PUBLISHED MAY 11, 1943. BY A. P. C.

M. J. RICHOU

APPARATUS OF THE KIND OF THE DIVING SUITS

Filed April 2, 1942

Serial No. 437,449

3 Sheets-Sheet 1

Fig. 1

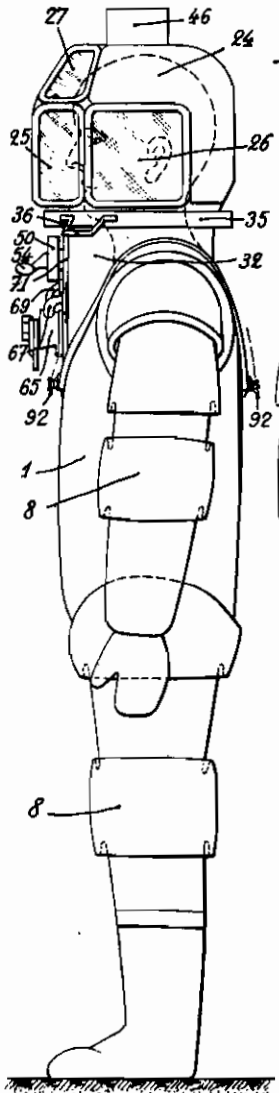


Fig. 2

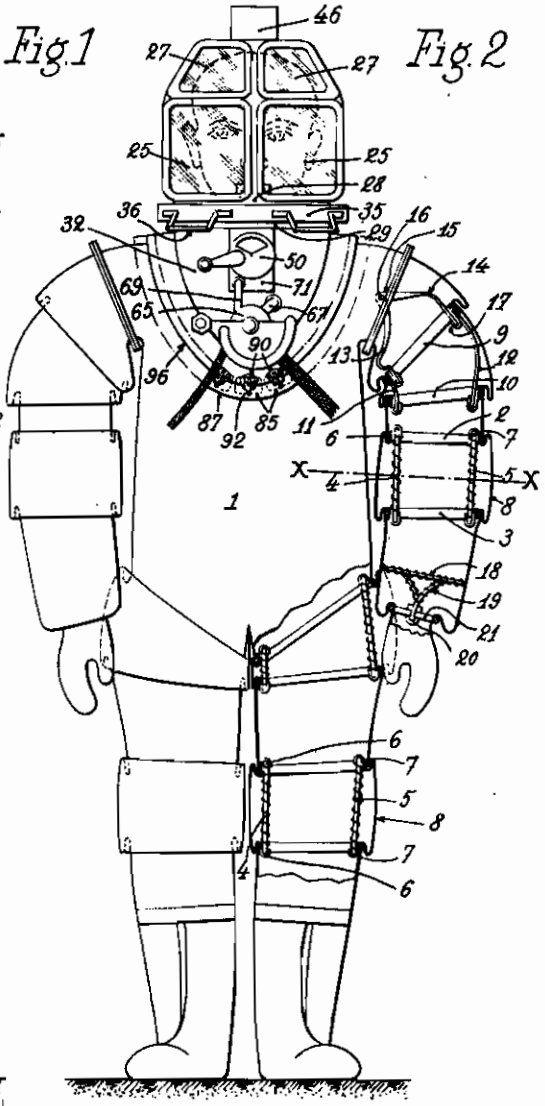


Fig. 12

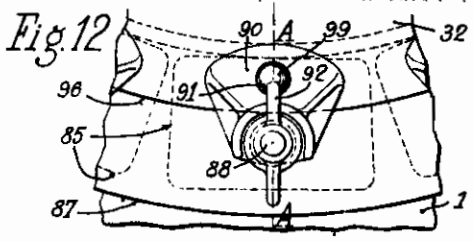
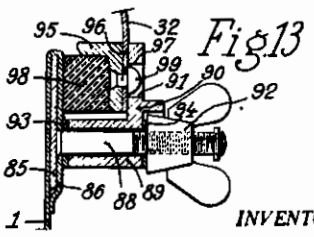


Fig. 13



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3 Sheets-Sheet 2

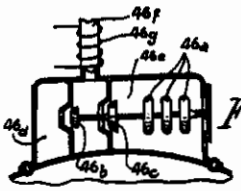

Fig. 16

Fig. 3

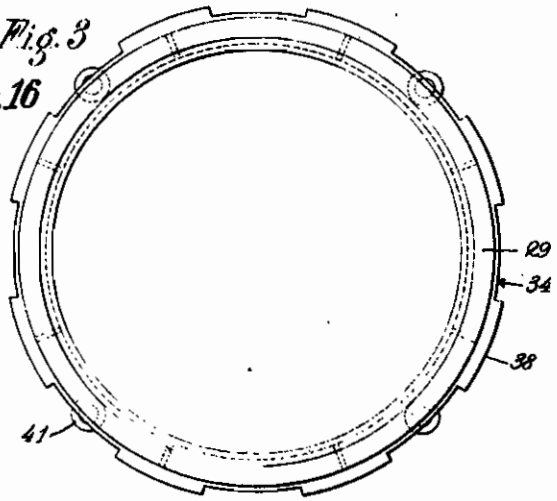

Fig. 15

Fig. 14

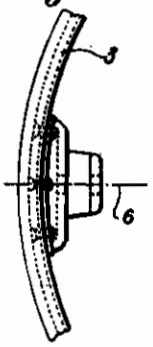

Fig. 4.

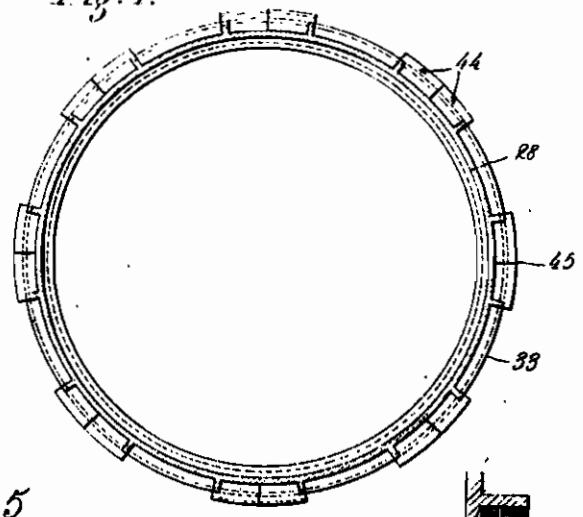

Fig. 5

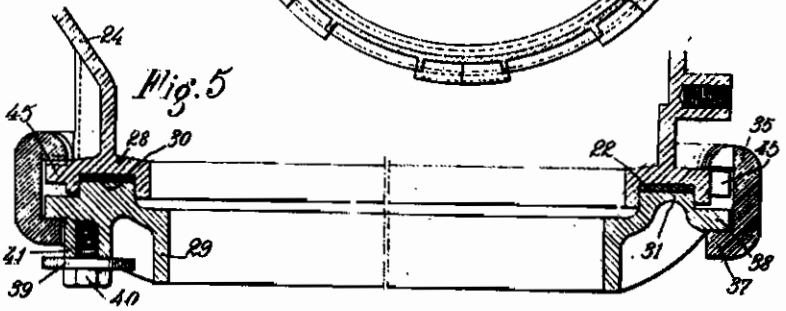

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Fig. 7

Fig. 6

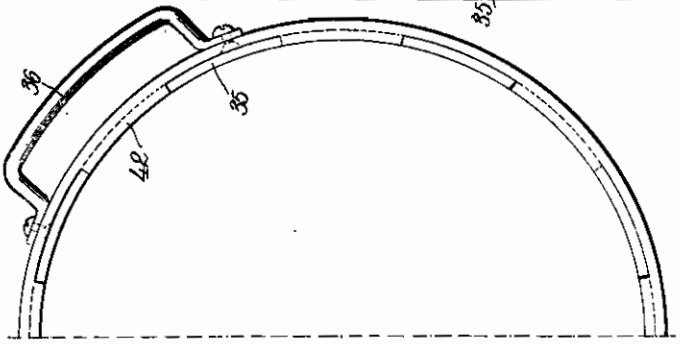


Fig. 8

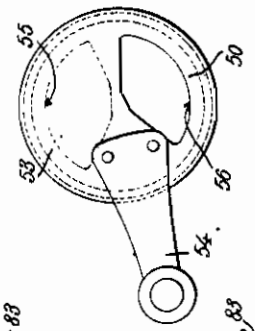


Fig. 9.

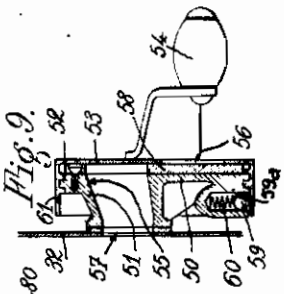
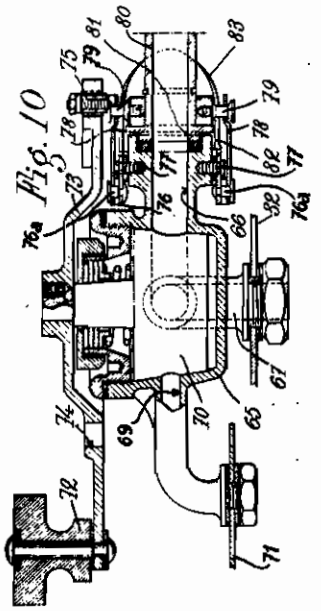


Fig. 10



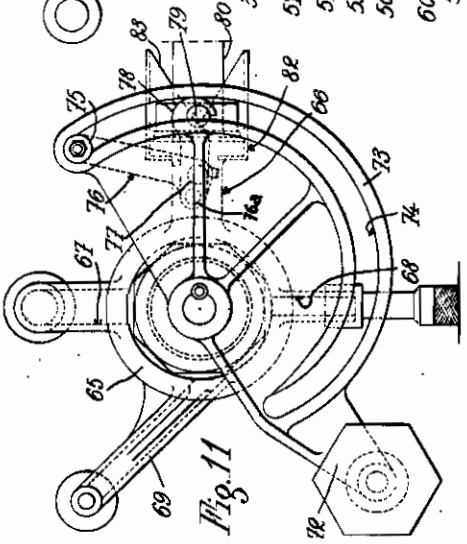


Fig. 11

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ALIEN PROPERTY CUSTODIAN

APPARATUS OF THE KIND OF THE DIVING SUITS

Maxime Jean Riehou, Paris, France; vested in the Alien Property Custodian

Application filed April 2, 1942

My invention relates to apparatus of the kind of the diving suit, generally comprising an air and water-tight garment combined with an air-tight helmet, and it concerns more particularly the apparatus of the kind above-referred to which are intended for use in an atmosphere of respiratory gas at a pressure different from normal, such as those for the crew of aircrafts for high altitudes where the air is highly rarefied.

My invention has for its object an apparauts of the kind above-referred to which will permit better visibility, more ease in moving and increased safety in operation of the parts ensuring proper respiration of the user.

A further object of my invention consists in constituting the air-tight garment in the vicinity of at least one of the articulations by a flexible material and by supporting said material by means so arranged that the play of said articulation is less affected by the action of internal pressure than if said means did not exist and preferably that said articulation remains substantially balanced irrespective of the decrease of external pressure.

Another object of my invention is to provide means whereby there may be admitted into the device for ensuring respiration of the user, either air from the outer atmosphere, or air from a compressor or the like, or a gas such as oxygen, said means being controllable through appropriate devices preferably supported by the breast-plate of the apparatus.

Still a further object of my invention is to provide the helmet with a number of windows so disposed, more particularly in front of the user, on both sides and in the upper part, as to ensure the maximum visibility in all directions.

Still a further object of my invention relates to the connecting means between the different parts of the apparatus and more particularly between the helmet and the breast-plate and between the breast-plate and the garment; and it consists in providing said means with quickly dismountable clamping parts. Said means may for instance comprise, in the case of the joint between helmet and breast-plate, a ring or collar so arranged as to exert a wedging action whereby the respective surfaces are pressed against each other.

In the annexed drawings:

Fig. 1 is a side view of an apparatus according to my invention.

Fig. 2 is a front view thereof.

Fig. 3 is a plan view to an enlarged scale of an annular member attached to the breast-plate for connecting same with the helmet.

Fig. 4 shows the corresponding annular member attached to the helmet.

Fig. 5 is an enlarged partial cross-section showing the aforesaid members in contacting relation and pressed against each other by the clamping ring.

Fig. 6 is a partial plan view of the clamping ring.

Fig. 7 is the corresponding cross-section.

Fig. 8 is a front view of the air valve.

Fig. 9 is a cross-section thereof.

Fig. 10 is a front view of the three-way controlling valve.

Fig. 11 is a cross-section thereof.

Fig. 12 is a fragmental front view showing to an enlarged scale a member for connection between the air-tight garment and the breast-plate.

Fig. 13 is a cross-section thereof.

Fig. 14 is a fragmental plan view showing an articulation member.

Fig. 15 is the corresponding cross-section.

Fig. 16 is a diagrammatical axial section of the pressure-limiting valve.

The apparatus illustrated in Figs. 1 and 2 is intended for use on aircrafts flying at high altitudes. It comprises an airtight garment 1, made of rubberized fabric or the like, strong enough to support the difference between internal and external pressure, and enclosing the user's body, as in the case of a diving suit. The said garment covers the legs, body and arms of the user and extends up to the breast-plate.

In order to facilitate the user's motions, the said garment is provided with appropriate articulations so arranged as to be substantially unaffected by the difference between internal and external pressure. Each articulation preferably comprises two rigid annular members 2 and 3 (Figs. 2, 14 and 15) disposed each side of the geometrical axis X—X of the articulation, the fabric being fixed to said members in any appropriate manner, and these two members are connected with each other by means of two rigid or non-rigid connecting rods 4 and 5, made for instance of steel cable, preferably braided with strings. Connecting rods 4 and 5 are substantially disposed in one and the same plane and the latter substantially contains the geometrical axis X—X of the articulation, as shown in Fig. 2 for an elbow, such axis being shown as parallel to the plane of the drawing for the sake of clearness.

Connecting rods 4 and 5 are pivoted to mem-

bers 2 and 3 about axes 6 and 7 substantially parallel to the articulations axis and preferably disposed beyond each corresponding member 2 or 3 with respect to the said articulations axis. It will easily be grasped, for instance, that in Fig. 15 axis 6 is situated below member 3, while the articulation axis X—X lies above same (Fig. 2).

The fabric of garment 1 is firmly attached to members 2 and 3 and the portion of fabric comprised between the latter is long enough to form a sort of bellows 8 affording the necessary degree of freedom for the articulation.

It will be seen in Fig. 2 that the same kind of arrangement is used for the knees. The articulation for the shoulders comprises two annular members 9 and 10 connected with each other by means of connecting rods 11 and 12 which are preferably curved, as shown. The upper member 9 is in turn connected by means of rods 13 and 14 with parts 15 fixed to the fabric. It will be noted that here the pivoting axes 16 of rods 13 and 14 on parts 15 is perpendicular to their pivoting axes 17 on member 9, such arrangement permitting motion of the arm in any direction.

The device corresponding to the wrist is somewhat similar, but the construction is simplified. It comprises a non-rigid ring 19, made of steel-cable, fixed to the fabric, for instance by stitching, and the said ring is connected to a rigid ring 21 by means of steel cables 19 pivoted at 20 on ring 21 and fixed by their other ends to ring 18.

The helmet 24 forming the upper part of the apparatus preferably comprises, as shown, two front windows 25, two side windows 26 and two upper windows 27, such an arrangement affording good visibility in any direction. Each window is formed of two thicknesses of safety glass with an electrical heating device in the intermediate space to prevent frost formation. The electric current may be supplied by the electrical system of the aircraft through an easily detachable plug.

The helmet is tightly fixed to the breast-plate of the apparatus by means of quickly removable connecting and clamping means preferably of the type acting through wedge-shaped portions. In the construction illustrated in Figs. 1 to 5, the connection between helmet and breast-plate comprises two annular members 28 and 29. Member 28 is integral with the lower part of the helmet (which is shown in section in Fig. 4) and it is provided with an annular groove 30 into which fits an annular projection 31 provided on member 29, a rubber ring 22 being interposed for air-tightness. Member 29 is attached to the upper part of the breast-plate. Moreover both members are provided with corresponding recesses or cut-out portions respectively 33 and 34 along their periphery.

Members 28 and 29 are clamped against each other by means of a clamping ring 35 (Figs. 5 to 7) provided with handles 36. Ring 35 preferably comprises a lower inner rib 37 adapted to be axially retained between the lower face of the plain portions 39 (Fig. 5), formed between the successive recesses 34 of member 29 (Fig. 3), and a number of washers 39 (Fig. 5) fixed by screws 40 against bosses 41 projecting downwardly below member 29.

Ring 35 is also formed at its upper part with a number of inwardly projecting portions 42 (Fig. 7) the number and dimensions of which correspond with the recesses or cut-out portions 33 and 34. These projecting portions 42 are formed with their lower face oblique both ways as shown at 43, the thickness decreasing from the middle to the ends. And the plain portions 45 (Fig. 4), formed between the successive recesses or cut-out portions 33 of member 28, have their upper face oblique both ways correspondingly as indicated at 44.

It will easily be grasped that the helmet may be properly placed on the breast-plate provided ring 35 is so disposed that the plain portions 45 of member 28 may pass between the successive projections 42 of ring 35. Then by rotating the latter in any direction the oblique faces 43 of ring 35 engage the oblique faces 44 of member 28 and clamp the latter downwardly against member 29, as shown in Fig. 5. By rotating ring 35 in the reverse direction, the parts become again disengaged.

The breast-plate 32 of the apparatus (Figs. 1 and 2) is also preferably connected with the garment 1 by means of quickly dismountable connecting means. This connection is effected along such a contour that when the breast-plate is detached, the opening in the garment is large enough for the user to have access into the same.

Figs. 1, 2, 12 and 13 show the preferred construction which ensures air-tightness while preserving some flexibility.

The joint comprises along its length a number of plates 85 regularly spaced from each other, these plates being disposed within a hem 88 formed on the upper edge 87 of garment 1. Fig. 2 only shows three of these plates, but it is understood that others are distributed along the whole length of edge 87. Each plate is provided with a threaded rod 88, fixed by welding or soldering, such rod receiving a socket 89 integral with a sector-shaped wing 90 provided with a hole 91. A fly-nut 92 screwed on rod 89 is adapted to press wing 90 against plate 85. Washers 93 and 94 are interposed respectively between plate 85 and socket 89, and between the latter and nut 92. An angle iron 95 extends along the edge of breast-plate 32 and is tightly fixed thereto by rivets 87, the distance between the successive rivets being equal to the distance between the successive holes 91 of wings 90. A continuous packing member 98, made of rubber, is disposed in the angle of iron 95 as shown.

To fix the breast-plate 32 on the garment 1, the edge of the former, with the angle iron 95 and the rubber packing 98, is introduced between plates 85 and wings 90, the heads 99 of rivets 97 being accommodated by holes 91, as shown in Fig. 13. Nuts 92 are then screwed up and the rubber packing 99 is thus firmly pressed against the edge 97 of the garment, which ensures air-tightness. The heads 99 are retained in position within holes 91, which prevents any slipping.

The joint between the breast plate and the garment could also be effected by non-dismountable means, in which case an opening would have to be provided in the garment for the user, such opening being closed by an air-tight closure.

The apparatus described comprises means to feed the inner space, or at least the helmet, with a respiratory gas under substantially constant pressure, the latter being maintained by a manometric device preferably disposed within a heat-insulated housing 46 (Figs. 1 and 2) at the upper part of the helmet. As shown in Fig. 16, this device comprises a set of barometric cells 48a submitted to the internal pressure within the helmet and actuating a double-seat valve

46*b*—46*c* which controls air exhaust from chambers 46*d* and 46*e* to the outer atmosphere through conduit 46*f*. An electrical heating element 46*g* is provided to avoid frost formation.

The air feeding means are so arranged as to permit free access of the outer air when the atmospheric pressure is sufficient, or admission of compressed air from an air compressor of the aircraft, or admission of oxygen, more particularly from a bottle carried by the user.

The gas controlling means are preferably supported by the breast-plate, whereby their actuation by the user is particularly easy. A control valve may be provided for each particular admission, or two admissions may be controlled by a multi-way valve, or there may be provided but one controlling distributor.

The construction illustrated comprises a valve controlling access of the outer air and a multi-way valve controlling compressed-air and oxygen admission.

The valve 50 controlling the access of outer air comprises (Figs. 1, 2, 8 and 9) a circular body 51 provided with a threaded periphery, as shown at 52. A cap 53 is screwed on body 51, the said cap being manually actuated by means of a handle 54. Body 51 and cap 53 are provided with sector-shaped openings 55 and 56. When cap 53 is screwed up on body 51, openings 55 and 56 are not in registering relation (position shown in Figs. 8 and 9). By unscrewing cap 53, openings 55 and 56 are brought in more or less complete registration, whereby air from the outer atmosphere may have access to an opening 51 provided through the breast-plate and thence to a conduit 71 (Fig. 1) which opens upwardly in the vicinity of the user's mouth. A packing plate 58 provides air-tightness at the closed position of the valve.

Valve 50 is preferably so arranged as to act as an emergency adjustable exhaust for the case of failure of the automatic exhaust device 46. To attain this purpose, body 51 is formed with a radial hole receiving a ball 59 pressed outwardly by a spring 60. Ball 59 may engage a number of holes or depressions 59*a* formed in a skirt 61 integral with cap 53. The user may thus adjust the degree of opening of the valve to maintain an appropriate pressure within the apparatus without any risk of accidental rotation under the action of vibrations, shocks and the like.

The multi-way valve is provided with means ensuring automatic disconnection of the compressed-air hose (or of any other line between the user and the craft) for a given position of the controlling handle and preferably for the position corresponding to oxygen admission, such an arrangement being of particular advantage when the user has to leave the aircraft by means of his parachute.

The said multi-way valve may comprise a body 65 (Figs. 10 and 11) with four conduits 66, 67, 68 and 69, and a rotatable plug 70 provided with two radial passages at right angle. According to the position of plug 70, conduit 66 is connected with conduit 67, or conduit 68 is connected with conduit 69. Conduit 66 receives a hose admitting compressed air; conduit 67 leads through the breast-plate into the apparatus; conduit 68 is connected with the oxygen bottle (not shown in Fig. 2); and conduit 69 leads to the aforesaid conduit 71.

Plug 70 is actuated by means of a handle 72 integral with a sector 73 provided with an arcuate elongated opening 74 in which there is engaged a roller 75 rotatably carried by a lever 76 (Fig. 11) pivoted at 77. As shown in Fig. 10, there are two pivots 77, lever 76 being in the form of a fork. Lever 76 carries pivots 76*a* (Figs. 10 and 11) for hooks 78 which engage pins 79 projecting radially from the end ring of the compressed-air hose 80.

At the position shown, which corresponds to the connection between conduits 66 and 67 (admission of compressed air into the apparatus) hooks 78 press the end-ring of hose 80 against a packing seat 81 provided within conduit 66. By rotating handle 70 anticlockwise through about 45°, the valve is wholly closed. Opening 74 being substantially circular in the vicinity of its right end (in Fig. 11), roller 75 is not actuated and hooks 78 are not moved. Of course handle 72 may be restored to its former position by rotating same clockwise through about 45°.

When handle 72 is rotated through about 180°, connection is established between the oxygen bottle and conduit 69, which permits oxygen access into the apparatus. Owing to the spiral shape of opening 74, roller 75 is moved towards the centre of the valve. Pivots 76*a* rotate anticlockwise about pivots 77 and therefore move towards the right of Fig. 11, whereby hooks 78 are progressively disengaged from pins 79. Hose 80 may thus be freely disconnected.

A tubular guide 82 fixed to conduit 66 is provided with a double V-shaped groove 83 forming a guide for pins 79 when hose 80 is to be connected with the valve body.

It will be noted that the air ports in the multi-way valve permit a strong air circulation within the apparatus thus ensuring respiration of the user and elimination of carbon dioxide and moisture.

It will be understood that the above description does not limit my invention, the details of which may vary within the ambit of the appending claims.

It may be noted for instance that the condition to be fulfilled to obtain perfect balance of an articulation irrespective of the difference between internal and external pressure, is that the volume comprised for instance within bellows 8 between members 2 and 3 does not vary when the articulation is actuated. If this volume tends to decrease, the internal pressure tends to extend the articulation i. e. to act against the user. But it may be of advantage to devise the parts in such a manner that the said volume tends either to decrease less than if the supporting means did not exist or to increase, in which case the articulation is not stable, the internal pressure acting respectively against or with the user when the latter rotates the articulation.

MAXIME JEAN RICHOU.