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(54) Deionization cell for the extinction of the electric arc.

(57) The present invention relates to a deionization cell for the extinction of the electric arc, particularly suitable for automatic magneto-thermal switches. In the cell itself special elements are provided for the subdivision of the arc and they are constituted by conductive bodies delimitated by a continuous convex curved surface (preferably spherical) and distributed and spaced so that the partial arcs which are generated tend to focus automatically between the nearest points of the curved facing surfaces. The mentioned spheres may be distributed within the entire space contained by the conductive fork which generates the arc expansion.

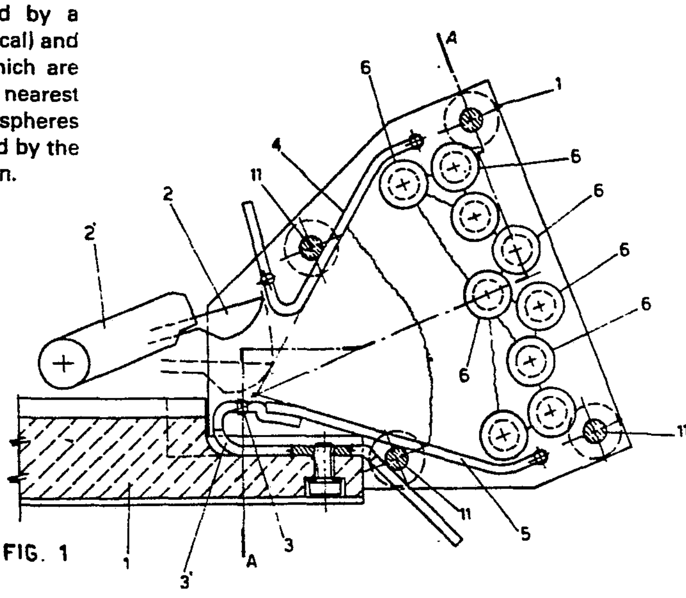

FIG. 1

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Deionization cell for the extinction of the electric arc

The present invention relates to a deionization cell for the extinction of an electric arc, particularly in the case of switches having an arc voltage somewhat high with respect to the circuit voltage in which these switches are to operate.

The known deionization cells are normally based on the principle of subdividing the electric arc in a certain number of partial arcs, each having the minimal self-supporting voltage, mainly determined by the kind of material or by the surface treatment of the material which forms the arc electrodes.

In its usual structure, the known deionization cell includes a fork formed by two jaws made of conductive and magnetizable material, these jaws being insulated from each other and spread apart starting from the entrance point, approximately in the area where the arc is forming, such as the opening area of the switch-contacts (where the arc moves while stretching) and by a series of conductive lamellae spread across this fork and oriented in such a way as to cut the impending arc.

Both the fork and the lamellae are surronded by two parallel walls of insulating material so that the arc, when formed, is pushed mainly by magnetic forces between the two jaws of the fork, stretching and cooling itself and finally colliding with the lamellae, which cut it into partial, more quickly estinguishable arcs.

The lamellae are generally parallel or slightly spread apart and are iron made or iron surface-treated, for instance copper-covered or nickel-covered iron.

Although the lamellae are distributed between the spread ends of the fork so that they attract the stretched arc and these lamellae are provided with gorges opened toward the incoming arc, in order to facilitate the formation of the magnetic arc and the entrance and the subdivision of the arc itself, not always are they able to create an environment suitable for the extinction of the arc itself. In fact damaging phenomena may arise which help the arc persistance or protract the extinction time.

This is because the lamellae are obtained by shearing plates and their edges may retain some indentations or even pins, among which the electric arc tends to stabilize. This stabilization may be generated in correspondance both of the incoming and of the outcoming edges of the partial arc.

Such tendency of the partial arc to stabilize at the edges of the lamellae is facilitated by the fact that the facing surfaces, parallel or slightly spread apart, of these lamellae, offer an unstable position to the partial arc so that the arc itself tends to slide over these surfaces moving toward the mentioned edges. Sometimes they reach a stability on these edges which helds on to the thrust of the magnetic forces and delays the arc extinction, with possible disastrous consequences for the circuit to be protected.

In order to limit the generation of these harmful phenomena, normally the lamellae are placed along a line stretching between the outer ends of the fork jaws, so that the electric arc reaches the plates stretched and cooled.

Such an arrangement, however, is not satisfactory as the arc needs a certain time to proceed along the fork, thus influencing the operation quickness without warranting the elimination of the above said phenomena. Operation times are extended to dangerous values under conditions of high short-circuit power.

The present invention proposes a new structure for the elements, designed to subdivide the electric arc and a new distribution of the same elements, in order to eliminate the above regrettable disadvantages.

The advantages of the proposed new system will be explained hereupon by presenting the various characteristics of the invention itself.

In accordance with the invention, the deionization cell, which utilizes a fork with spread jaws, is characterized by the fact that the elements designed to subdivide the arc - namely, the "arc electrodes" - are made of conductive material and delimitated by a convex curved surface - continuous in shape, that is without solution of continuity - so that the partial electric arc, which forms between couples of close elements, tends to focus automatically between the closest points of the curved facing surfaces.

This first characteristic allows the control of the stability area of the partial arcs and permits a linear gradient of the partial arc voltages. This stability of the partial arc between two facing convex surfaces in beneficial in relation to the arc control, particularly with reference to a linear voltage distribution, while presenting no resistance to the forces of the magnetic fields generated by the same arc. Therefore the best conditions for the cooling and the extinction of the partial arc itself are found.

In a preferred solution, the above mentioned convex curved elements are made up of spheres, whose production in high series, at low cost and with perfectly smoothed surfaces, is technologically well known. In an alternative, characteristic solution, these convex curved elements are ellipsoidal or oval in shape.

These elements - in a preferred and characteristic solution - are distributed within the space limited by the jaws of the fork in such a way as to occupy totally or partially this space. In particular it is possible to arrange these elements much closer to the area where the arc is forming than by using the iron lamellae. Such an arrangement shortens strongly the arc path·time before subdivision and offers an immediate and progressive subdivision which greatly reduces the extinction time, thus permitting a higher quickness when the switch is provided with these elements.

Such elements, on the other hand, can be made up of ferrous material, thus providing a magnetic selfentering of the arc which prevents undesirable movements leading to harmful phenomena, should the arc come out of the deionization cell.

The ferrous material can be specially treated on the surface for production reasons and in order to increase the arc stability or to increase the cathodic voltage. Use of non-ferrous metallic material can also be contemplated and in this case the action of pushing the arc into the deionization cell is provided by magnetic circuits external to the deionization cell itself.

According to another characteristic form of the invention, the elements can be made up of graphite thus acquiring remarkable advantages. The graphite, as a matter of fact, is a material possessing a perfect capability of resistance to the destructive arc action, practically immune from wear and tear. It is not subjected to the formation of craters or to fusion phenomena and possesses a high specific heat which remarkably contributes to the arc cooling. It also offers a high cathodic and anodic voltage and is particularly advantageous in the subdivision of the electric arc as, subdivision being equal, the passing energy is lower.

The object of the invention, simply as a non limitative example, is shown in the enclosed drawings where:

figure 1 shows the deionization cell in a first possible solution;
figure 2 is a section according to the dotted line AA of figure 1;
figure 3 is a plan drawing of one of the containment insulated wall of the deionization cell;
figure 4 presents a different, preferred solution of the invention.

With reference to figure 1, it is indicated by 1 a portion of the wall of an electrical equipment envelope, such as an automatic switch.

Schematically are indicated a mobile contact 2 supported by a contact-holder 2' and a fixed contact 3 supported by a contact-holder 3', which can be extended externally of the envelope up to the connecting terminal of an external conductor. In front of contact 2 and 3 the fork of the deionization cell opens its two spred jaws 4 and 5, whose narrower part is in front of contact 2 and 3, in such a way as to lure the entrance of the arc which forms at the moment when mobile contact 2 is opened in respect of the fixed contact 3. The arc lays its extremities on the jaws 4 and 5 and is pushed into the fork by the magnetic circuits generated by the arc itself so that the arc is stretched while proceeding along the fork.

Between the two ends of the jaws 4 and 5, the arc movement is intercepted by subdividing elements made up by spheres 6 positioned in such a way that the mutual distance between contiguous couples of spheres is almost equal. As already said, the spherical shape of elements 6 is the preferred one, but the elements can be shaped in whatever different form, provided that their external surface be a curved one, without solution of continuity, for instance an oval or elliptical or any equivalent form, able of facing two convex surfaces between two contiguous elements: the partial arc can then stabilize between the two closest points.

Figure 1 also shows by dotted lines a possible progression in the arc subdivision. Although elements 6 - spherical or of any other shape - have been indicated equal in size, they may have different dimensions for instance different diameter or axis, without any negative impact on the invention results.

Again with reference to figure 1, figure 2 and figure 3, it is easily perceived that spheres 6 (or differently shaped elements) are supported by two lateral walls 7 and 8, made up by insulating material presenting respectively the holes 9 and 10 having a diameter smaller than the spheres one, so that they can partially hold the spheres on both sides; these walls 7 and 8 are connected to each other by means of transversal pins 11, differently positioned. Externally to the insulated supporting walls 7 and 8, two other full, intermediate walls 12 and 13 do exist, which are able to insulate also those portions of the spheres housed in holes 9 and 10. Finally two more external walls 14 and 15 make up the envelope of the electrical equipment.

As already said, elements 6 for the subdivision of the electric arc may be of ferrous material thus providing a magnetic self-centering action by the arc itself and making it unprobable that undesired movements, leading to harmful phenomena, may cause the electric arc coming out of the deionization cell.

These elements, however, may be made up of ferrous material coated on the surface so that, beside the self-centering action of the arc, it is possible to obtain a protective action and an increased stability of the arc together with an increased cathodic voltage.

The same elements 6 may be produced, with several advantages, in graphite for the reasons and with the benefits previously specified.

With reference now to figure 4 and in view if the advantages of the magnetic self-centering of the arc, of the possibility of partial arc stabilization between the two closest points of two convex surfaces perfectly smoothed, and of the reduction of fusion and crater formation, elements 6 for the arc subdivision are presently arranged closer to the entrance of the fork, so that the path of the arc before its subdivision is remarkably reduced, thus concurrently reducing its extinction time and therefore increasing the breaking power of the switch.

As shown by the dashed lines in figure 4, the elements 6 for the arc subdivision may occupy not only an area between the jaws 4 and 5, but also the entire space comprised between these jaws, so that a labyrinth is offered to the arc, where it is submitted to a progressive subdivision, the consequence being a greater quickness in cooling and extinction.

Of course, everything said for the elements of figure 1 is also valid for figure 4 as well as for the structure indicated in figure 2 for the support and the lateral insulation of elements 6.

Similarly the invention is not limited by the types of solutions just presented, but it comprehends all those additions and variations that may be envisaged by an expert technician and which are comprised in the spirit of the invention as pointed out in the following claims.

Claims

1. A deionization cell for the extinction of the electric arc, characterized by a fork with two jaws which spread outward from the area where the arc is formed, in such a way that the arc proceeds between the two jaws, stretching up to impact upon a barrier of conductive elements or arc electrodes, among which the arc is subdivided into partial arcs. This cell is characterized by the fact that these elements are made up of conductive material, delimited by a continuous convex curved surface, so that between couples of contiguous elements the partial arc tends to self-center between the closest points of the facing curved surfaces.

2. A deionization cell as in claim 1, such elements for the arc subdivision being made up by spheres.

3. A deionization cell as in claim 1, such elements for the arc subdivision being oval or ellipsoidal in shape.

4. A deionization cell as in claim 1, the elements for the arc subdivision being distributed within the space limited by the two jaws of the fork, so as to occupy totally or partially such space, and arranged in such a way that the distance between couples of such elements be almost constant.

5. A deionization cell as in claims 1 and 4, characterized by the fact that the elements for the arc subdivision are

arranged close to the arc entrance into the fork, so that the arc path is reduced.

6. A deionization cell as in claim 1, where the elements for the arc subdivision are made up of ferrous material.

7. A deionization cell as in claim 1, where the elements for the arc subdivision are made up of ferrous material coated on the surface.

8. A deionization cell as in claim 1, where the elements for the arc subdivision are made up of graphite.

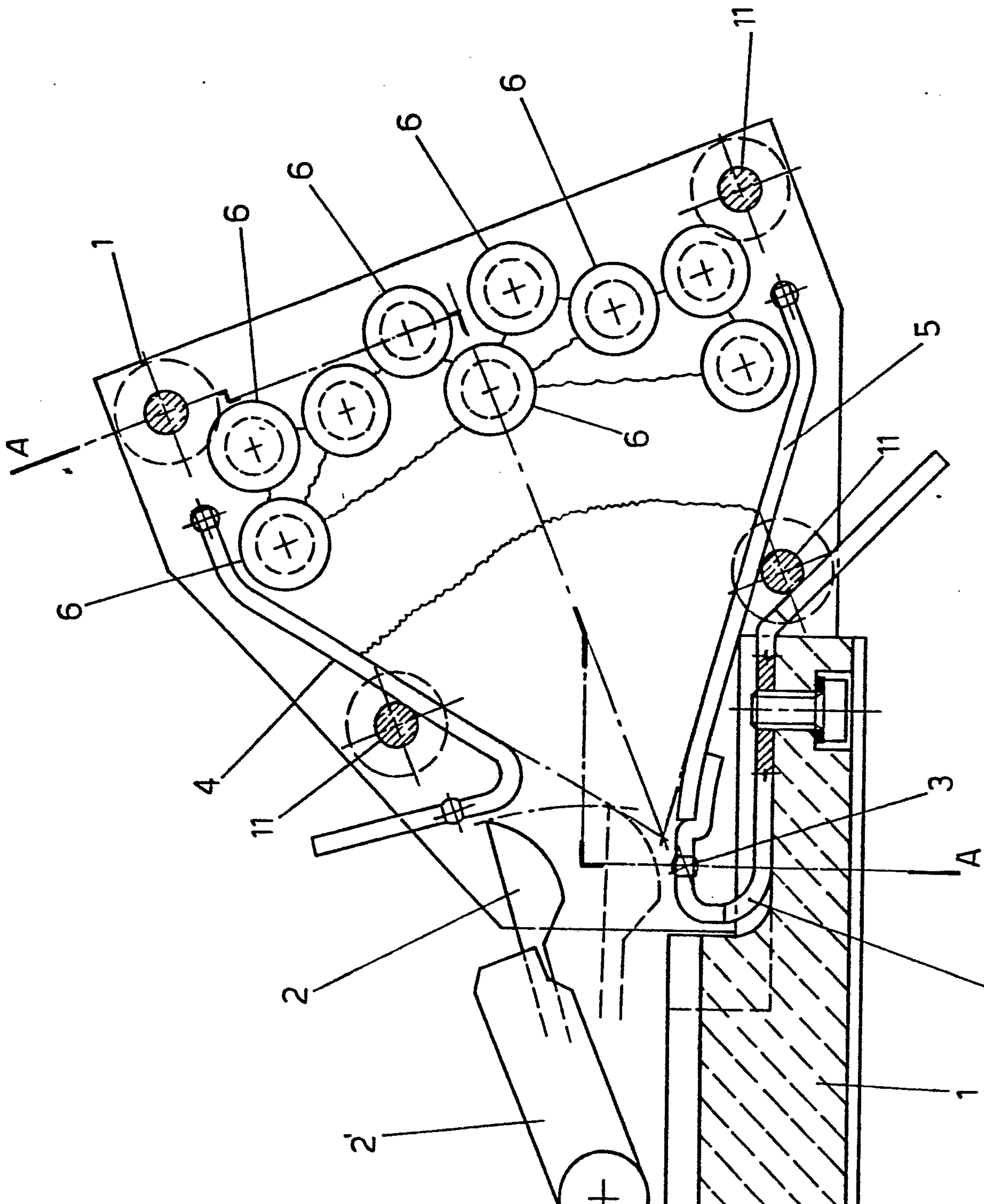

FIG. 1

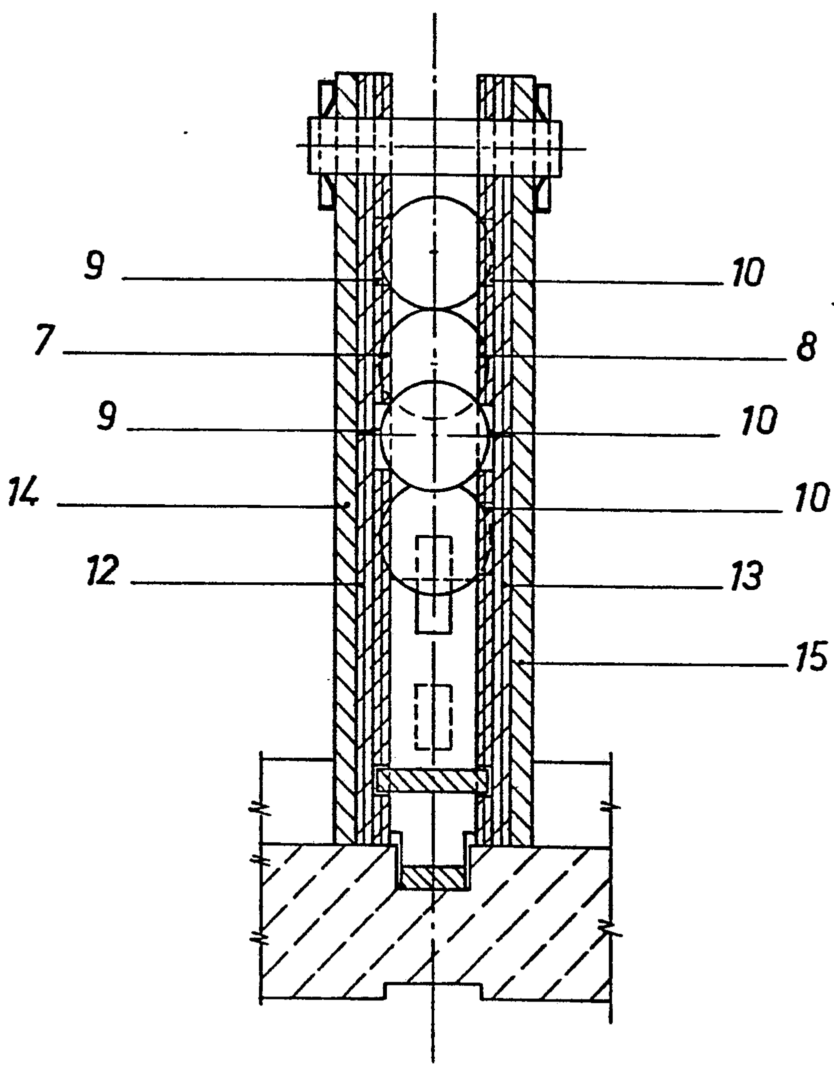

FIG. 2

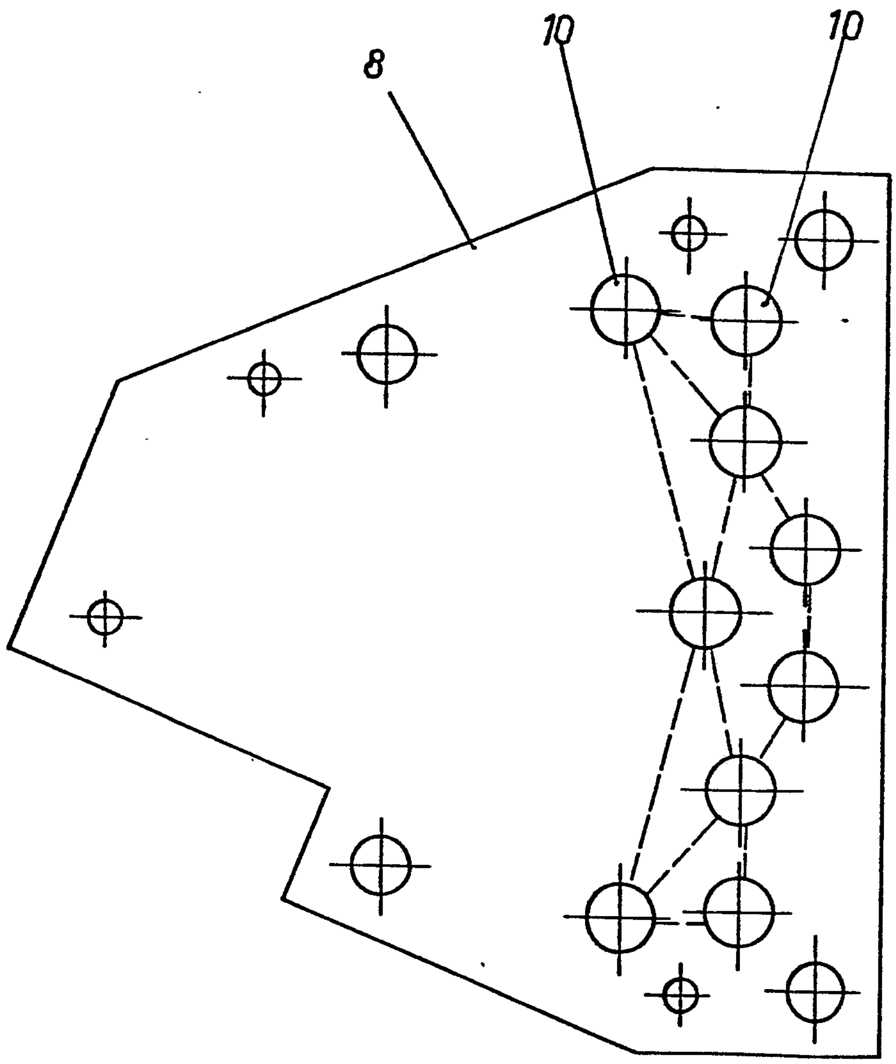

FIG. 3

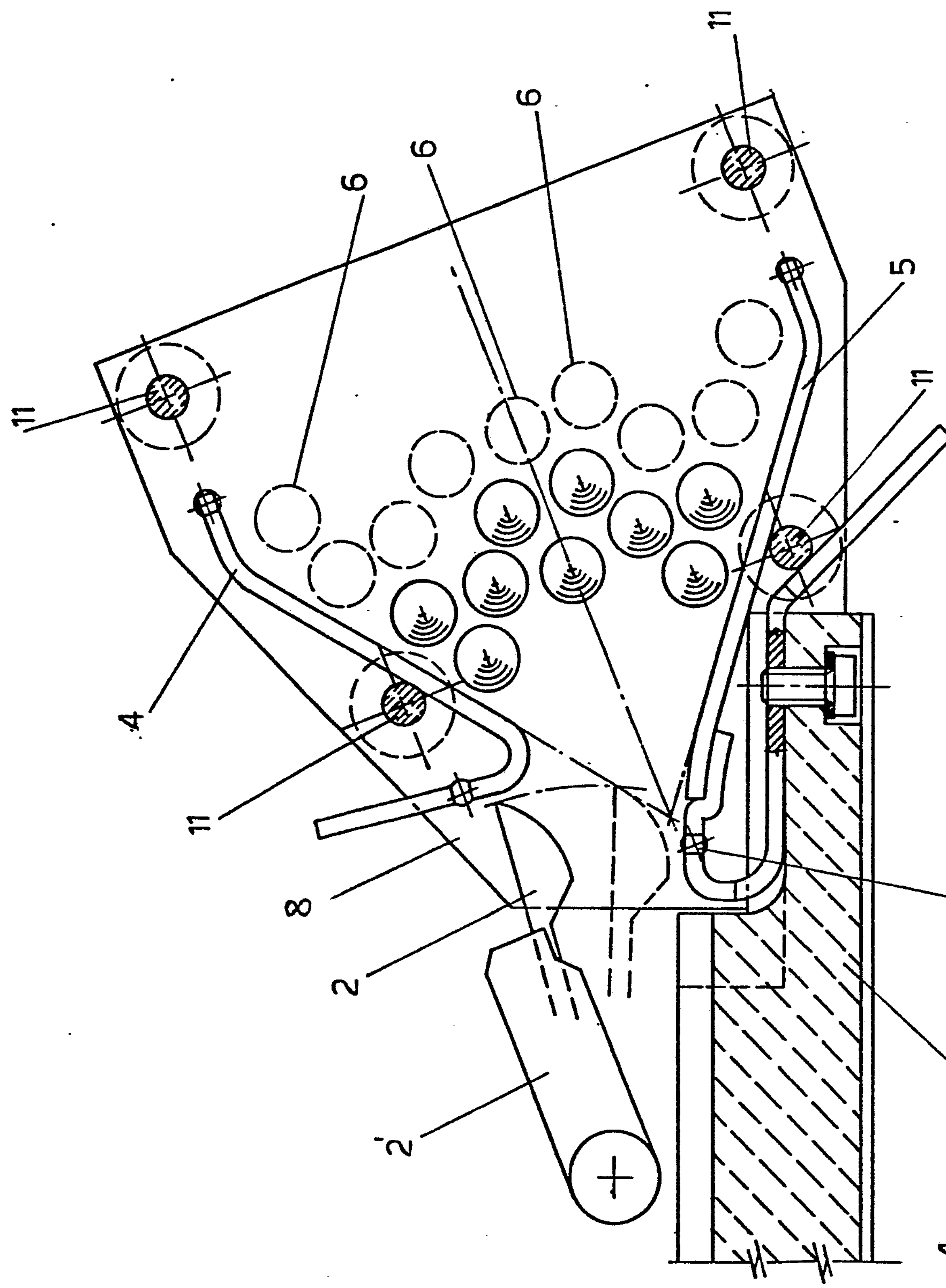

FIG. 4