adopted which has been successfully employed on rotary shakers in the laboratories of Boots Pure Drug Co., Nottingham, England (Lumb, personal communication). The shake flasks are inserted between 4 rubber disks (figs 1 and 6). Alternate rows of these disks are removable for loading the board. Several boards with different spacings between the rubber disks for taking shake flasks of different sizes are available.

Capacity.

Shakers of different capacities have been constructed and are in use. The one whose dimensions are given in the drawings is the largest so far made and is capable of carrying 100 flasks of 500 ml. capacity. Other shakers are capable of carrying maximum loads of 36 to 64 flasks of 500 ml. capacity; they are driven by the same size motor, but the dimensions of stand and board are smaller.

Maintenance.

For the smooth running of the shaker it is important that all bearings are well lubricated and the bearings between which the steel balls move are kept highly polished. The steel balls and their bearings are well covered with grease. Apart from greasing no other maintenance is required. No repair of any kind has so far been necessary after the lapse of one year's practically continuous use.

Discussion.

The advantages of rotary over reciprocating shakers and their aeration efficiencies have been discussed by Chain and Gualandi (1954).

The rotary shaker described above has been in almost continuous use in this laboratory for well over one year and has not given any mechanical trouble. By the method of suspending the board on steel balls instead of connecting it to the stand in the conventional way by means of universal joints friction is greatly reduced and the shaker works almost noiselessly. The springs connecting the board to the stand ensure

smooth and regular movement. The advantages of the present over commercially available models are simplicity of construction, lighter weight, greatly reduced friction of the moving parts and hence less wear and greater mechanical stability and durability, and almost complete freedom from noise and vibration. These features enable the present model to be used in the normal laboratory without giving inconvenience to the occupants.

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REFERENCE

E. B. Chain and G. Gualandi (1954). Rendiconti dell'Istituto Superiore di Sanità, *17* English Edition, p. 5.