July 1, 1969 K. FRICKER 3,453,199
ANODE FOR USE IN ALUMINUM ELECTROLYSIS HAVING
A PEG IN ITS HEAD PROTECTED BY A SLEEVE
Filed Sept. 26, 1966 Sheet 1 of 3

Fig. 1.

PRIOR ART

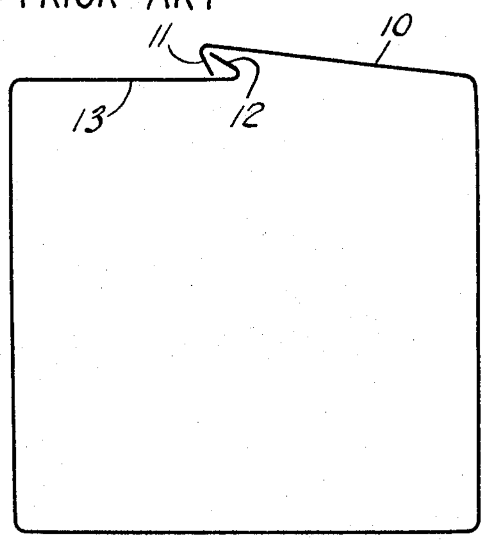
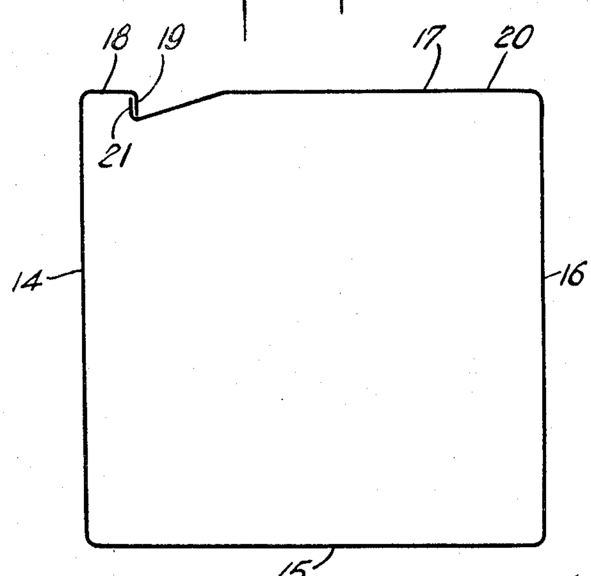


Fig. 2.



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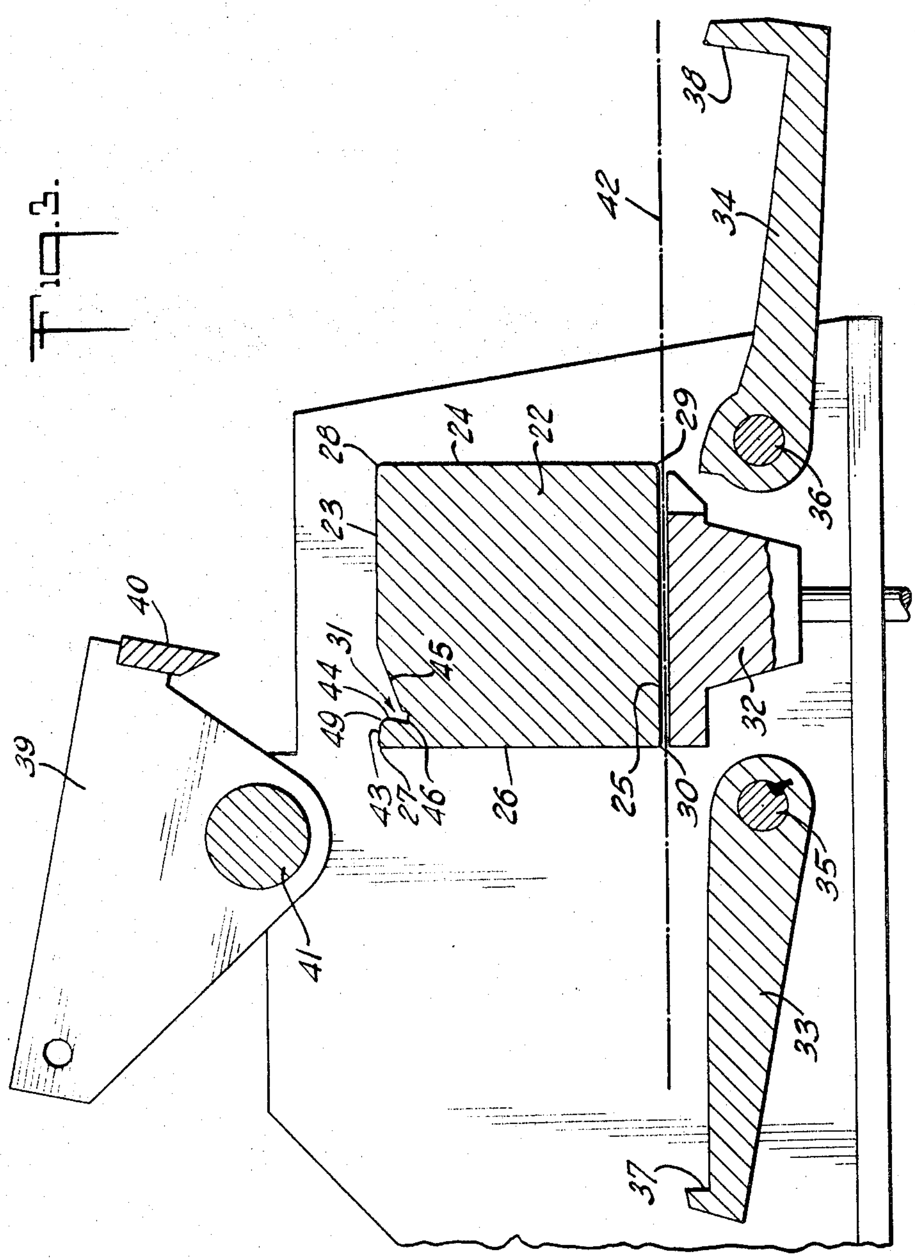

Fig. 3

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Fig. 4.

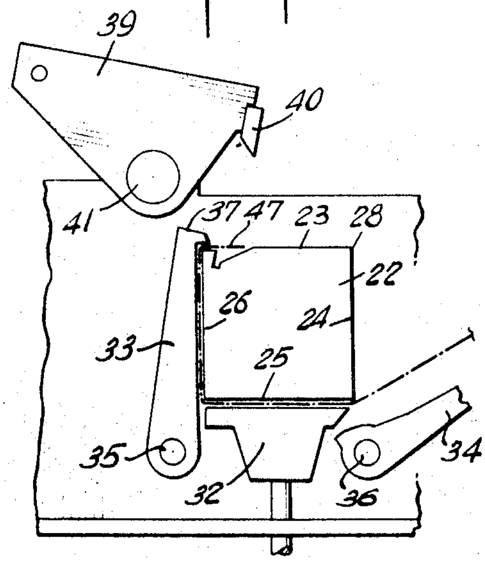


Fig. 5.

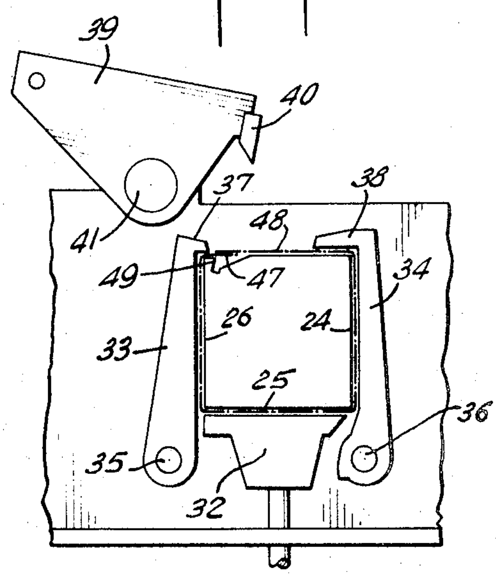


Fig. 7.

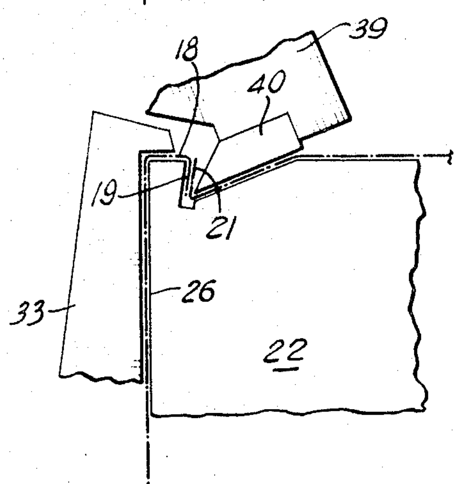
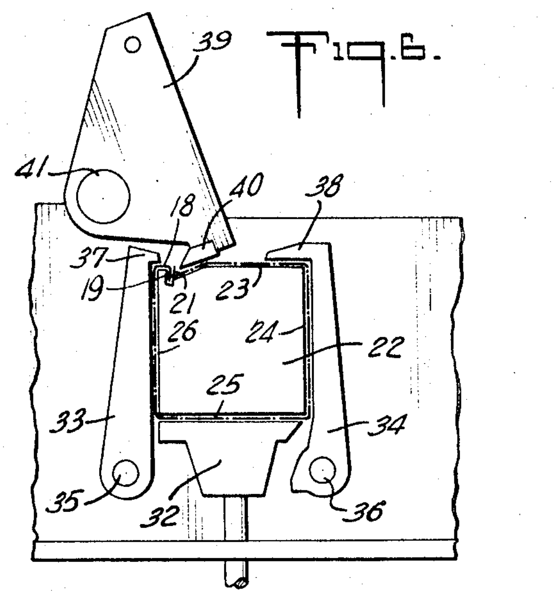


Fig. 6.



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ANODE FOR USE IN ALUMINUM ELECTROLYSIS HAVING A PEG IN ITS HEAD PROTECTED BY A SLEEVE

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Int. Cl. B01k 3/04
U.S. Cl. 204—286 8 Claims

Baked ("burnt") carbon anode rod-electrodes or block-electrodes for the fusion electrolysis of aluminum in a fluoride electrolyte are generally provided with an iron peg which is inserted in the upper part (the head) of the carbon anode electrode and is fixed there by ramming a granular or pasty synthetic carbon composition around it or by pouring in a molten synthetic carbon composition. A carbon anode rod-electrode, for example, ordinarily has a cross-section of about 300 x 300 mm. to 500 x 500 mm. in width and a height of about 400–550 mm. The iron peg is used to connect the electrode to the power supply by clamping.

When the carbon anode electrode has been inserted in the electrolytic furnace, its head becomes heated to about 180° C. After 6 days, the temperaure at this point rises on an average to about 290° C. Because of wear, the carbon anode must be gradually lowered. Finally it is so low that the iron peg also dips into the cryolite melt. The lower end of the peg surrounded by the carbon composition is protected by it, but not that part thereof which projects from the carbon electrode. So that this part may not scale off and be partly dissolved in the electrolyte, it, also, must be protected. This is achieved, for example, with the aid of a synthetic carbon composition (coke-pitch mixture) which is rammed or poured into a socket placed in a recess on the head of the anode. A collar of sheet aluminum (which is hereinafter called a "sleeve") is very suitable as a socket, because aluminum that is melted away does not contaminate the bath and is recovered in the cathodic layer of aluminum.

For an iron peg with a cross-section of 100 x 100 mm., for example, a sleeve which is about 170 x 170 mm. in plan and about 100–200 mm. in height is used. The thickness of the sheet metal, for example, is about 1 mm. Hard-rolled pure aluminum sheet, the cleanness and surface condition of which (scaly, scratched, etc.) are (practically speaking) of no importance, is advantageously used for making the sleeve. It is therefore advantageous to use waste sheet. Of course, alloyed aluminum may also be employed, if it does not contain alloying metals in such quantity as to contaminate the aluminum recovered in the electrolytic cell in an unacceptable manner.

As the iron pegs have a rectangular cross-section, preferably one that is square, sleeves of square or other rectangular cross-section are used. To this end, the recess in the head of the carbon anode rod is square or otherwise rectangular and the sleeve fits closely into this recess.

In accordance with the invention, such a sleeve consists of a strip of sheet aluminum which is folded to produce a tube of substantially rectangular cross-section with three flat walls, and with the edges of the strip meeting and interlocking part way along the fourth wall, one of the edges being bent to form a first flange projecting inwardly into the rectangle outlining the sleeve, and the other edge being bent to form an inclined portion extending inwardly into this rectangle and at the end of the inclined portion an outwardly extending second flange, the first flange hooking into the outwardly-facing substantially V-shaped groove formed between the inclined portion and the second flange.

With this arrangement no part of the interlocking edges of the strip lies outside the rectangular section of the sleeve, and the sleeve can nest easily in a rectangular recess in the head of a carbon anode electrode around its peg.

The invention also comprises sleeve-forming apparatus comprising a former of rectangular section around which a strip of sheet aluminum is arranged to be bent to form the sleeve or tube and which has three smooth faces for forming the three flat walls of the tube and a fourth face formed with a V-shaped groove extending parallel to the edges of the former with the base of the groove adjacent to that face of the former over which the wall of the tube which will carry the part of the fourth wall of the tube on which the first flange is formed, a pressure jaw for clamping the aluminum strip against the middle of the three flat faces of the former, a pair of shaping jaws which are arranged to be swung up so that they each closely embrace a different one of the other two flat faces and part of the grooved face of the former in order to bend the strip which is clamped by the clamping jaw against one flat face of the former along the other two flat faces of the former and over the grooved face of the former, and an element having a folding edge which is arranged to be swung against the grooved face of the former so that the folding edge enters the V-shaped groove and forms the first flange and the inclined portion and second flange on the edges of the strip by forcing them into the groove of the former.

FIG. 1 shows in horizontal cross-section a sleeve of a type on which the present invention is an improvement;

FIG. 2 shows a sleeve according to the invention, likewise in horizontal cross-section;

FIG. 3 illustrates diagrammatically and in longitudinal section an apparatus for producing a sleeve such as shown in FIG. 2;

FIGS. 4, 5, and 6 are diagrammatic views from the view point of FIG. 3 but on smaller scale showing three successive working positions of the shaping tool of the apparatus of FIG. 3; and

FIG. 7 shows a detail portion of FIG. 6 on an enlarged scale.

In a factory of applicant's assignee in Switzerland, an aluminum sleeve is being used which is made of a strip of sheet the two ends of which are united by a clasp joint or fold. This sleeve, which is shown in FIG. 1 in horizontal cross-section as it comes from the automatic manufacturing machine, is not the subject of the present invention. The sleeve has an approximately square cross-section, but the wall portion **10** with its inwardly folded end **11** and the outwardly bent edge **12** of the wall portion **13** project from the square plan. The bent edges **11** and **12** must still be beaten or pressed flat, so that a clasp joint may be formed to prevent the sleeve from opening when the synthetic carbon composition is poured in, and to provide the completely square horizontal cross-section enabling the sleeve to be inserted in the square recess in the head of the anode.

The sleeve for protecting the iron peg according to the present invention is likewise made of a strip of sheet aluminum, but is so designed that it does not require a clasp joint and fits closely into a square or other rectangular recess. It is exemplified in FIG. 2, in horizontal cross-section, and has walls **14**, **15** and **16** which are flat and unshaped. A fourth wall **17** consists of a wall portion **18** which is folded by 90° from the wall **14** and which itself has an edge flange **19** folded inwardly by, for example, about 90°—preferably 90 to 100°—or (more generally) by an angle between 45 (more specifically 70) and 130°, and a part **20** folded by 90° from the wall **16** and bent slightly inwards approximately in the last third of its width and having a flange **21** folded outwards so as to be at an angle—preferably 90 to 100°—between 45 (more specifically 70) and 130° with the plane of wall **17**, and preferably substantially parallel to the flange **19**. The flange **21** engages behind the flange **19** in use. Consequently, the wall **17** partially projects inwards, but not outwards.

The width of the part **18** must be at least so large that the flange **21** can engage without any difficulty between the wall **14** and the flange **19**. On the other hand, it should be sufficiently small to support the part **20** against yielding to any significant extent under the pressure of the synthetic carbon composition poured in between the iron peg and the sleeve. It is also to be borne in mind that a too narrow wall part **18** makes it difficult to produce the sleeve by means of the apparatus according to the present invention which is described hereinafter. A width of 15 to 25 mm. (including rounded corners) is very suitable in the case of a sleeve with a cross-section of about 170 x 170 mm. With rigid material, e.g. hard pure sheet aluminum 1 mm. thick, the wall part **18** may be up to about 40 mm. wide in the case of the sleeve in question without any disadvantage. The width of the flange **19**, including the rounded corner, is, for example 8 to 10 mm. and that of the flange **21** is about 10 mm. Small tolerances in the dimensions of the walls **14**, **15** and **16** are permissible, since we are not concerned with a high-precision apparatus in the present case.

The flanges **19** and **21** must be so shaped that they are held together in the position of use and do not become disengaged from one another without some external effect. The angle which they each form with the other sheet-metal part must be such that this clamping action is ensured in the position of use.

After the synthetic carbon composition has been poured in between the iron peg and the present sleeve, there are no more precautions to be taken with the sleeve.

The supplementary operation of making a clasp joint, necessary with the old FIG. 1 sleeve, is dispensed with when the sleeve according to the present invention is employed, so that expense is saved. In view of the large number of carbon electrodes per furnace and the large series of furnaces, this saving of expense is important. Fractions of cents per kg. are counted in the production of aluminum; every fraction saved has a notable effect in the final balance sheet of a factory.

In certain of its aspects the invention contemplates the provision of apparatus for producing the new sleeve. This apparatus, as exemplified in FIGS. 3 to 6, essentially comprises a pressure-shaping former **22** with shaping surfaces **23**, **24**, **25** and **26** and shaping edges **27**, **28**, **29** and **30**. It has a recess **31** of approximately V-shaped cross-section in the surface **23**, the recess being parallel to the shaping edge **27** and its lowest point being in the vicinity of the edge **27**. A pressure jaw **32** can be pressed against the surface **25** which is opposite the surface **23** with the recess **31**. Two bending jaws **33** and **34** can be swung in succession about pivots **35** and **36**, respectively, and have a free edge offset through 90° with respect to projections **37** and **38**, respectively. These bending jaws are arranged on opposite sides of the press-shaping former **22** with their pivotal axes parallel to the length of the recess **31** and can be swung against the surfaces **26** and **24**, so that they embrace the edges **27** and **28**. The bendign jaw **33**, the projection **37** of which is located in the vicinity of the recess **31** during the operation of the apparatus, is arranged to be swung first. An element **39** equipped with a sharp folding edge **40** can swing about a pivot spindle **41** into a position in which its folding edge **40** engages in the recess **31**. Driving and control means known per se are provided for actuating the pressure jaw **32**, the bending jaws **33** and **34**, and the element **39**, as well as for ejecting the sleeve.

Of course, the width of the surfaces **23**, **24**, **25** and **26**, the bending jaws **33** and **34** and the edge **40** is related to the width of the sheet metal to be worked, that is the height of the sleeve to be produced.

The apparatus is preferably set up with the former **22** directed upwards, but it could also be used in any other desired position.

In FIGS. 3 to 6 it is assumed that the apparatus is in the preferred position, with the former **22** directed upwards. The sheet aluminum is unwound from a reel in the form of a strip **42** which, for example, is about 100–200 mm. wide and about 1 mm. thick by means of rolls serving as a conveying device and is introduced into the gap between the former **22** and the pressure jaw **32**, pushed forward until it is in the vicinity of the free end of the bending jaw **33** and cut to the required length. The sheet metal is indicated in FIGS. 3 to 6 in chain-dotted lines. The former **22** has on the side where the surface **23** is located, along the recess **31**, a marginal surface **43** which preferably slopes slightly downwards; this slope is provided to take into consideration the springing back of the folded sheet metal. After ejection, the marginal part **18** (FIG. 7) should form a right angle with the wall **14**. The side wall **44** of the recess **31** is at an angle of about 90°, preferably somewhat less (up to about 80°), to the marginal surface **43**. The side wall **45** of the recess **31** forms in turn an obtuse angle of, for example, 145 to 165° with the surface **23** of the former. The groove **46** is advantageous, because it receives small portions of material by which the required length of the piece of sheet metal cut to size is exceeded, but it is not absolutely essential. The length of the strip **42** emerging between the former **22** and the pressure jaw **32** should be such that the strip can be bent around the edges **30** and **27** onto the surface **44** (FIG. 3) and form the flange **19** (FIG. 7) at this point. A limit switch (not shown) is arranged at the point of furthest advance of the sheet-metal strip **42** and, on contact with the sheet metal **42**, stops the conveying device by transmitting a pulse. At the same time, the sheet metal is clamped upwardly against the former **22** from below by the pressure jaw **32** and the shears, which are likewise not shown, are operated and cut the sheet metal from the strip to the required length. That part of the piece of sheet metal cut to size which projects beyond the bending jaw **34** must be of such length, that, after being bent round the edges **29** and **28**, it extends as far as the marginal surface **43**, covers at this point the other end of the piece of sheet metal cut to size, which end is bent round the edge **27**, and can form the flange **21** (FIG. 7) under the effect of the pointed folding member **40**.

The bending operation begins simultaneously with the cutting off or immediately thereafter, by the bending jaw **33** comprising the projection **37** bending one part of the piece of sheet metal cut to size round the edges **30** and **27**. The position reached is shown in FIG. 4. As can be seen, the edge **47** of the sheet metal projects horizontally beyond the inner edge **49** of the surface **43** approximately as far as the middle of the recess **31**. Shortly thereafter, the longer part of the piece of sheet metal cut to size is bent round the edges **29** and **28** of the former **22** by the bending jaw **34** comprising the long projection **38**, so that after this operation has been carried out the two ends of the sheet metal are located over the recess **31**, as shown in FIG. 5. It is apparent from this that after this operation the edge **48** of the sheet metal covers the edge **47** to beyond the edge **49**.

It is furthermore apparent from FIG. 5 that, the right-angled projection **37** of the bending jaw **33** extends only so far over the surface **43** that it does not interfere with the placing of the edge **48** on the edge **47** by the bending jaw **34**. The projection **38** does not need to be longer than the projection **37**, because its function is to bend the piece of sheet metal cut to size round the edge **28** through 90°. In the illustrated example, however, it is considerably longer, so that the sheet metal is guided over a longer distance after being bent round the edge **28** and its edge **48** rests satisfactorily on the edge **47** when, during the next operation, the sharp edge **40** forces the two edges lying one on the other into the recess **31**.

In the position according to FIG. 5, the transmission of a pulse for the bending element **39** takes place by way of a limit switch and the bending element forces the two free ends **47** and **48** of the cut piece of sheet metal into the groove by means of the edge **40**, as a result of which the final position according to FIG. 6 is reached. In this figure, the folded flanges **19** and **21** of the sleeve as shown in FIG. 2 can be seen.

The sleeve is now finished. The bending jaws and the element **39** are swung back, the pressure jaw **32** is lowered and the sleeve is ejected automatically.

Of particularly great importance in the apparatus according to the present invention are the recess **31** in the former **22** and the pointed folding member of the element **39**, the co-operation of which produces the folding of the free ends of the cut piece of sheet metal in the required manner in a single operation, the flanges **19** and **21** being formed.

When the sleeve ejected from the apparatus according to the present invention is employed, it is opened at the flanges **19** and **21** and placed round the iron peg of the carbon anode rod, whereupon the flange **21** is made to engage behind the flange **19** and the sleeve is inserted in the square recess in the head of the carbon anode rod.

What is claimed is:

1. A carbon anode electrode for use in the fusion electrolysis of aluminum and having in its head an electrically conducting peg, wherein the peg is surrounded by a sleeve consisting of a strip of sheet aluminum which is folded to produce a tube of substantially rectangular cross-section with three flat walls and with the edges of the strip meeting and interlocking part way along the fourth wall, one of the edges being bent to form a first flange projecting inwardly and the other edge being bent to form an inwardly inclined portion having at its end an outwardly extending second flange, the first flange hooking into the outwardly facing groove formed by the inclined portion and the second flange.

2. Apparatus according to claim **1**, in which the first flange is folded between about 45 and 130° from the plane of the fourth wall and the second flange is bent so as to be at an angle of about 45 to 130° with the plane of the fourth wall.

3. Apparatus according to claim **2**, in which the first flange is at an angle of from about 70 to about 130° from the plane of the fourth wall and the second flange is substantially parallel thereto.

4. Apparatus according to claim **3**, in which the first flange is folded back at an angle of from 90 to 100°.

5. Apparatus according to claim **1** which has a substantially square cross-section.

6. Apparatus according to claim **1**, in which the part of the fourth wall carrying the second flange is wider than the part of the fourth wall carrying the first flange.

7. Apparatus according to claim **6** which has a substantially square cross section with a side of approximately 170 mm. and wherein the width of the part of the fourth wall carrying the first flange is at most 40 mm.

8. Apparatus according to claim **7** wherein the width of the part of the fourth wall carrying the first flange is between 15 and 25 mm.

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U.S. Cl. X.R.

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