Oct. 4, 1966 J. LEMER 3,276,604

SHIELDED ENCLOSURE WITH ROTARY MANIPULATOR

Filed Sept. 25, 1964 3 Sheets-Sheet 1

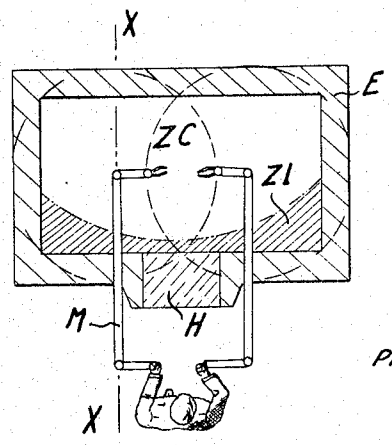


FIG.1
PRIOR ART

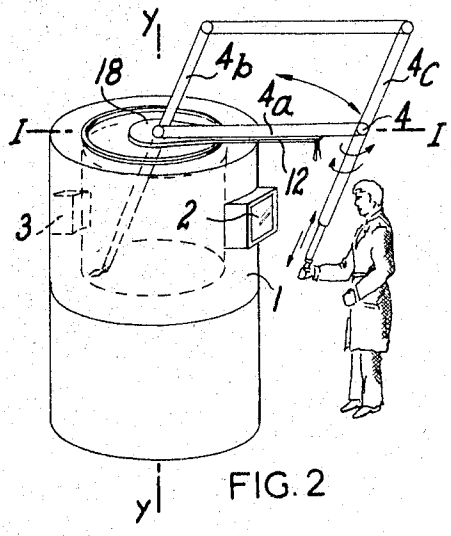


FIG. 2

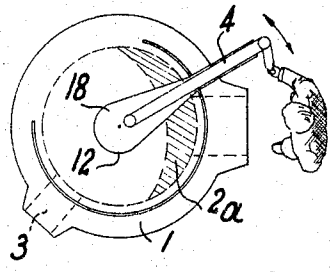


FIG. 3

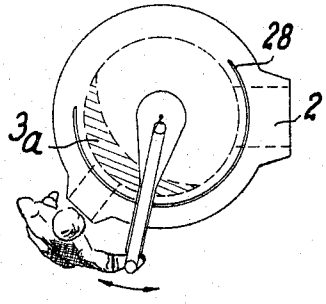


FIG.4

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SHIELDED ENCLOSURE WITH ROTARY MANIPULATOR

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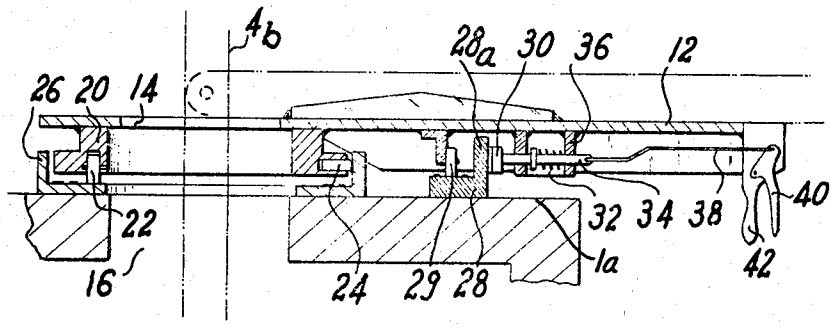


FIG. 5

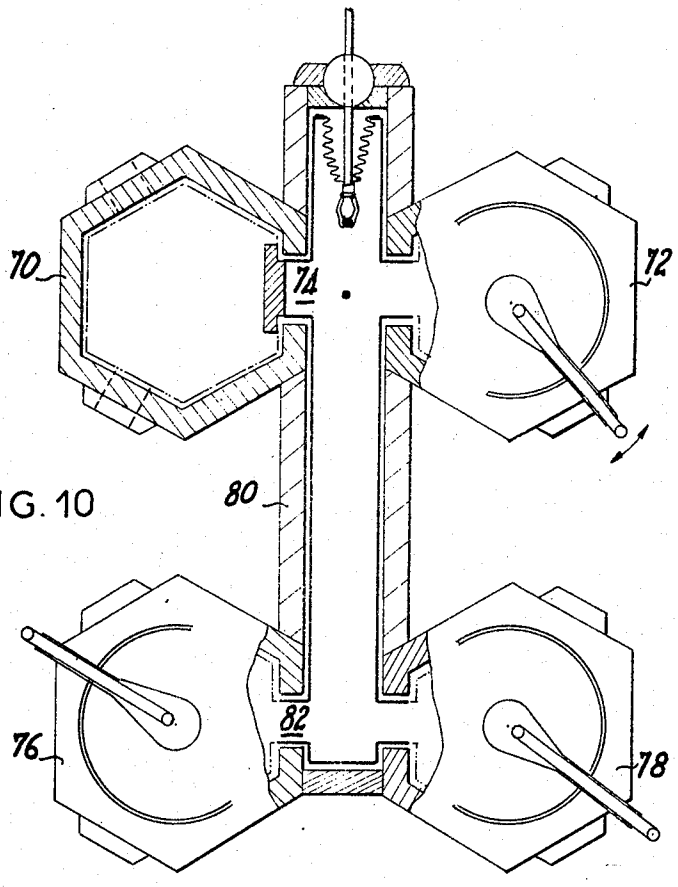


FIG. 10

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Oct. 4, 1966 J. LEMER 3,276,604

SHIELDED ENCLOSURE WITH ROTARY MANIPULATOR

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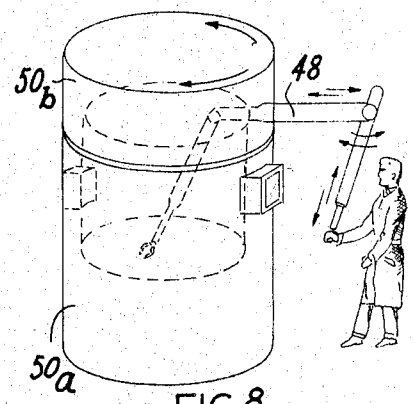


FIG.8

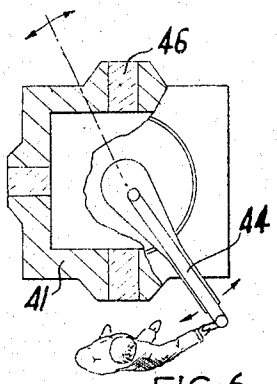


FIG.6

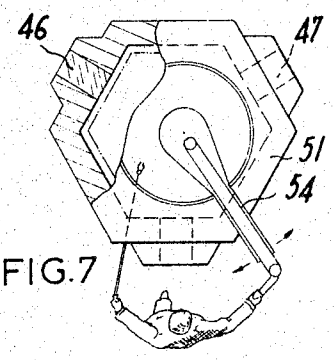


FIG.7

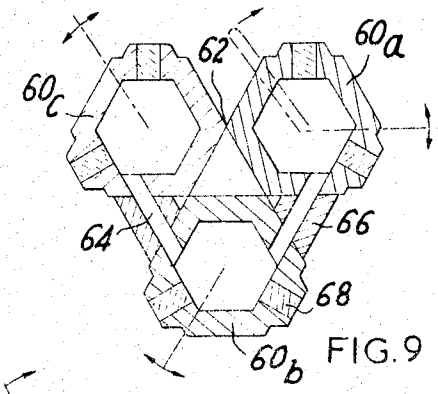


FIG.9

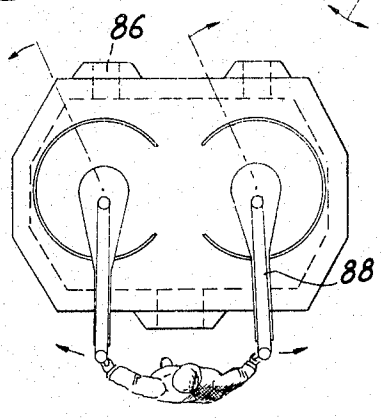


FIG.11

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SHIELDED ENCLOSURE WITH ROTARY MANIPULATOR

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Claims priority, application France, Oct. 1, 1963, 949,517
11 Claims. (Cl. 214—1)

In specialized laboratories, the manipulation of dangerous products and more particularly radioactive products is carried out in the interior of enclosures or so-called "hot cells" having walls which are fabricated of special materials with a view to affording biological protection for operators who are stationed outside such enclosures.

As a general rule, the walls delimit an internal volume of parallelipipedal configuration and a horizontal operating floor of rectangular configuration.

In the majority of such cases, the products to be processed are remote-handled by means of two manipulators of suitable design which permit of accurate reproduction of the movements performed by the operator, visibility through the walls being afforded by an inspection window.

Two types of manipulators are at present in existence: one which traverses a vertical wall, the other which traverses the top horizontal wall of the enclosure. In all cases of utilization at the present time, the bases of manipulators are made integral with the enclosure structure.

In theory, the manipulators are capable of gripping an object which is located at any point of the operating area within the interior of the enclosure if this latter is correctly designed.

In practice, this is not the case. The inspection window entails a relatively high capital expenditure, is not of sufficiently large size to permit of full visibility within the interior of the enclosure and it proves a matter of difficulty to grip an object both easily and correctly in certain zones, especially in the zone which is located immediately behind the front wall in which the window is mounted.

Moreover, the use of two associated manipulators results in a total effective operating area which is fairly limited compared with the effective area which is swept by a single manipulator owing to the necessary presence of a central zone of interference. Furthermore, experience has proved that one of the two manipulators is not employed to the full extent of its possibilities.

The object of the present invention is to overcome the disadvantages referred-to above by constructing an enclosure or "hot cell" which provides full visibility of the interior and in which handling operations are made possible at all points, even when employing a single manipulator.

The enclosure according to the invention is characterized in that it comprises a wall having the shape of a hollow prism which is closed at the extremities thereof and which surrounds an operating floor, at least two windows for viewing the entire enclosure which are angularly displaced relatively to each other, a manipulator which traverses the top face of the wall and which is mounted on a support, said support being adapted to rotate about an axis which is parallel to or superimposed on the axis of the enclosure. The movement of rotation of the above-mentioned support in turn produces the rotational movement of the manipulator control system around the enclosure itself.

The manipulator control system is thus brought close to any one of the windows, which makes it possible to perform a handling operation with total visibility at any operating point within the interior of the enclosure.

According to a preferred form of embodiment, the enclosure comprises a single manipulator which traverses the top face of the enclosure and is mounted on a support which is carried on said top face and which is adapted to rotate parallel to this latter about an axis in the vicinity of its center.

According to an alternative form of embodiment, said enclosure comprises a first cylindrical-wall section which is closed at the bottom, a second cylindrical-wall section which is closed at the top and which is rotatable with respect to the first and a manipulator which traverses the lateral wall of said rotatable section and which is made fast for rotation with this latter.

This invention also extends to installations comprising shielded enclosures which are equipped with rotary manipulators, assembled side by side and connected together by means of one or a number of tunnels.

The advantages and characteristic features of the invention will in any case be brought out by the following description of a shielded enclosure in accordance with the invention as given by way of non-limitative example and as illustrated in the accompanying drawings:

In these drawings:

FIG. 1 shows diagrammatically an enclosure which is equipped with two manipulators of known type.

FIG. 2 is a view in perspective of an enclosure in accordance with the invention.

FIGS. 3 and 4 are overhead views of the enclosure of FIG. 2 in two different positions of the manipulator.

FIG. 5 is a sectional view on a larger scale of the manipulator support, this view being taken along line I—I of FIG. 2 .

FIGS. 6 and 7 are part-sectional overhead views of alternative forms of embodiment of the enclosure.

FIG. 8 is a diagrammatic view in perspective of an enclosure which is equipped with a manipulator of the frontal access type.

FIGS. 9 and 10 are plan views of two forms of embodiment of an installation in which provision is made for a plurality of enclosures which communicate with each other.

FIG. 11 is a plan view of an enclosure which is equipped with two rotary manipulators.

The handling enclosures which are usually employed comprise, as in the case of the enclosure which is illustrated in FIG. 1, a parallelipipedal wall E formed of a material designed to provide protection against radioactive radiation and fitted with an inspection window 4. Manipulators M which are in most cases two in number are mounted on said wall E in such a manner as to permit of operation from the exterior. Said manipulators therefore traverse either the top face or a lateral face of the enclosure. These manipulators M are articulated in such a manner as to permit of displacement of their grappling members in a large number of directions but are mounted on stationary bases and the axes X—X of said manipulators always remain the same.

It is therefore observed that the zone XC is swept by both manipulators at the same time, with the result that full advantage is not taken of their potential capabilities and that, above all, the zone XI located close to the wall in which the window is fitted is not visible through said wall. It is therefore extremely difficult to work in this portion of the enclosure and the operating area is reduced accordingly.

In order to overcome these disadvantages and to permit of more complete utilization of the manipulator within the entire enclosure, provision is made according to the present invention for an enclosure (as shown in FIGS. 2, 3, 4), the outer wall 1 of which has a prismatic shape and pierced with at least two windows 2, 3 located pref-

erably at the same level. The axes of said windows make an angle such that it is possible through each one of these latter to control the entire zone which is not visible through the other window. That zone 2*a* which is not visible through the window **2** (as shown in FIG. 4) is perfectly visible through the window **3** and conversely that zone 3*a* (as shown in FIG. 4) which cannot be controlled through the window **3** is readily controlled through the window **2**. All points of the enclosure can thus be observed and controlled.

A manipulator **4** is mounted on said enclosure **1**. The body 4*a* of said manipulator which rests on the top face 1*a* of said enclosure and the slave-arm 4*b* passes at **16** through said top face whilst the master-arm 4*c* is free outside the enclosure. In accordance with the invention, the body 4*a* rests on a supporting arm **12** which terminates around the slave-arm 4*b* in a rounded head **18** pierced with a bore **14** which provides a passageway for said slave-arm 4*b* (as shown in FIG. 5); the diameter of said bore is similar to that of the opening **16** of the enclosure **1** and the axis thereof is very close to that of the head itself. Beneath the head **18** is mounted an annular member **20** which serves as support for horizontal-axis rollers **22** and vertical-axis rollers **24** which are arranged in alternate sequence around the periphery of said annular member **20** and which are adapted to roll on an annular track **26** fixed around the opening **16**. The supporting arm **12** is thus capable of rotating about the axes of the openings **16** and **14** and of traveling over the entire surface of face 1*a*.

When this rotational movement of the supporting arm takes place, the slave-arm 4*b* rotates about its own axis whilst the master-arm 4*c* rotates around the enclosure **1**. Said slave-arm can thus be moved to any desired point and can in particular be placed close to either one window or the other, depending on the point of the enclosure which has to be controlled. The entire enclosure can thus be utilized and the manipulator is always within easy reach of the operator at any selected handling location as controlled through any window.

The face 1*a* of the enclosure is also provided around the roller-track or rail **26** with an angle-iron member **28** having the shape of a circular arc and an L-shaped cross-section which is parallel to said rail **26** and which extends at least over the distance between the windows **2** and **3** and can even form a full circle. The vertical side 28*a* of the L is directed towards the master-arm 4*c* and a brake-shoe **30** is clamped against said side 28*a* by a spring **32**, said spring being mounted around a rod **34** which is integral with said brake-shoe between two abutments **36** which are secured beneath the supporting arm and which are traversed by said rod **34**. A cable **38** connects said rod **36** to a lever **40** which is mounted on an operating handle **42**. The rollers **29** which are mounted beneath the supporting arm **12** and which are adapted to run on the angle-iron member **28** facilitate the movement of rotation and forestall any possibility of rubbing friction of said arm **12** against the edge 28*a* of the angle-iron member. By producing action on the lever **40**, a pull is exerted on the cable and on the rod, thereby causing the brake-shoe **30** to withdraw. The supporting arm being thus disengaged, any displacement of the handle **42** around the enclosure produces the rotation of the supporting arm **12** and consequently the rotation of the manipulator. As soon as action is no longer exerted on the lever **40**, the spring **32** thrusts back the brake-shoe **30**, the supporting arm is locked in position and the manipulator can then be operated.

The dimensions of the enclosure **1** and manipulator **4** are such that the total area of the operating floor and the major part of the volume of the enclosure can be reached by the manipulator, the entire internal volume being controlled through the windows. To this end, the axis of the opening **16** and consequently the rotational axis of the supporting arm **12** and of the manipulator **4** is located in the vicinity of the axis *y*—*y* of the enclosure **1** and can even in certain cases coincide with this latter but is preferably located at a short distance therefrom as shown in FIGS. 2, 3 and 4.

In the last-mentioned figures, there has been shown an enclosure **1** having a cylindrical shape and a circular base, although it will be understood that said enclosure could assume the shape of any prism wherein the base of said prism can be inscribed either completely or partially in a circle having a radius which is shorter than the length of the body 4*a*. FIGS. 6 and 7 show respectively an enclosure **41** having a square base and an enclosure **51** having a hexagonal base each equipped with a rotary manipulator **44** and **54**. One of the aforesaid enclosures is fitted with three windows **46** and the other enclosure is fitted with two windows **46** and a lock-chamber **47**, each of said windows being located at the center of one side whilst the windows of the enclosure **51** are angularly displaced through an angle of 120°. In these two forms of embodiment, the annular member **28** is circular and the manipulator is designed to perform one complete revolution about the rotational axis of the supporting arm **12**. Access to the enclosure is possible around the entire periphery thereof since any movement from one window to another can be made in either direction.

According to another alternative form of embodiment whereby the manipulator **4** of the overhead-access type is replaced by a manipulator **48** designed for frontal access, the enclosure **50** consists of two sections which are preferably cylindrical, namely a bottom section 50*a* which is closed by a base and a top section 50*b* which is closed by a ceiling. The manipulator **8** traverses the lateral wall of the upper cylinder 50*b* in such a manner that the articulation of the slave-arm is located inside the enclosure whilst the master-arm is freely movable externally of this latter. The upper section 50*b* then performs the function of a support for the manipulator and is rotatably mounted on the lower section 50*a* by means, for example, of roller-bearings (not shown in the drawings) which are enclosed within corresponding annular channels of both sections and protected by the channel walls in order to prevent any passage of radiation to the exterior of the enclosure. A locking system permits the immobilization of the two sections relatively to each other in the different positions thereof whilst two windows **2**, **3** are provided for the purpose of controlling the interior of the enclosure. Said windows **2**, **3** are preferably fitted in the stationary section 50*a* but could also be fitted in the rotary support 50*b*.

Each enclosure which is equipped with a rotary manipulator can either be employed separately so that the entire external surface thereof is accessible or else form part of a processing installation comprising a number of enclosures assembled side by side.

FIG. 9 shows an installation of this type in which three identical enclosure 60*a*, 60*b*, 60*c* of hexagonal configuration are mounted one against the other, contiguously in pairs along one of their arrises **62**. Each of these enclosures is provided with at least one lateral lock-chamber **64** having an oblique axis, the enclosure 60*b*, for example, having two lock-chambers. Each lock-chamber is mounted coaxially with the lock-chamber of the adjacent enclosure and a tunnel-section **66** is mounted between the two lock-chambers. At least three faces of each hexagon are accessible from the outside. Two windows **68** are placed in one of these free faces and a rotary support permits of the displacement of the manipulator control system around these same faces. The angle of 120° which is made between the windows permits of full visual control over the enclosure which can accordingly be utilized to the full extent. In addition, each manipulator can be set at an angle of inclination which is sufficient for the purpose of reaching the connecting tunnel **66**. The parts to be handled can thus readily be transferred from one enclosure to the other and there is thus provided a simple

installation having small overall dimensions which can be utilized to its full capacity.

Other enclosures of cylindrical or prismatic configuration can be assembled in a different manner, for example, as shown in FIG. 10, wherein two enclosures **70, 72** are placed one beside the other, the two opposite faces thereof being joined to a common lock-chamber **74**. As is the case with the enclosures **60**, the enclosures **70** and **72** are fitted with two windows which are displaced through an angle of approximately 120° and are equipped with a rotary manipulator which is capable of reaching the interior of the lock-chamber. At the time of an operation requiring successive handling operations, the aforesaid enclosures **70, 72** are connected to other similar groups of two enclosures **76, 78** by means of a tunnel **80** and this latter communicates with the lock-chambers **74** and **82** which serve to connect the two enclosures of each group. Since only one face of the enclosure is inaccessible from the exterior, the manipulator is capable of rotating around the major part of said enclosure and it is possible to pass from one window to another without difficulty.

Although this invention is more especially concerned with enclosures which are equipped with only one rotary manipulator which permits the possibility of reaching the entire internal volume, the invention also extends to enclosures which are equipped with two or more rotary manipulators. An enclosure of this type comprising two two manipulators is illustrated in FIG. 11 wherein an octogonal enclosure **84** is fited with three windows **86** and equipped with two manipulators **88** which are adapted to rotate about two axes located in the vicinity of the axial plane of said enclosure. Each manipulator is adapted to rotate around one half of the enclosure and the handling operation can take place at any desired point.

It will be apparent that a large number of other forms and combinations both of enclosures and of rotary manipulators could be contemplated without thereby departing from the scope or the spirit of the invention. Other types of rotary supports could also be employed.

Of simple design and inexpensive to manufacture, the shielded enclosures of this invention can provide the necessary protection against various types of radiation. Such enclosures can in fact comprise one or a number of shield walls according to requirements such as, for example, a glove box for protection against alpha radiation surrounded by shielding which provides a barrier against gamma radiation. It is also possible without affecting the efficiency of the manipulator to equip enclosures with a number of different accessories such as handling grabs which are pivotally attached by means of universal joint systems (FIG. 7), introduction lock-chambers, bellows-type seals and the like. Such enclosures are additionally adapted to the most diversified handling operations, whether involving the manipulation of radioactive products or not, and even to the storage of radioactive products or to the measurement of such products.

What I claim is:

1. A shielded enclosure comprising a protecting wall having the shape of a prism which is closed at one end, an operating floor surrounded by said wall, at least two windows for supervising handling operations within the entire enclosure and angularly spaced with respect to each other, a manipulator which traverses the top parts of said wall, a support for said manipulator carried by said wall and rotatable about an axis which is located parallel to and in the vicinity of the axis of the enclosure, means for guiding the rotational movement of said support which in turn produces the rotary displacement of the manipulator and members for locking the support and securing the manipulator against rotation.

2. A shielded enclosure as defined in claim **1**, comprising a single manipulator which traverses the top face of the enclosure and which is mounted on a support, said support being carried on said top face and rotatable about an axis which is parallel to the axis of said enclosure and in very close proximity thereto.

3. A shielded enclosure as defined in claim **1**, comprising a protecting wall constituted by a right cylinder having a circular base.

4. A shielded enclosure as defined in claim **1**, comprising an annular rail fixed around the opening traversed by the manipulator and an arm for supporting said manipulator and terminating in a head fitted with rollers which are designed to guide the rotational movement of the support and which are adapted to run along said rail.

5. A shielded enclosure as defined in claim **1**, comprising a curved angle-iron member which is concentric with the opening traversed by the manipulator, a brake-shoe which is maintained applied against said angle-iron member and means for withdrawing said brake-shoe during the rotational movement of the support.

6. A shielded enclosure as defined in claim **1**, comprising a first cylindrical-wall section which is closed at the bottom, a second cylindrical-wall section which is closed at the top and which is mounted so as to be rotatable with respect to the first and a manipulator which traverses the lateral wall of said rotatable section and which is made fast for rotation with said rotatable section.

7. A shielded enclosure as defined in claim **6**, comprising members for guiding the rotational movement of the top section and mounted in leak-tight manner between the two wall sections.

8. A shielded enclosure as defined in claim **1**, comprising at least three windows for viewing the entire enclosure, a plurality of manipulators which traverse the top face of the wall, a support for each of said manipulators and rotatable about a vertical axis in the vicinity of the axial plane of said enclosure, members for guiding the rotational movement of each support and means for locking each support in position independently.

9. A handling installation, comprising two shielded enclosures according to claim **1**, each enclosure being provided with a lateral lock-chamber, a connecting tunnel which is coaxial with the two lock-chambers and, mounted on each enclosure, a rotary manipulator designed to reach the interior of the tunnel and a support for moving the manipulator control system around almost the entire periphery of the enclosure.

10. A handling installation, comprising three enclosures according to claim **1** which are each provided with at least one lateral lock-chamber and which are mounted tangentially to each other, at least two tunnels providing a communication between said enclosures and coaxial with the lock-chambers which are interconnected by means of said tunnels and, mounted on each enclosure, one manipulator designed to reach the interior of the tunnel and a support for moving the control system of said manipulator in rotation around one half of said enclosure.

11. A handling installation, comprising a plurality of groups of two shielded enclosures according to claim **9** and a collector tunnel providing a communication between the tunnels of the different groups.

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R. G. SHERIDAN, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,276,604 October 4, 1966

Jacques Lemer

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 4, for "La Baule les Pims" read -- La Baule les Pins --; column 5, line 63, for "parts" read -- part --.

Signed and sealed this 5th day of September 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents