Report on the technical inquiry into the

CMA CGM OTELLO

Bureau d'enquêtes sur les évènements de mer

Report on the technical inquiry into the

LOSS OVERBOARD OF CONTAINERS CARRIED ON DECK

CASE OF THE

CMA CGM OTELLO

BAY OF BISCAY

17TH FEBRUARY 2006

Warning

This report has been drawn up according to the provisions of Clause III of Act No.2002-3 passed by the French government on 3rd January 2002 and the decree of enforcement No.2004-85 of 26th January 2004 relating to technical investigations after marine casualties and terrestrial accidents or incidents and in compliance with the "Code for the Investigation of Marine Casualties and Accidents" laid out in Resolutions A.849(20) and A.884(21) adopted by the International Maritime Organization (IMO) on 27/11/97 and 25/11/99.

It sets out the conclusions reached by the investigators of the *BEA*mer on the circumstances and causes of the accident under investigation.

In compliance with the above mentioned provisions, the analysis of this incident has not been carried out in order to determine or apportion criminal responsibility nor to assess individual or collective liability. **Its sole purpose is to identify relevant safety issues and thereby prevent similar accidents in the future**. The use of this report for other purposes could therefore lead to erroneous interpretations.

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List of abbreviations

ABS	:	American Bureau of Shipping
***BEA*mer**	:	Bureau d'enquêtes sur les évènements de mer (Marine Accident Investigation Office)
FAT (or TA)	:	Fully Automatic Twistlock
GM	:	Metacentric height
GPS	:	Global Positioning System
IMO	:	International Maritime Organization
kW	:	Kilowatt
MOU	:	Paris Memorandum Of Understanding
SAT (or SA)	:	Semi Automatic Twistlock
SOLAS	:	International Convention for the Safety Of Life At Sea
TEU	:	Twenty Equivalent Unit
TL	:	Twistlock
UMS	:	Universal Measurement System

1 Circumstances

The Marseilles-registered 8238 TEU container vessel *CMA-CGM OTELLO* was bound for Le Havre from Port Kelang (Malaysia) via the Suez Canal which she transited on 12th February 2006, and the Straits of Gibraltar through which she passed on 16th February 2006.

After Cape Saint Vincent which the vessel rounded on the same day she proceeded northwards and was subjected to an increasing westerly wind generating wind waves on a heavy northwest swell, with the result that the vessel was pitching heavily.

At 0100 on the 17th February she passed Cape Finisterre and set course to 027°. The vessel was pitching and rolling in seas which, by this time, had become very rough.

At 0725 the crew noticed that 50 40-foot containers had been lost overboard while 20 others had shifted and collapsed; all of them had been stowed on the starboard side abaft the superstructures. The incident was thought to have taken place between 0500 and 0725. The master informed the competent authorities, then proceeded to Le Havre, arriving there on 18th February 2006.

It is worth noting that, at the same moment, another container vessel lost two containers with six others collapsing on the deck and that, on the following day a third container vessel lost 77 containers in the same area with 55 others being damaged.

Speaking more generally, it is thought that some 2500 containers are lost at sea each year, representing about 0.006% of the total carried (a British magazine recently put the figure at 0.005% which it compared to the 1.57% of luggage lost in air travel, concluding, tongue in cheek, that carriage by sea is more efficient and safer!).

2 VESSEL

2.1 Main characteristics

- Type : container carrier ;
- Flag : French;

- Registry : RI 924659 ;
- MMSI number : 635 009 600 ;
- Owner/manager : CMA-CGM ;
- Construction : Hyundaï Heavy Industy Co.Ltd
  Ulsan – Corée . Hull N°1646 ;
- Length : 334.07 m / 319 m ;
- Breadth : 42.80 m ;
- Depth : 24.60 m ;
- Draught : 14.52 m ;
- Freeboard : 5 749 mm ;
- Gross tonnage : 91 410 ;
- Number of containers : 8 238 TEU, with 4 403 on deck;
- Engine : MAN B&W 12K98 MC
  93 360 BHP / 68 640 kW at 94 rpm
  consumption : 250 Mt per day ;
- Propeller : 6 fixed blades - 9100 mm in diameter;
- Speed : 25 knots.

2.2 Classification - Certification

The *OTELLO* is classified and certified by Bureau Veritas (except for international and national safety certificates) :

- Class 1, hull and machinery spaces;
- Container ship;
- Unrestricted navigation;
- VERISTAR-HULL (monitoring of the structure);
- Automated engine room, at sea and in harbour;
- Hull survey afloat.

She holds a "certificate for fixed container securing equipment" comprising an appendix which :

- lists the fixed and movable securing systems;
- details the certificates of approval by type and the equipment inspection certificates as well as listing the approved securing plans.

All the certificates were issued on 25th November 2005.

The cargo securing manual was approved on 2nd November 2005. It contains descriptions of, and explanations of how to assemble, secure and maintain :

- the fixed welded elements, in the holds, on the hatch covers and on deck used for
- locking the containers in place and installing the lashing bars;
- the different types of twistlocks, including the manual twistlocks for standard
- containers and the other automatic (FAT) and semi-automatic twistlocks;

as well as the loading and securing plans, on deck and in the holds, bay by bay.

3 CREW

The crew comprised

- 16 persons as per the Minimum safe manning certificate issued by the head of the French International Registry (RIF) in Marseilles on 16th June 2006 and included :
    - four deck officers including the master,
    - three engineer officers,
    - three boatswains,
    - one general purpose seaman,
    - two agents in the steward's/catering department,
- the vessel had a total complement of 30 persons, 14 of whom were French (most of the officers), the remaining 16 being Romanian.

The minimum complement and work organization on board enabled the ship to be operated correctly.

It is to be noted, however, that in order to reinforce the bridge watch in the event that a second lookout was required, four crew members had to work in watches (six hours on, six hours off).

On the other hand :

- upkeep and maintenance,
- and especially adjusting and resecuring of the deck cargo (half a day's work for four or five men),

could only be carried out using the full complement.

The master had commanded container ships for 17 years and had been in command of the *OTELLO* since 17th December 2005.

4 SEQUENCE OF EVENTS

16th February 2006

0842, having rounded Cape Saint Vincent the vessel was proceeding on course 347°.

1315, she rounded Cape Rocca and altered course to 001°. She then encountered a long northwest swell of height 4 metres which induced pronounced pitching. Subsequently the westnorthwest to westsouthwest wind continued to increase steadily up to force 7 or 8 and the height of the northwest swell increased up to 6 metres. The pitching became more pronounced. The vessel was making 23 knots.

17th February 2006

0100, the vessel passed Cape Finisterre and altered course to 027° with the engines at 90 then 92 rpm. The sea was described as very rough and the rolling and pitching as pronounced.

0725, from the bridge, a number of stacks were seen to have collapsed in bays 66 to 70 on the starboard quarter; some 50 containers had been lost overboard between **0500** and **0725**, that is, between the positions 44° 35'N / 08° 46'W and 45° 29'N / 08° 07'W. Safety messages were transmitted. The vessel continued to roll (10 to 20°) and pitch on the heavy northnorthwesterly swell.

0810, the engine was set to 90 rpm.

1024, a container was sighted in position 43°31'N / 07° 20.5'W.

1102, two more containers lost overboard in position 46°22.2'N / 07°12.9'W.

1650, passed Ushant, course 060°.

After **2000** the weather improved bringing a lessening in the platform motions.

5 INSPECTIONS

On arrival in Le Havre the vessel underwent two inspections.

1 - A special inspection carried out by the Le Havre Ship Safety Centre.

The report of this inspection :

- relates how the damaged containers were unloaded. They were "placed at the disposal of the surveyors" but no-one, it seems, thought to check the weight of the containers which could have been weighed while they were being handled.
- mentions that the cargo securing equipment would be assessed by the manufacturer (German Lashing);
- repeats the extracts from the master's Sea Protest concerning the loss of the containers on 17th February 2006.

On the other hand, a number of photographs were taken during the inspection which will be analysed in § 8.2.5 and in the annex entitled "Photographs".

2 - An inspection carried out by the Dutch consultancy firm BMT on behalf of the owners.

The report briefly relates the incident and the inspection of the cargo lashing equipment.

"The constituent parts of the lashing system were installed in compliance with the stipulations of the cargo securing manual (this can only be affirmed for those which had remained in place ...). The equipment – which dated from the vessel's maiden voyage in November 2005 – was found to be in good order and well maintained."

"The loss of the containers is thought to have occurred at about 0525 when the vessel took a much larger roll than the others."

6 WEATHER CONDITIONS

Information about weather conditions was obtained :

1 – from the master's Sea Protest which repeats the information recorded in the log book.

No information about platform motion was found before the passage of Cape Rocca, heading northwards.

- At 1315 on 16th February, with Cape Rocca on the beam, a long northwest swell was encountered which generated pronounced pitching.
- 1800, pitching in heavy northwest swell.
- At 0000 on 17th February, with Cape Finisterre abeam, course 027° : rough sea from the northwest, northwest swell of height 5 to 6 metres, pronounced rolling and pitching.
- 0400, same remarks : rolling 15 to 20°.
- 0725, containers seen to be missing, thought to have happened between 0500 and 0725.
- 0800, heavy swell from northnorthwest : rolling and pitching.

2 – from the Northwood weather centre (UK).

On 16th February, the Northwood weather services recorded depressions of 960 hPa over the north of England, generating westnorthwest winds with a fairly steep gradient. Atmospheric pressure over the southern areas of the Bay of Biscay was about 1005 hPa.

3 – from ARGOSS, a specialised company for metocean information, for an analysis of the wave fields in the area between 16th and 19th February; for the 17th this gave a significant wave height (30% of the waves) of about 6 to 7 metres, with a period of 6 seconds, from westnorthwest.

In these conditions, the highest waves (the so-called exceptional waves, representing 1% or one wave in sixty), could have reached a height of fifteen or so metres at the time of the incident.

4 – Partial conclusion :

The weather conditions, as the crew themselves remarked, were in no way exceptional for that area at that time of the year, but did lead to significant platform motion.

7 CARGO LOADING

7.1 Containers

- Containers are rectangular boxes comprising (see the annex entitled photographs):
  - 4 longitudinal side rails, with pockets in the two lower ones for handling by fork lift trucks,
  - 4 transverse cross members,
  - 4 vertical corner posts which take most of the load when the containers are stacked,
  - 8 corner castings to which the other elements are fitted and which are used for handling the containers (vertical openings), interconnecting containers (horizontal openings) and lashing them (vertical openings),
  - two longitudinal side wall panels made from corrugated steel (corrugated bulkheads), enabling them to withstand bending forces and helping to increase vertical strength between the upper and lower longitudinal rails.

- floor and roof panels,
- a double door at one end of the container.

- There are four standard container "sizes" :

  L x l x h : 20' x 8' x 8'6''

  40' x 8' x 8'6'' / 9'6''

  45' x 8' x 9'6''

  48' / 53' x 8'6'' x 9'6.5''

  The most used, especially on large container ships, are the 40 foot containers, which correspond in length to the length of one bay.

- Containers are certified and periodically inspected by approved organizations, notably the classification societies, according to the requirements of the International Convention for Safe Containers (CSC 72 as amended) :

  - Certificates attest the container's ability to withstand stresses during handling and stowage – lifting, stacking, load, racking, longitudinal stresses - as well as the rigidity of the side wall panels.
  - In theory, containers are inspected five years after their manufacturing date and every 30 months thereafter, or continuously (shipowner) or following major repairs.

- Containers are usually maintained by their owners.
  In practice, a visual inspection after stripping can lead to the container's being send to a repair yard where repairs will be carried out only after an inspection and on the basis of an estimate.

  If we leave major damage to one side, such as crushing, tearing, or other large structural deformations making it impossible for a container to be used alongside its counterparts (as would be the case, for example, when the side walls of a container had been pushed outwards by more than 5 cms – or 2.5 cms on each side), in short, any damage resulting in repair costs greater than the resale value of the container, minor damage to containers, such as welding defects, corrosion or minor denting/small holes, can often be repaired.

It is worthy of note that the insurance companies condemn the laxity of shipowners concerning maintenance and the acceptation of sub-standard containers, but show little reaction to the loss of containers carried on deck (10,000 in 2005 of the 7.9 million TEUs in use, that is, 0.006%).

One British P & I club, however, considers that in the event that container lashing is not in compliance with the cargo securing manual, the shipowner's limited liability should be waived.

It should also be stressed that monitoring of container maintenance is not strict enough and that as they are certified, it is difficult to refuse containers from another company.

7.2 Handling

Except when they are transported at ground level by fork lift trucks, in which case they are carried on forks inserted into pockets on the lower side rail, containers are handled by the corner castings :

- either by means of spreaders under gantry cranes, which is the case in all of the large terminals: the spreaders fasten themselves automatically to the four corner castings at the same time and, in most cases, automatically adjust the point of application of the load by moving the hoist to a position vertically above the container's centre of gravity which is often out of line with the geometrical centre of gravity (by at least 10% in 15% of the cases),
- or by appliances equipped with prehensile "claws",
- or even, in some "secondary" ports by hooks which cause more wear and tear than the other systems and can knock the corner castings out of shape.

7.3 Loading

Containers are stowed according to their destinations and, in theory, their mass which is known officially only from the declaration made by the shipper.

Now, it would appear that many containers are over-weight (18% of them by more than 6 tonnes ...) and this has consequences on the vessel's stability, on the resistance of the containers stowed under them and on the acceleration forces when they are stowed at the top of the stack.

The gantry crane operator is the only person who knows the real weight, but he has no means of making this information available, and, in any case, is not aware of the declared weight.

The containers are stowed in the holds, generally by means of cell guide rails, and then on deck.

On deck, they are placed one above the other in stacks, the weight of each stack being so limited so that it can withstand maximum vertical acceleration forces of 1.8g.

On the *OTELLO* the containers were stacked seven high on the hatch covers, and directly on the deck for the first two bays right forward.

With a full load, more containers are carried on deck than in the holds, for reasons of tonnage, and therefore taxes (as far the *OTELLO* was concerned, the carrying capacity for containers in the holds and on deck was 3835 and 4403 respectively).

Loading is monitored by computer by the ship-planner and must be approved and checked by the chief officer using the information he is given, often at the last minute.

7.4 Securing

The manner for securing containers is set out in the cargo securing manual, which is tailored to meet the specific needs of the ship, gives detailed instructions and must be approved.

Securing containers for carriage on deck is based on :

- locking containers on the deck fittings and interconnecting them (twistlocks),
- a system of lashing bars which only concerns the first three tiers.

7.4.1 Locking (see sketch in annex entitled "Securing")

a) - The first tier of containers is locked on to the stacking cones which are welded on the hatchcovers or on the deck right forward, by means of manual twistlocks the locked position of which is usually indicated by the position of the yellow lever to the left and can therefore be verified.

But there are also right-locking twistlocks, available on request, as indicated in the manual.

b) - At the time of the incident, the other tiers on the *OTELLO* were all secured by automatic twistlocks (FAT) inserted into the corner castings of the container to be loaded with the locking cones then being inserted into the corner castings of the container which is already on board on to which they lock when the chamfered part is fully engaged (see annex).

The advantage of this system is that it requires no intervention from stevedoring personnel which increases safety, as well as reducing handling time and costs.

It does, however, have several disadvantages: among these, as for all locks, can be listed wear, strain, distorsion or even cracks leading to ever-increasing play to which can be added the wearing down of the corner castings. The upshot is that twistlocks can work loose and their play is likely to be increased to a dangerous extent by the platform motions of the vessel, by rolling and pitching (especially if they alternate) or by slamming of the vessel, all of which may lead to the twistlock breaking, especially under the effect of transverse accelerations.

It should be borne in mind that :

- once they are in position, these twistlocks cannot be seen and it is impossible to verify if they are open or locked,
- FAT twistlocks often fall due to faulty installation by stevedores.

Finally, discharging the containers is also automatic. It has been noticed that a tractive force on the spreader barely greater than that required to lift the container is sufficient to disengage the "chamfered part". The same effect could therefore be produced under the effect of transverse accelerations or even vibrations which are more marked at the stern of a container ship due to the wide, flat transom stern, with the result that FATs could work free. Thus open twistlocks have often been observed when containers are lifted.

Following Paris Memorandum of Understanding inspections, FAT in general are found to be in a rather poor condition.

7.4.2 Lashing (see annex)

Strictly speaking lashing concerns only the first three tiers of containers (the four others are fixed to this "base" only by means of FAT).

The system comprises lashing bars which are attached to D-rings welded on to the hatch covers or deck and which are fitted with turnbuckle type screw fittings into one end of which a bar of the requisite length fitted with tightening nuts is inserted and at the other end of which can be found an ad hoc fitting which is inserted into the corner casting (vertical opening).

The tension of the lashing bars is adjusted by the turnbuckles and these are the elements which are checked and retightened, if necessary, at sea.

It is worth remembering that this somewhat rudimentary system is subjected to severe stresses, especially when the bars work loose in bad weather which is precisely when it is not possible to retighten them. This can result in breakages, which can also be the result of strain, or of defects in the metal of the bars themselves.

It is also worth bearing in mind that for a ship like the *OTELLO*, it takes four or five men half a day to retighten all the lashings.

As the lashing was carried out by stevedores, it can reasonably be assumed that the crew, who are responsible for checking them, did not have time to verify the lashings between the end of loading and the time the vessel set sail.

Paris MOU inspections show that, in 10% of cases, the lashing does not comply with the cargo securing manual and that, in 30% of cases, the equipment is considered to be of only average or poor quality.

7.5 Initial stability

The vessel's initial stability as well as the loading plan from which it is calculated must be checked and approved by the Chief mate.

To this end, the loading plan, drawn up ashore, is sent to the Chief mate who enters the data into the ship's loading computer. In the event of faulty weight distribution likely to jeopardize the vessel's stability, an alarm sounds. Once again it is the "official" weight of the container/containers which is taken into account and not their actual weight if they are over-weight.

Also worthy of note is the fact that the fluid GM varies considerably according to the position of the hull on the swell.

While this can be calculated using the draught measurements after loading, and while flagrant errors in weight and cargo distribution (especially dangerous cargo) brought to light by the loading plan can be rectified, the true weight of the over-weight containers remains a mystery.

8 POSSIBLE CAUSES FOR THE LOSS OF CONTAINERS CARRIED ON DECK

8.1 Platform motions

8.1.1 "Normal" motions

All ships, including the largest, are subjected to platform motions due to the weather conditions: wind, wind waves, swell, cross seas/swell, abnormal waves, to say nothing of rogue waves, all give rise to rolling and pitching motions, amongst others. These can be simple or combined with each other and set up stresses in the ship beam, notably in flexion and/or torsion, as well as movements of the hatch covers to which the containers are fixed.

This is particularly noticeable on large container ships on which the surface of the containers can be seen from the bridge to "undulate and ripple", to such an extent that the master of one container ship said that in heavy weather he "wondered whether the bow and stern of the vessel were still joined together". Another observed that, with zero list at the bridge, there was a permanent difference of 10 cms between the port and starboard draughts amidships.

It is sometimes possible to reduce the forces to which the vessel is subjected :

- by adapting the vessel's course to the prevailing conditions, on condition that such "pitfalls" as parametric rolling (see below) are avoided,
- by reducing speed ... while still keeping to schedule.

8.1.2 "Special" motions

These motions are closely linked to the hull forms of container ships.

Indeed, due to the way in which they are operated, that is :

- the requirement to carry a maximum number of containers which must be correctly stowed with minimum handling time,
- the necessity of providing a fast, regular service.

container ship hull forms have their own particular characteristics, viz :

- a long bow section with fine lines below the waterline (hydrodynamic) and a pronounced flare above the waterline giving a wide deck area in the upper part of the deadworks,
- a more traditional midships section with a vertical side shell but only over a fairly short length,
- a practically flat underside to the transom stern enabling a large diameter propeller (9 metres in the event) to operate with sufficient clearance under the ship's stern counter without increasing the draught aft.

These design characteristics have consequences, in particular, on the ship's stability, on roll conditions and, in some cases, on seakeeping.

a) Stability

Because of their particular hull forms, these ships experience considerable variations in stability, as demonstrated by fluctuations in their GM.

Indeed, as the vessel moves through waves or swell, the wetted surface of the hull varies considerably according to their length and period.

It is smallest when the hull is supported on the crest of a wave amidships and greatest in the opposite situation.

The GM can therefore vary considerably and rapidly thereby generating a very jerky rolling motion. This phenomenon has also been observed to increase due to a vessel taking on ballast (too) quickly because the minimum value of its GM appears to be too small. Generally speaking such platform motions are little suited to the carriage of cargo on deck.

b) Synchronous rolling

Synchronous rolling occurs when the natural rolling period of a ship coincides with the encounter wave period.

This phenomenon usually occurs in quartering seas, which was not the case for the *OTELLO.*

c) Parametric rolling

Parametric rolling is inherent in the design of container ships and the variations of stability described above. It occurs most frequently when the ship is in head seas approaching within an envelope of 30° either side of the bow with a wavelength similar to ship's length, which was not the case for the *OTELLO*. This can cause the ship to take on a series of large, brutal rolls (in the region of 30°) and even result in the ship's falling off her course by 30°, giving the impression of being out of control (which, in fact, proved to be more than an impression for one container ship caught in a similar situation).

It should also be noted that such abnormal behaviour can occur with the vessel hove to, in heavy weather.

8.1.3 The case of the *OTELLO*

The platform motions of the *OTELLO*, however pronounced they may have been, seem to belong to the gamut of the "normal" motions described in § 8.1.1, but were "unusual" in that there was a series of pronounced pitching motions followed by a series of pronounced rolls.

They nonetheless contributed to the loss of the containers. The pitching undoubtedly caused damage to the deck cargo lashing and securing systems, which was further amplified by the subsequent rolling – reaching at least 20° - causing several seriously weakened container stacks to topple over.

8.2 Deck cargo

8.2.1 Stack height

For 8000 TEU container ships stack height has increased from three or four tiers to seven. This has obviously increased the load on the intermediate containers and led to changes in the way containers are lashed on deck. (see below).

8.2.2 Accelerations

Consequently, greater accelerations, especially transverse accelerations, will be experienced by the containers at the top of the stack which, under the effects of the wind and the rolling motion, will generate :

- compression forces on the lower containers on the side to which the ship is listing causing their sides to bulge outwards, and leading to deformation and buckling of the corner posts ...
- tension forces on the twistlocks on the other side. This tensile force will be similar to or even greater than that exerted by the spreaders when they unload a container which is theoretically firmly attached to the one immediately below it.
- These accelerations can be amplified if the cargo within a container is not secured or inadequately so.

8.2.3 "A certain number" of over-weight containers

Experience has shown that the weight of many containers is in excess of the weight declared by the shipper (18% of them exceed the declared weight by more than 6 tons).

Only the people who load the containers, especially on ships, really know the exact weight of the containers but they are unaware of the declared weight and are therefore unable to point out any discrepancies. As for the "ship planners", it would seem that they only work from the declared weights.

It is to be noted that at some terminals containers loaded with the same product are arbitrarily estimated as having the same weight however the product is packaged.

The consequences of all this include :

- the possibility of excess weight at the top of the stacks with the previously mentioned consequences as far as forces and accelerations are concerned, not to mention stability,
- the possibility of setting up shearing stresses which may damage the vessel's structure (fissures, cracks),
- the possibility of lashing failures.

We again emphasize that when the damaged containers which had remained on board after breaking loose were unloaded for inspection, they could have been weighed, thereby enabling their actual weights to be compared to their declared weights.

8.2.4 Poorly balanced stowage

As has been explained previously (§ 7), there are several standard sizes for containers. Thus the bays can accommodate two 20' containers or one 40' container.

In practice, it is possible to :

- stow two 20' containers on a 40' container, even though this is apparently unusual, in which case the two 20' containers can only be secured at one end, the weight of their two other ends, moreover, being borne by the middle section of the 40' container's top side rails,
- stack containers having the same length but of different heights,
- stow 45' containers on 40' containers placed higher than the lashing bars, which means that, unless we are dealing with jumboized 40' containers, they can only be secured to those ends of the 40' containers flush with their own ends.

It is to be noted that the use of 45' containers is becoming more widespread as this length corresponds to the length of HGV trailers, a tendency which means an increase in the length of rail wagons from 80' to 90' is also being considered.

8.2.5 Lashing

The lashing system, for its part, suffers, more or less directly, the consequences of the movements of the deck cargo.

a) Lashing bars

If the *OTELLO'S* lashing bars had worked loose and it was not possible to retighten them due to the heavy weather, they may well have broken due to a tractile force, causing a stack of containers to topple over. They were sent to the manufacturer for analysis as soon as the vessel berthed in Le Havre and it was not possible to examine them.

b) Twistlocks

- The twistlocks used on board the *OTELLO* for the stowage of the containers in the bays which suffered damage were fully automatic twistlocks (FAT), enabling loading and discharging to be effected by spreaders alone (for details of how they work see the annex entitled "Lashing").
- The annotated photographs in the annex entitled "Photographs" show a number of malfunctions, especially as far as these FATs are concerned :

1- A FAT has come out of the corner casting of the lower container,

2- A FAT has come out of the corner casting of the upper container (more unusual),

3- A FAT has come out of the corner casting of the lower container but its chamfered part (on the side opposite the so-called red nose) seems to be deformed / worn,

4 and 5- same remarks as above,

5- worn corner casting,

6- corner casting without FAT,

7- buckled corner post (weight, acceleration ...) and 45' container "out of line",

8- corner castings with and without FATs,

9- misaligned 45' container.

9 CONCLUSIONS

Container losses may be due, wholly or in part, to the causes mentioned in this chapter.

However, as far as the *OTELLO'S* containers are concerned, the main cause would certainly seem to incriminate the automatic twistlocks (FATs) :

- either because they were missing,
- or because the fact that they had come out of the corner fittings - as they were worn and eroded the low acceleration forces generated by the vessel's pitching could have been sufficient to make them slip out of the corner castings - was conducive to certain stacks toppling over in the event of heavy rolling.

10 ACTION TAKEN, ESPECIALLY BY THE VESSEL’S OWNERS

10.1 Replacement of the twistlocks of the aft deck load

- To begin with, the owners decreased the stack height to four containers for the aft deck load,
- they then reverted to seven-high stacks after replacing the automatic twistlocks (FAT) by semi-automatic twistlocks (SAT – see annex entitled “Lashing”). Securing the containers is now carried out in the following manner :
    - using manual twistlocks to secure the base tier on the stacking cones. They are locked by pushing a yellow lever to the left, which means that it can be seen at a glance whether they are locked or not. Unfortunately the documents concerning this type of twistlock mention that, on request, they can be supplied with the locked position to the right …
    - using semi-automatic twistlocks (SAT), which are in fact manual twistlocks, for the other containers. They are fixed manually to the bottom corner castings of the containers to be loaded and, once loaded, secured manually to the containers underneath.

Discounting human error and any play which may exist between the various elements, it is thus possible to make sure that the containers are firmly interconnected - which was not the case with the FAT the main function of which was, in fact, to prevent the containers from shifting.

10.2 Lashings

Even before the incidents, the *OTELLO'S* owners had taken the initiative of adding a lashing bar from the bottom inboard corner casing of the outboard base tier to the bottom outboard corner casing in tier four (see annex entitled "Lashing").

10.3 Surveys

The owners had two surveys carried out :

- the first one concerned the securing equipment, lashing bars and twistlocks. As far as the twistlocks were concerned, one of the surveys called the design of the automatic twistlocks (FAT) into question,
- The other one concerned the containers it had been possible to "recover". The *BEA*mer had asked if it was possible to be informed of their mass and, if so, to compare the figures with those of the loading plan.

10.4 Studies

- The owners had two studies carried out on stowage and parametric rolling.
- Moreover, they are also participating in a specialized working group : the Lashing@sea project (2006).
    - Objectives : lashing procedures and incidents, loading, loading systems, recommendations.
    - Accidents, statistics.
    - Participants in this Joint Industry Project : shipowners, suppliers, classification societies, insurance companies, ship management

companies, governments, the Dutch laboratory MARIN (Maritime Research Institute Netherlands).

- Vessels concerned : two large container ships, one heavy lift ship, two ROROs and a coastal feeder vessel.
- The topics studied, apart from the actual lashing procedures themselves, notably the use of automatic twistlocks (FAT) (play, vibrations), include platform motions: rolling, pitching, slamming, hogging, sagging, torsion and movement of hatch covers.
- Accelerations on containers as a result of these movements and the effect of wind.

The results of this study should be known in 2008 but will apparently not be published for a further two years after that date.

10.5 Expert systems

The owners have had equipment installed on one of *OTELLO'S* sister ships with a view to warning those running the ship when the vessel is likely to behave in a particular way, involving especially increasing the risk of losing containers overboard.

10.6 Stability

This company's ship planner has stability software at his disposal concerning the ship which enables him to follow the effects of loading the ship on her stability.

10.7 Other information

It should be noted that :

- the IMO has issued instructions to masters indicating how they should act to avoid parametric rolling.
- the ABS has published a document on this phenomenon.

11 RECOMMENDATIONS

The present document based on the loss of containers overboard from the *CMA CGM OTELLO,* constitutes in fact a study of this type of incident on this type of vessel.

As a result the various recommendations it makes, whether they concern technical matters, statutory rules or legal aspects, are intended for several organizations or entities, as, first and foremost, it is important that actions already undertaken should be followed through to a conclusion and their findings made known as soon as possible.

The case of vessels transporting containers between sea ports and inland ports should also be taken into account as a number of them have been the victims of serious incidents.

Although the following recommendations are mainly aimed at actors in the maritime industry the *BEA*mer considers that all the actors in the chain of container transport may have to become involved in order for them to be applied.

11.1 Technical recommendations

11.1.1 As the hull forms of container ships make them susceptible to erratic behaviour, it would be advisable to examine how they might be modified.

11.1.2 Failing this, or in addition, it would be advisable to provide them with stabilizer systems, preferably passive ones capable of acting at slow speeds.

11.1.3 Taking all this into account and bearing in mind just how difficult it is to make a realistic appraisal of the state of the sea or the behavior of a ship from a closed bridge situated close to the stern of bigger and bigger, higher and higher ships, it would also be advisable to provide such ships with expert systems which :

- take account of what is really happening outside the ship, especially in so far as weather conditions are concerned (wind direction and force, wind waves, cross seas, swell(s), height(s), period(s) … and so on),

- analyse the behaviour of the ship platform (strain gauges, accelerometers, inertial measurement units, GPS, variations in GM etc.),
- analyse these data and compare them with “models”,
- and offer one or several solutions to assist the master in making his decisions.

11.1.4 These “intelligent” systems should not restrict themselves to the most characteristic behavioural problems of container ships (as it happens), but should also provide a follow-up to, record and even count the occurrences of the numerous stresses to which the ship is subjected.

11.1.5 Advantage should be taken of any incident of this type :

- To weigh the containers and compare their weights with the declared weights,
- To open the containers and compare their contents with those declared in the bill of lading, especially if dangerous goods are involved.

These recommendations are meant more particularly for :

- shipbuilders,
- classification societies,
- shipowners and the organizations which represent them,
- shippers and insurance brokers.

11.1.6 In accordance with the observations of the previously-mentioned British P & I Club, it would be advisable to improve the training of sea-going personnel in these areas.

11.2 Regulatory recommendations

11.2.1 These expert systems should become mandatory in the international rules of the IMO (SOLAS) for all vessels of this type at least, in order to increase the safety of these vessels which have already suffered damage in several accidents (fissures, cracks…) and to avoid confusion between users.

11.2.2 Henceforth, the structural evolution and protection and maintenance of the "double hulls" of these still relatively new ships should be closely monitored.

11.2.3 An amendment of the 1969 IMO Convention on Tonnage Measurement should be considered, by which hold capacity would be increased and, de facto, the number of containers carried on deck decreased.

These recommendations are meant more particularly for :

- International (IMO) and European (EMSA) organizations,
- shipbuilders,
- classification societies,
- shipowners and the organizations which represent them.

11.2.4 Emergency response system contracts between shipowners and the vessel's classification society should be developed and possibly made mandatory for larger container ships.

11.3 Legal recommendations

The notion of the crew's responsibility should be reconsidered concerning :

- acceptation of the loading plan which they only become completely aware of, as far as weights and stowage are concerned, after it has been carried out.
- checking lashing arrangements before the ship sets sail, which is usually immediately after loading has been completed.

This recommendation is meant more particularly for :

- IMO (Legal committee),
- shipowners and the organizations which represent them,
- professional seafarers' organizations.

LIST OF ANNEXES

Annex A

Decision to hold an enquiry

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Bureau d'enquêtes sur
les événements de mer

Paris, le 03 AVR. 2006
N/réf. : *BEA*mer/IGSAM/MTETM

000065

DÉCISION

Le directeur du Bureau d'enquêtes sur les événements de mer ;

VU la loi n°2002-3 du 3 janvier 2002 relative aux enquêtes techniques après événements de mer ;

VU le décret n° 2004-85 du 26 janvier 2004 relatif aux enquêtes techniques après événement de mer, accident ou incident de transport terrestre ;

VU l'arrêté ministériel du 17 février 2004 portant nomination du Directeur du Bureau d'enquêtes sur les événements de mer ;

VU l'arrêté ministériel du 18 Juillet 2005 portant délégation de signature au Directeur du Bureau d'enquêtes sur les événements de mer ;

VU le compte-rendu d'événement de mer établi le 20 02 2006 par le centre de sécurité des navires du HAVRE

CONSIDERANT les échanges entre le Bureau d'enquêtes sur les événements de mer, le « Maritime Accidents Investigation Branch » (Royaume UNI) et le Bahamas Maritime Authority » (Iles Bahamas) sur des accidents similaires.

DÉCIDE

Article 1 : En application de l'article 14 de la loi sus-visée, une enquête technique est ouverte concernant la perte, survenue le 17 février 2006 dans le Golfe de Gascogne, de 50 conteneurs par le navire *CMA CGM OTHELLO* immatriculé à Port aux Français sous le N° FK 924659 pavillon français.

Article 2 : Elle aura pour but de rechercher les causes et de tirer les enseignements que ces événements comportent pour la sécurité maritime, et sera menée dans le respect des textes applicables, notamment le titre III de la loi sus-visée et la résolution A.849 (20) de l'Organisation Maritime Internationale.

Ministère des Transports,
de l'Equipement,
du Tourisme
et de la Mer

*BEA*mer

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92055 LA DEFENSE CEDEX
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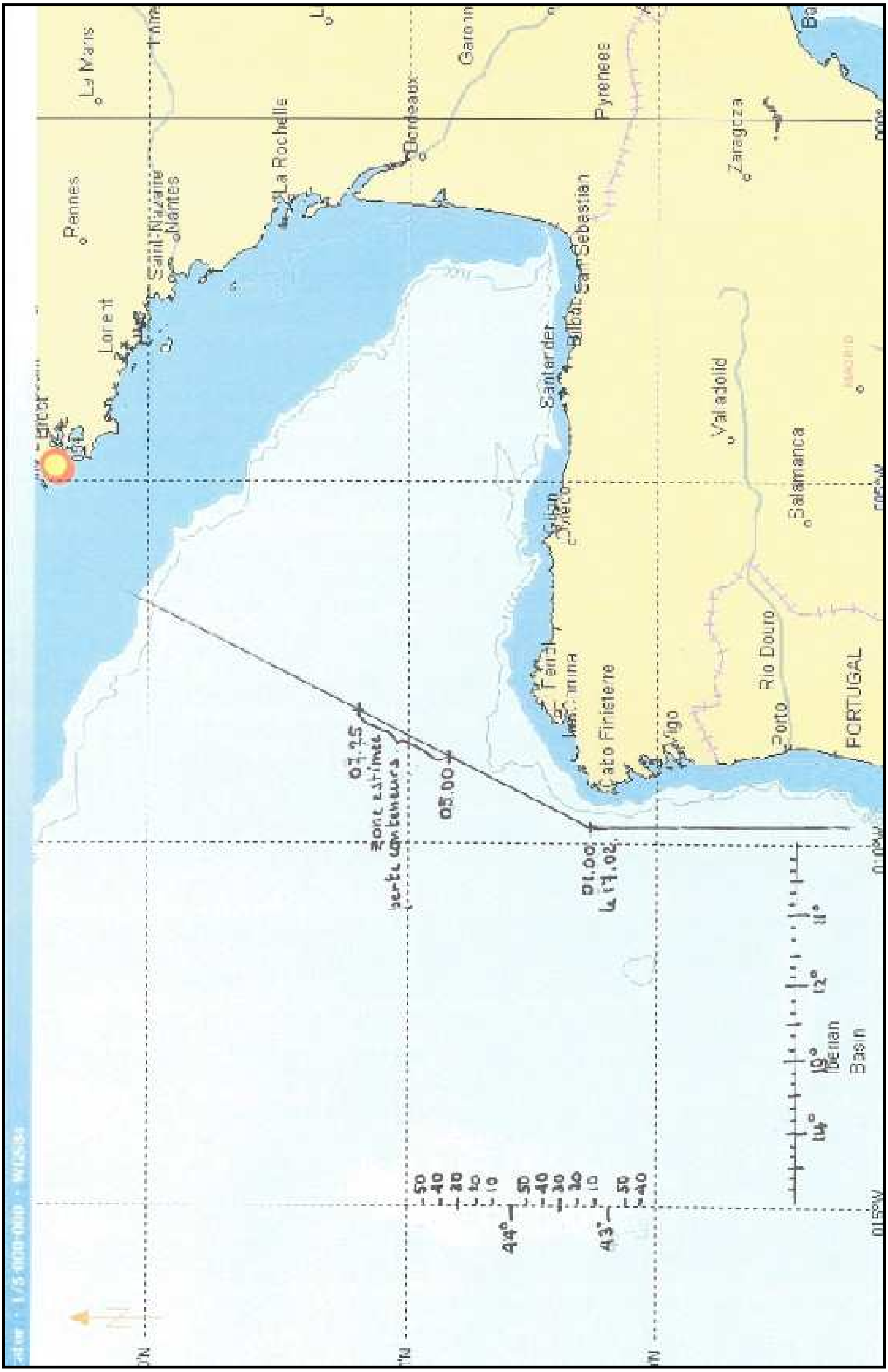
Bea-Mer@equipement.gouv.fr

L'administrateur Général des affaires maritimes
Jean-Marc SCHINDLER

Annex B

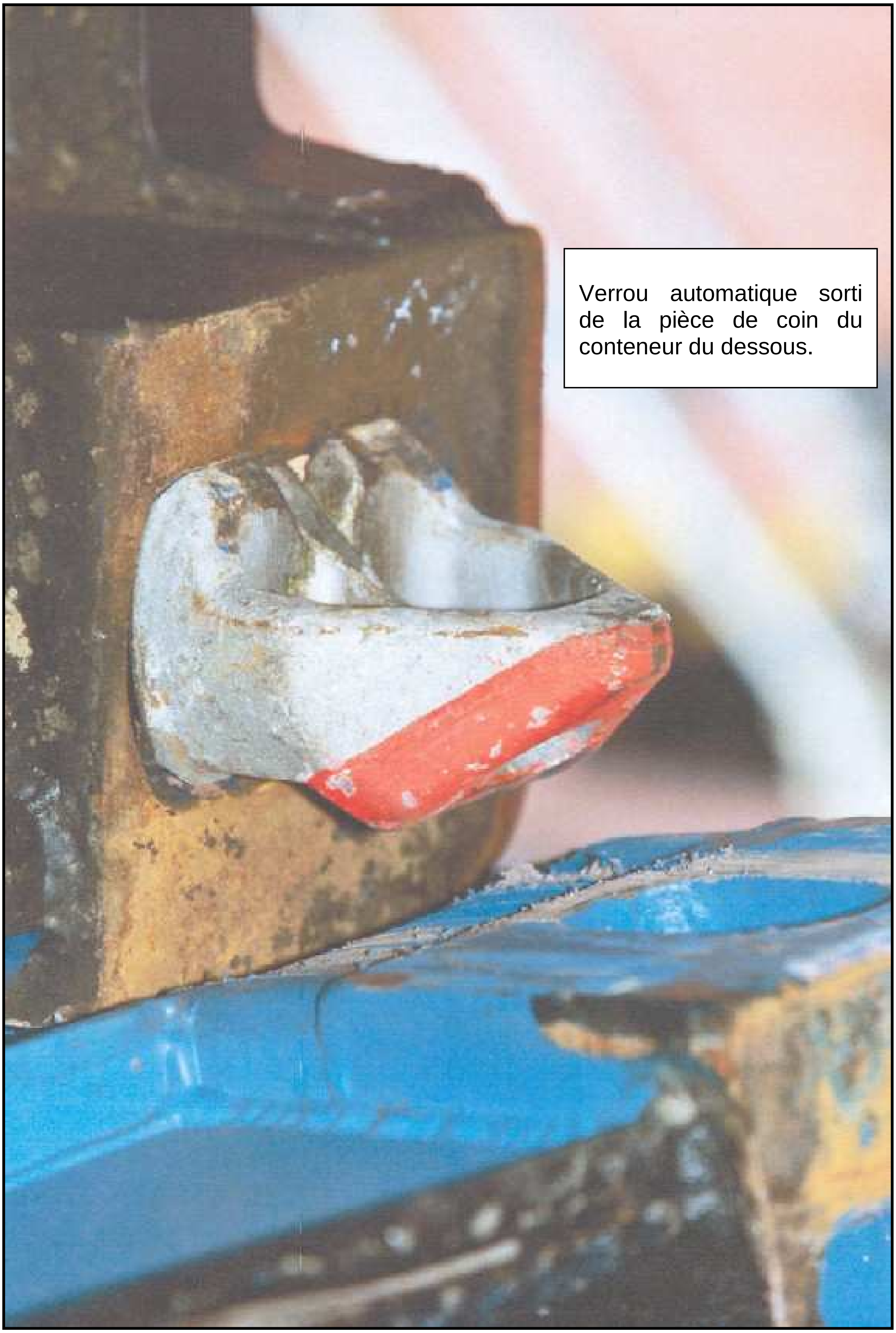
Charts



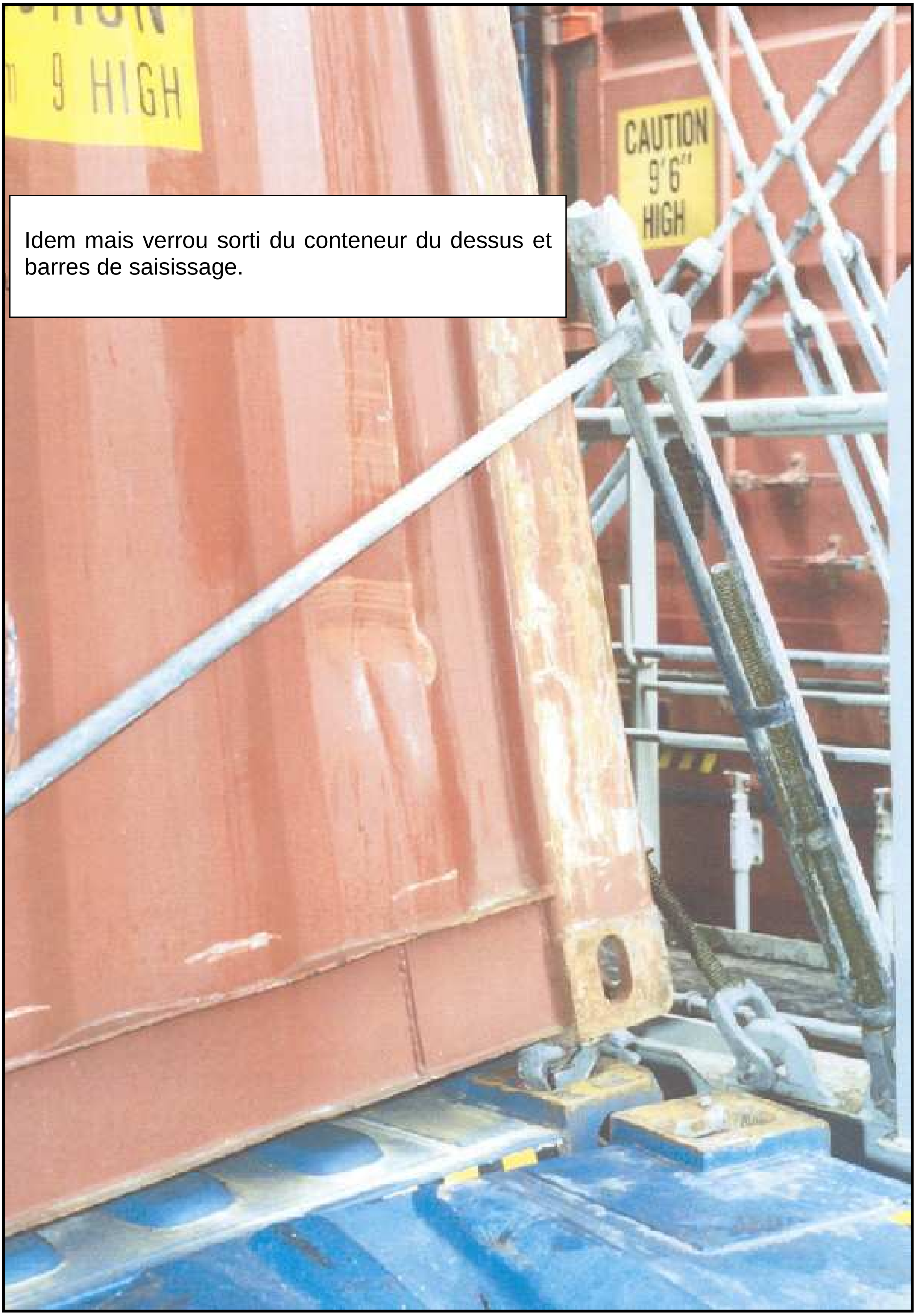
Le Mans
Rennes
Lorient
Saint-Nazaire
Nantes
La Rochelle
Bordeaux
Pyrenees
San Sebastian
Bilbao
Santander
Gijon
Oviedo
Cabo Finisterre
Vigo
Porto
Rio Douro
PORTUGAL
Valladolid
Salamanca
Zaragoza
Iberian
Basin
07.15
zone estimée
perte conteneurs
05.00
01.00
le 17.02
44°
43°
14°
12°
11°
10°

Annex C

Photographs



Verrou automatique sorti de la pièce de coin du conteneur du dessous.



Idem mais verrou sorti du conteneur du dessus et barres de saisissage.

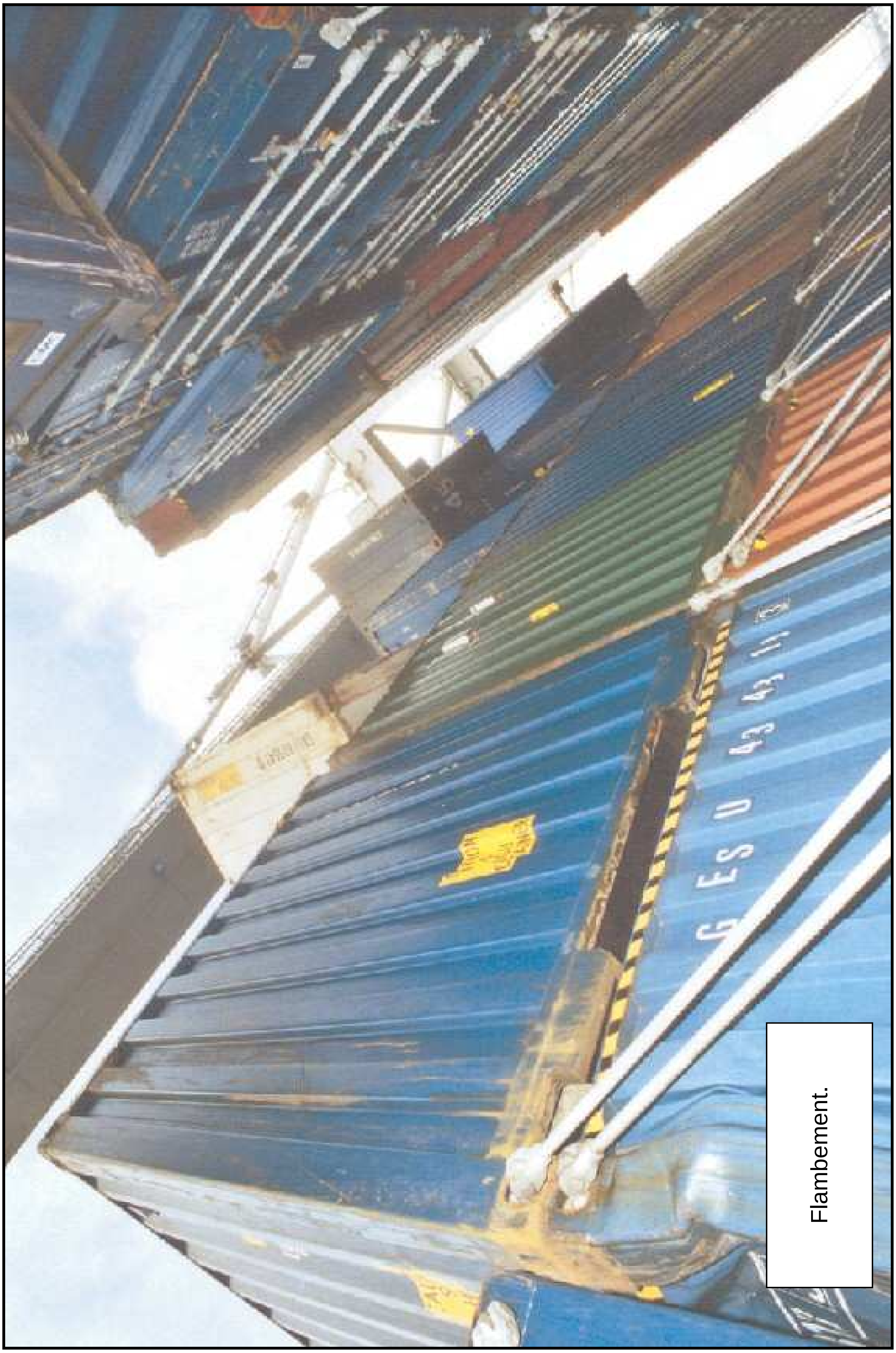
Verrou automatique sorti de la pièce de coin du conteneur inférieur et dont la partie biseautée paraît usée.

On voit à l'intérieur le levier de verrouillage sur la pièce de coin du conteneur supérieur.


Identique à la page précédente.
953996

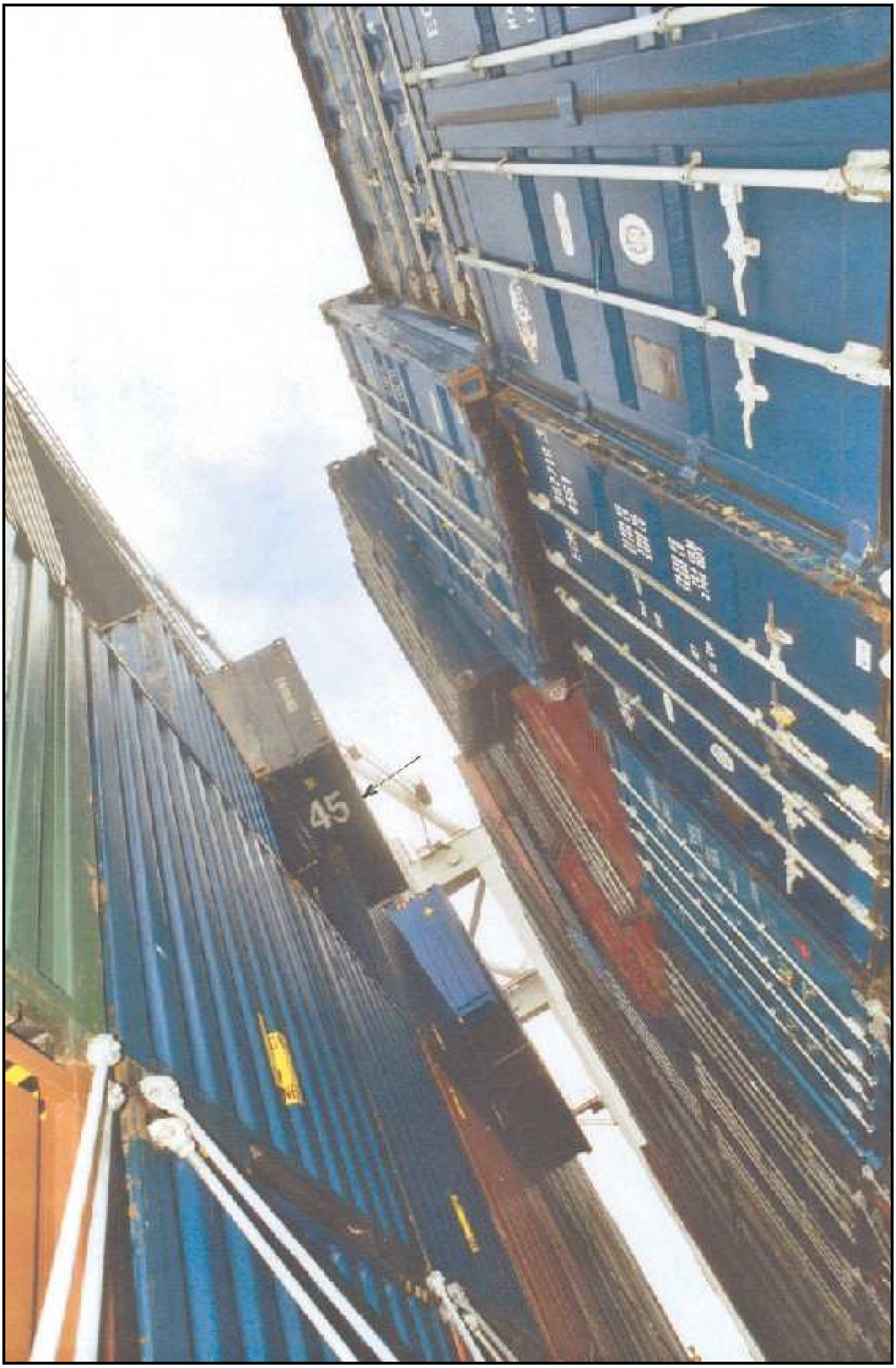
Pièce de coin érodée.


Pièce de coin sans verrou.



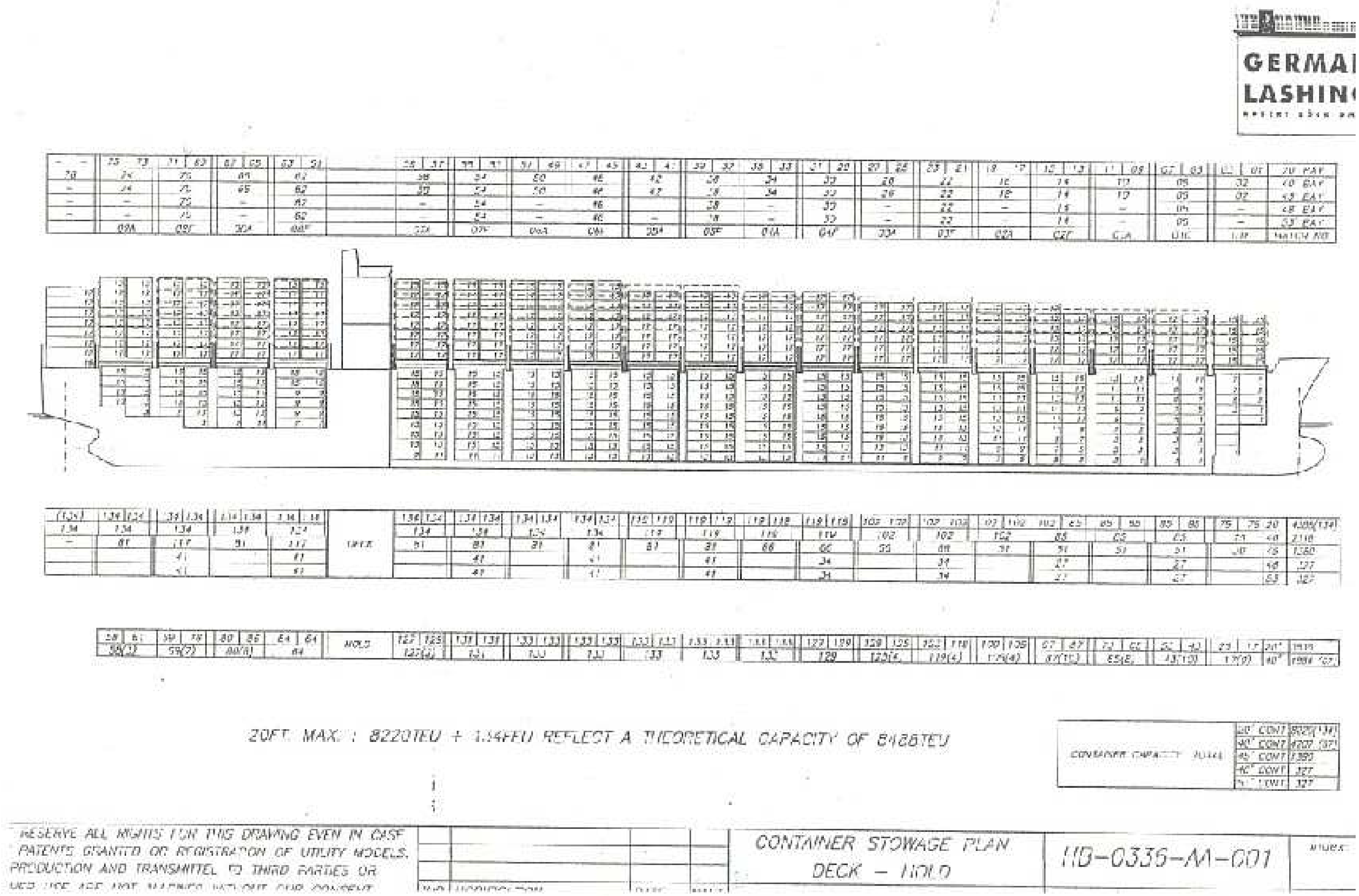
Flambement.

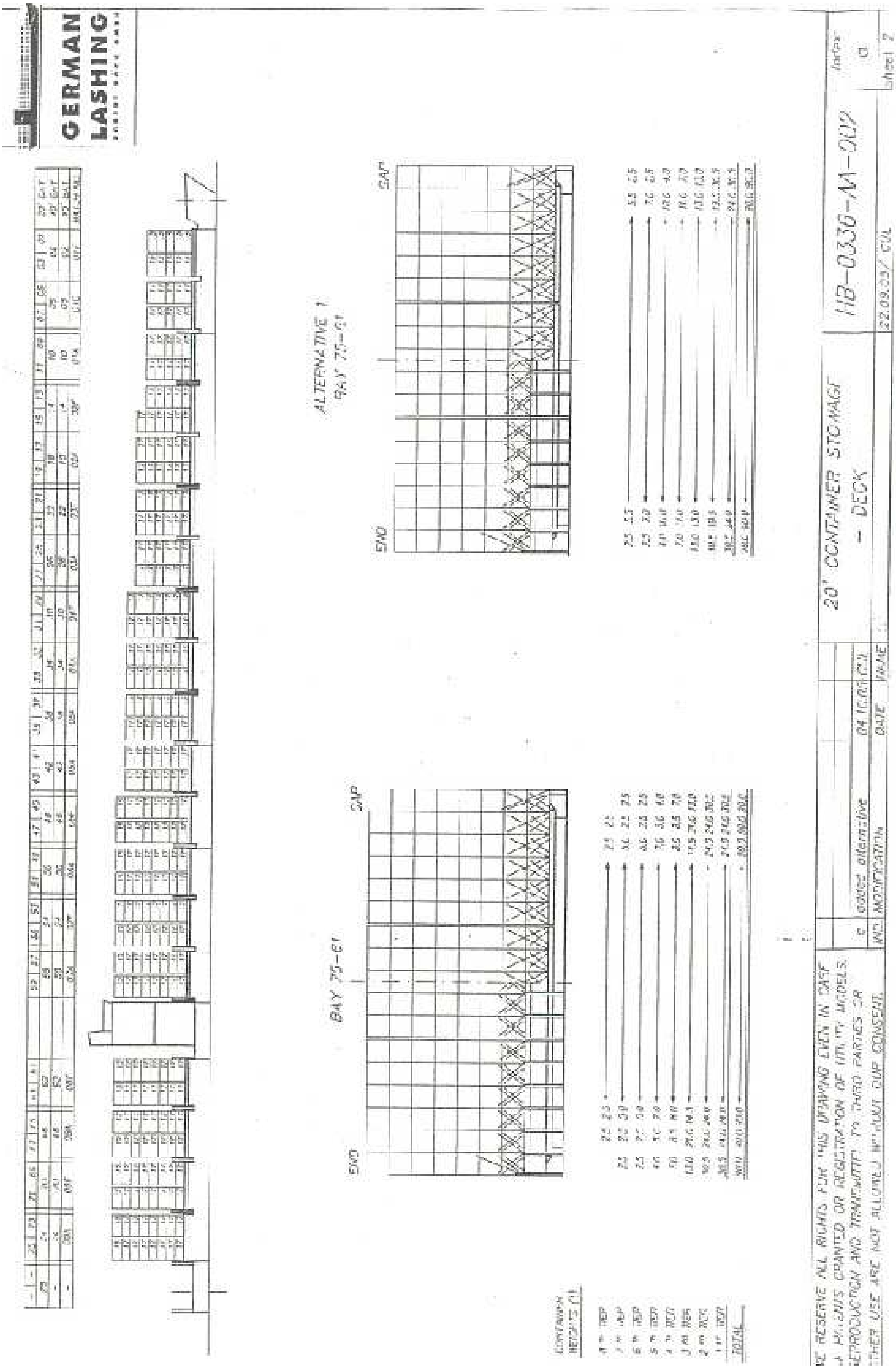
Pièces de coin avec et sans TA.



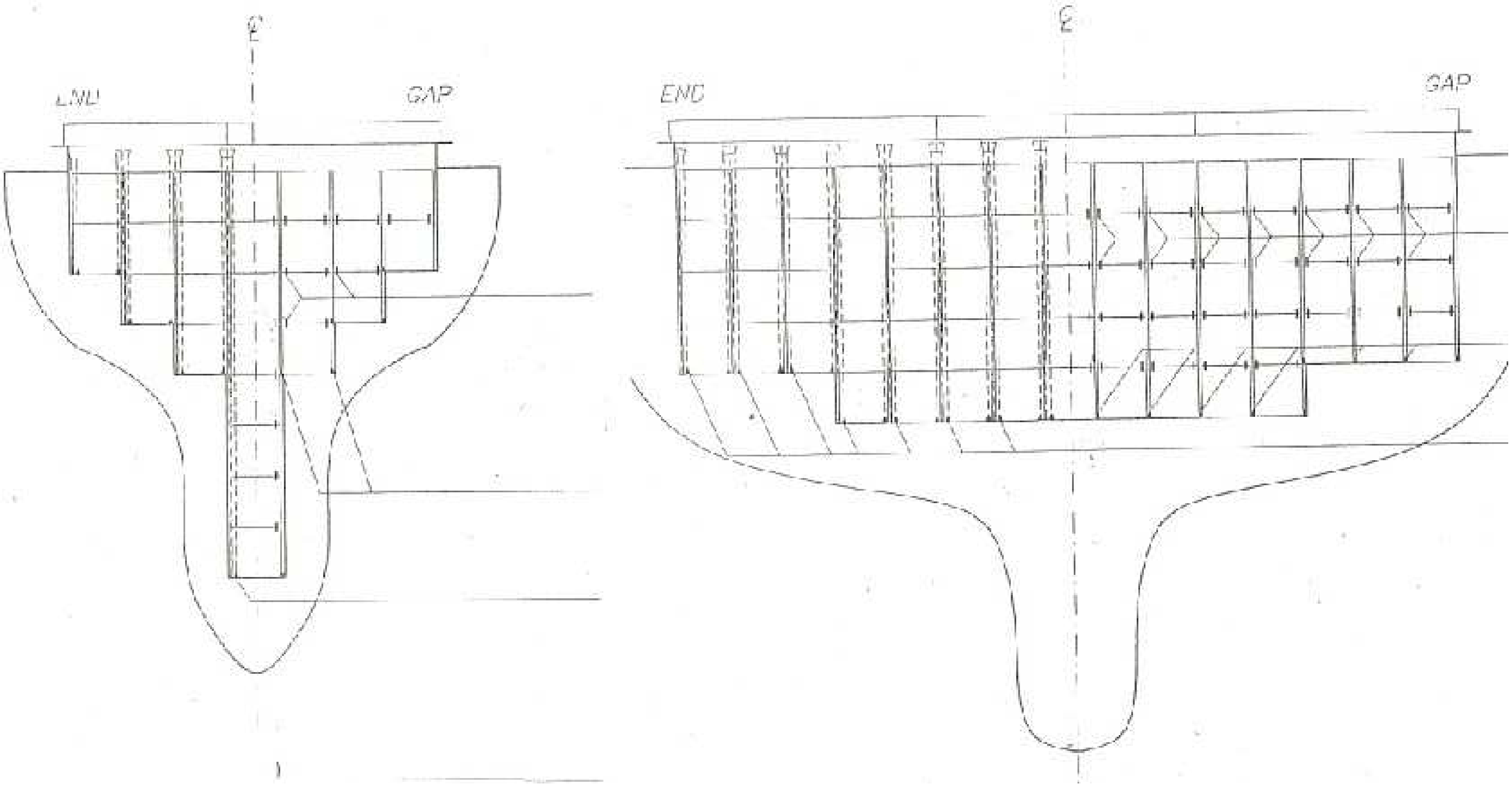
Annex D

Loading


GERMAN
LASHING
20FT MAX. : 8220TEU + 134FEU REFLECT A THEORETICAL CAPACITY OF 8488TEU
CONTAINER CAPACITY TOTAL
RESERVE ALL RIGHTS FOR THIS DRAWING EVEN IN CASE PATENTS GRANTED OR REGISTRATION OF UTILITY MODELS. PRODUCTION AND TRANSMITTEL TO THIRD PARTIES OR
CONTAINER STOWAGE PLAN
DECK - HOLD
HD-0335-M-001


GERMAN LASHING
BAY 75-81
ALTERNATIVE 1
BAY 75-81
END
GAP
20' CONTAINER STOWAGE
– DECK
HB-0330-AA-002
22.09.03/ CUL
Sheet 2

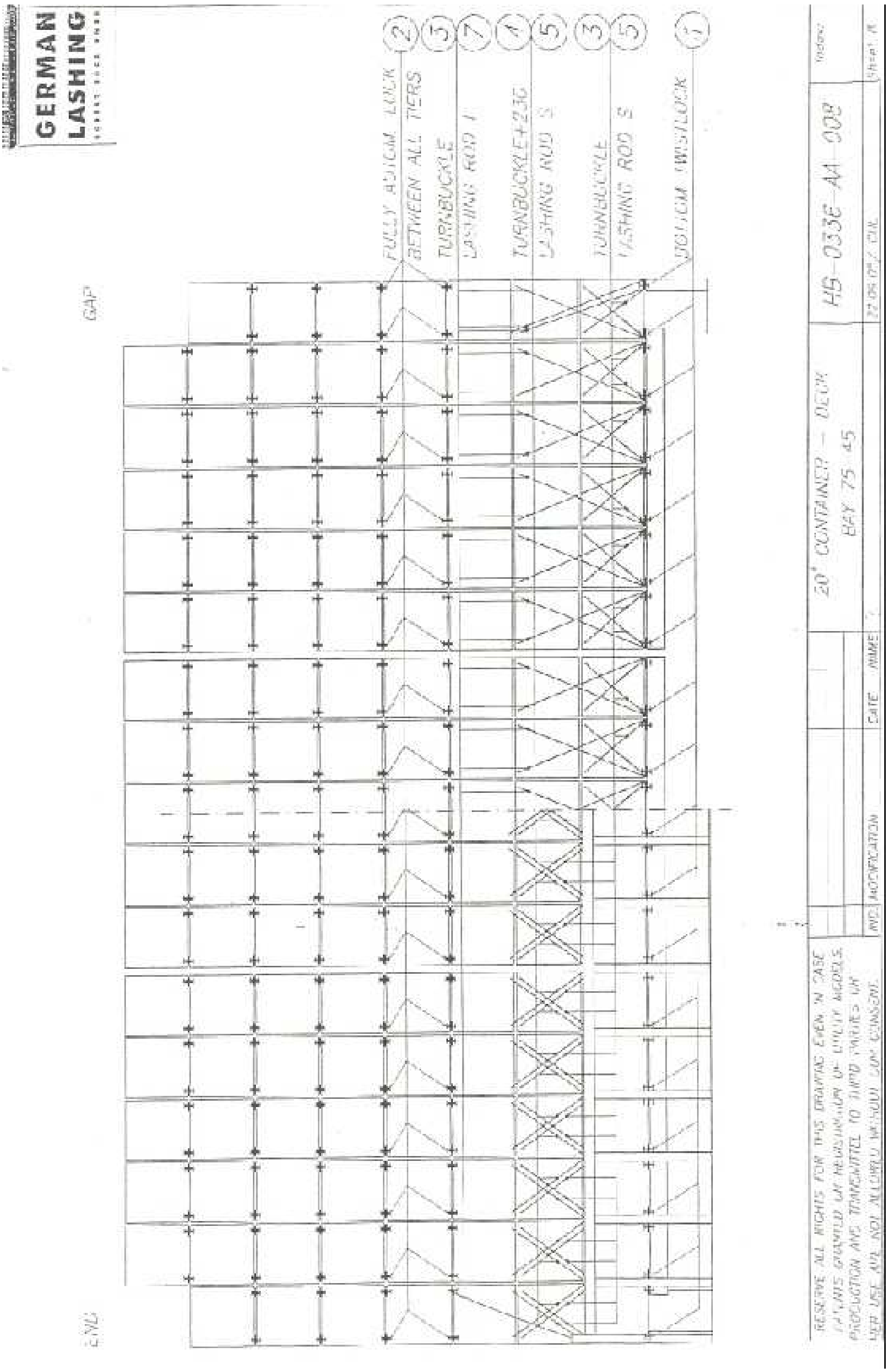
Chargement dans les cales avant et arrière permettant d'apprécier les formes de carène.



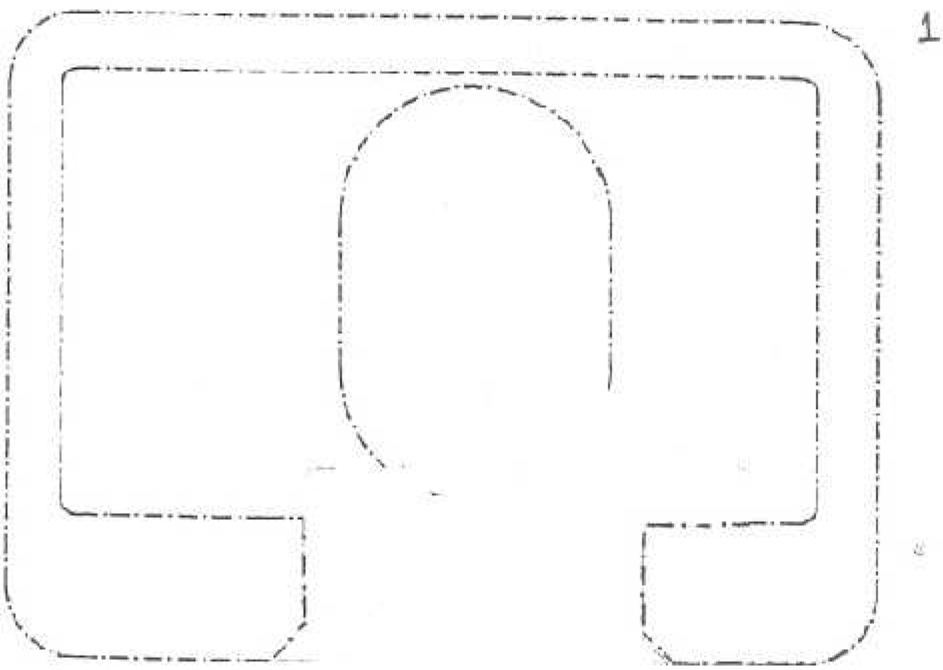
Annex E

Lashing

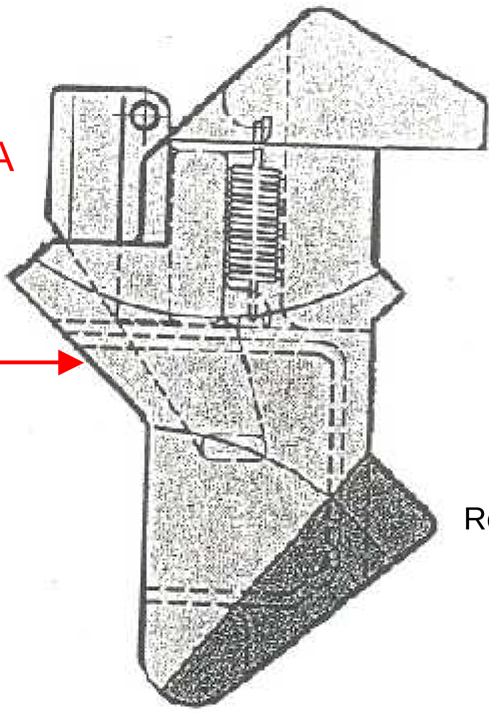
Avant	**TA**
Après	**SA**


GERMAN
LASHING
GAP
FULLY AUTOM. LOCK
BETWEEN ALL TIERS
TURNBUCKLE
LASHING ROD
TURNBUCKLE+230
LASHING ROD S
TURNBUCKLE
LASHING ROD S
20' CONTAINER - DECK
BAY 75 45
HS-0336-AA-008
DATE
NAME
MODIFICATION

Pièce de coin
du conteneur
supérieur.



A



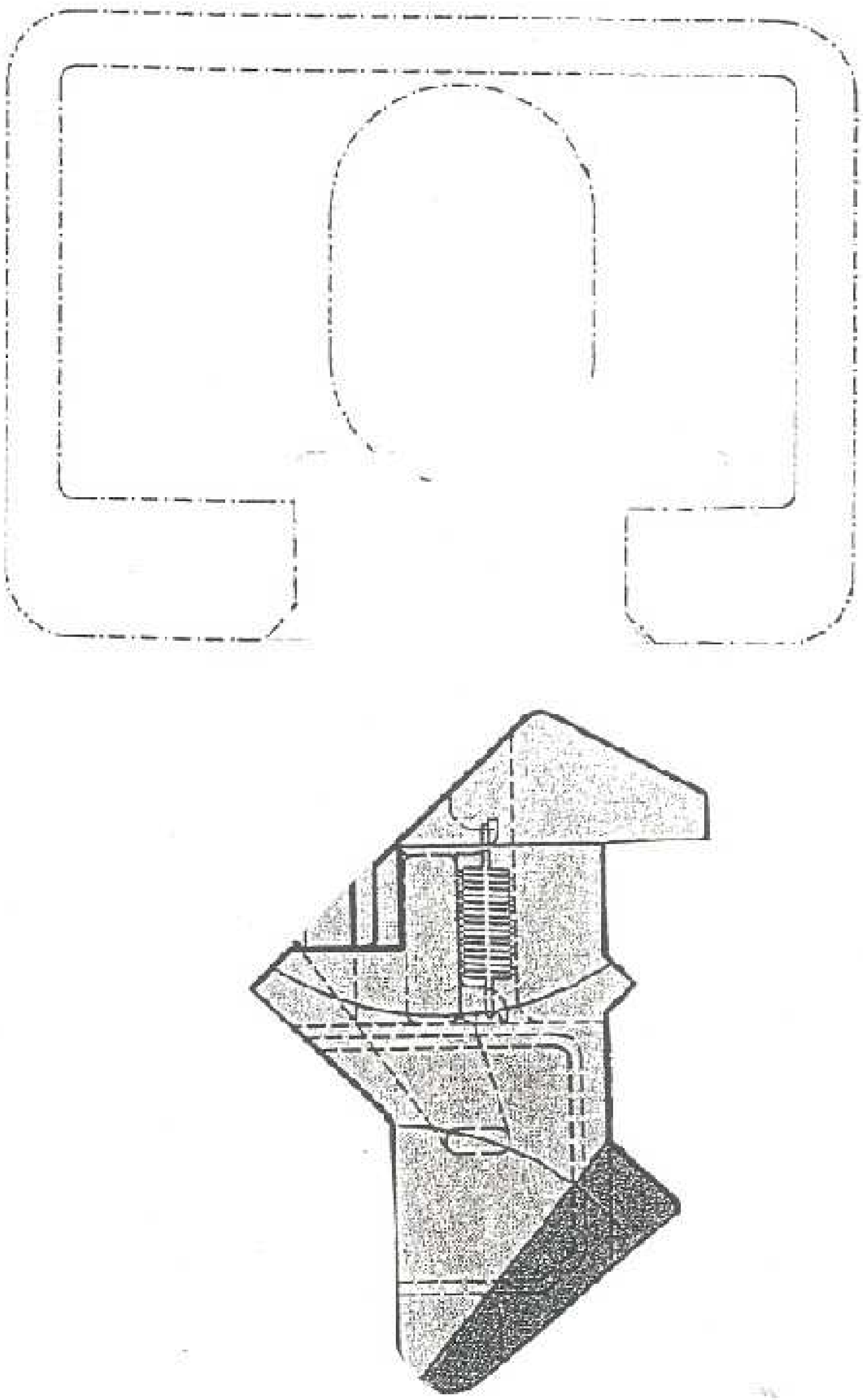
Partie « biseautée » / glissière

Red nose.

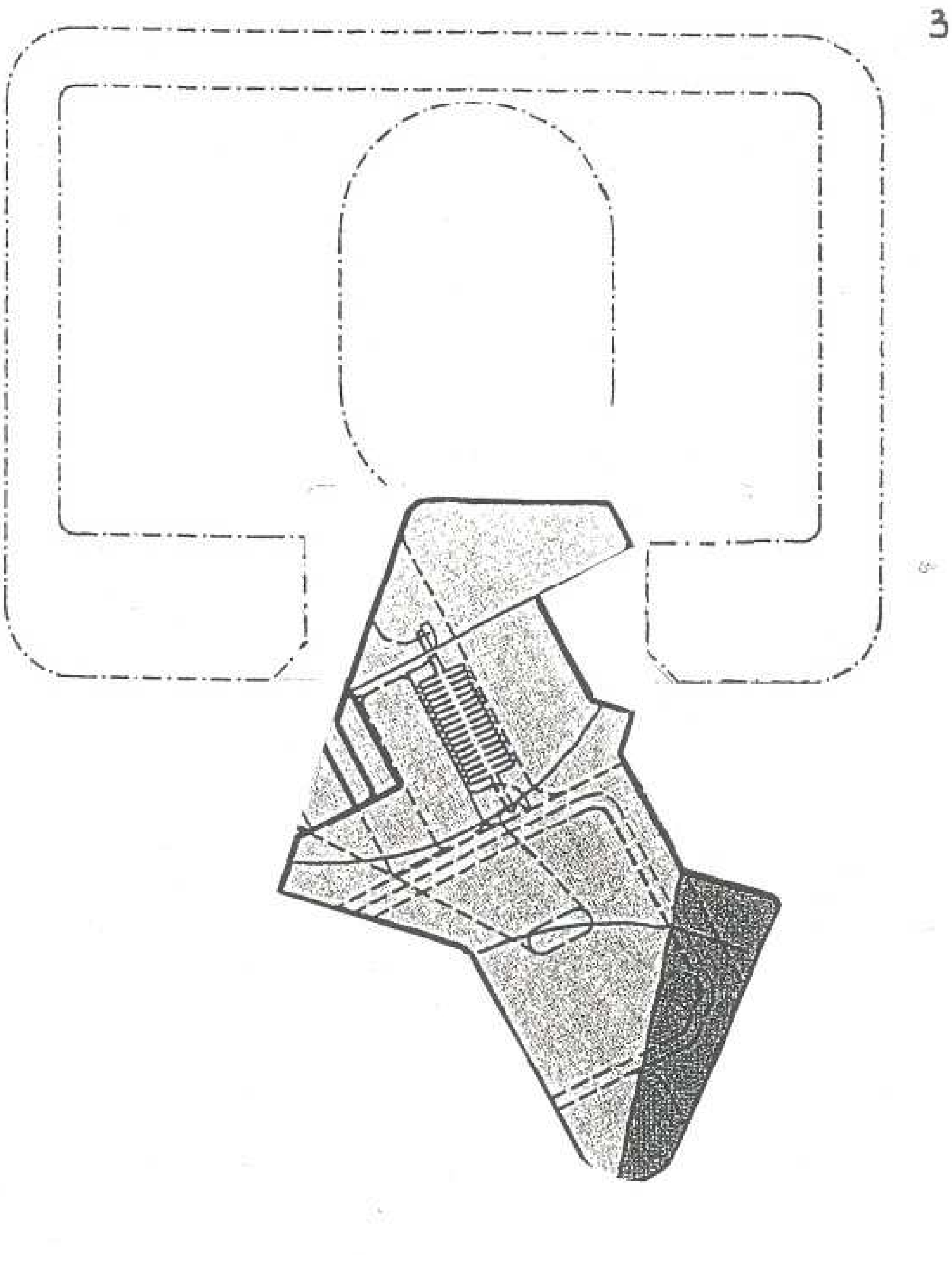
Présentation du TA dans la pièce de coin du conteneur à charger.

« Verrouillage » A non effacé.

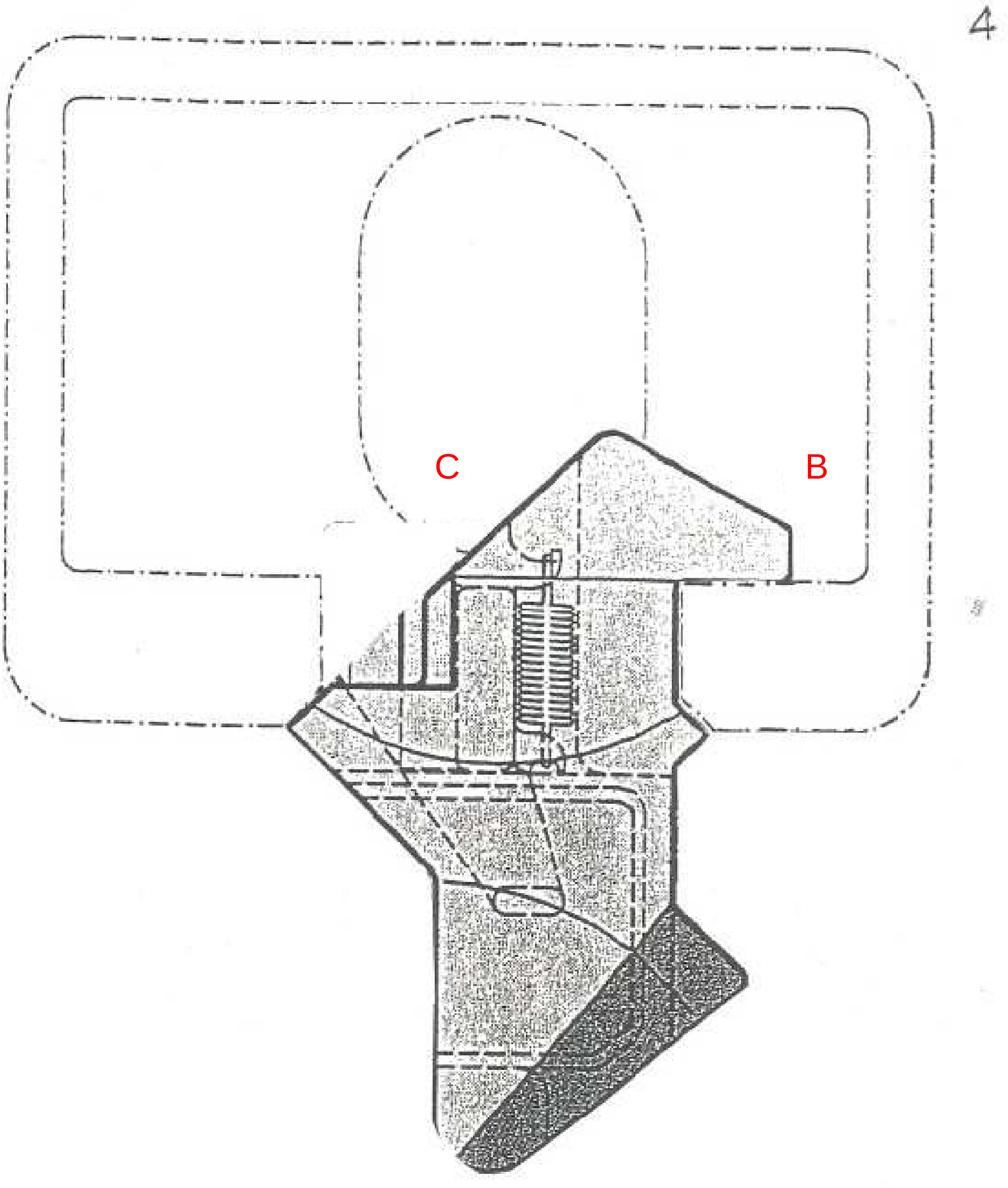
2



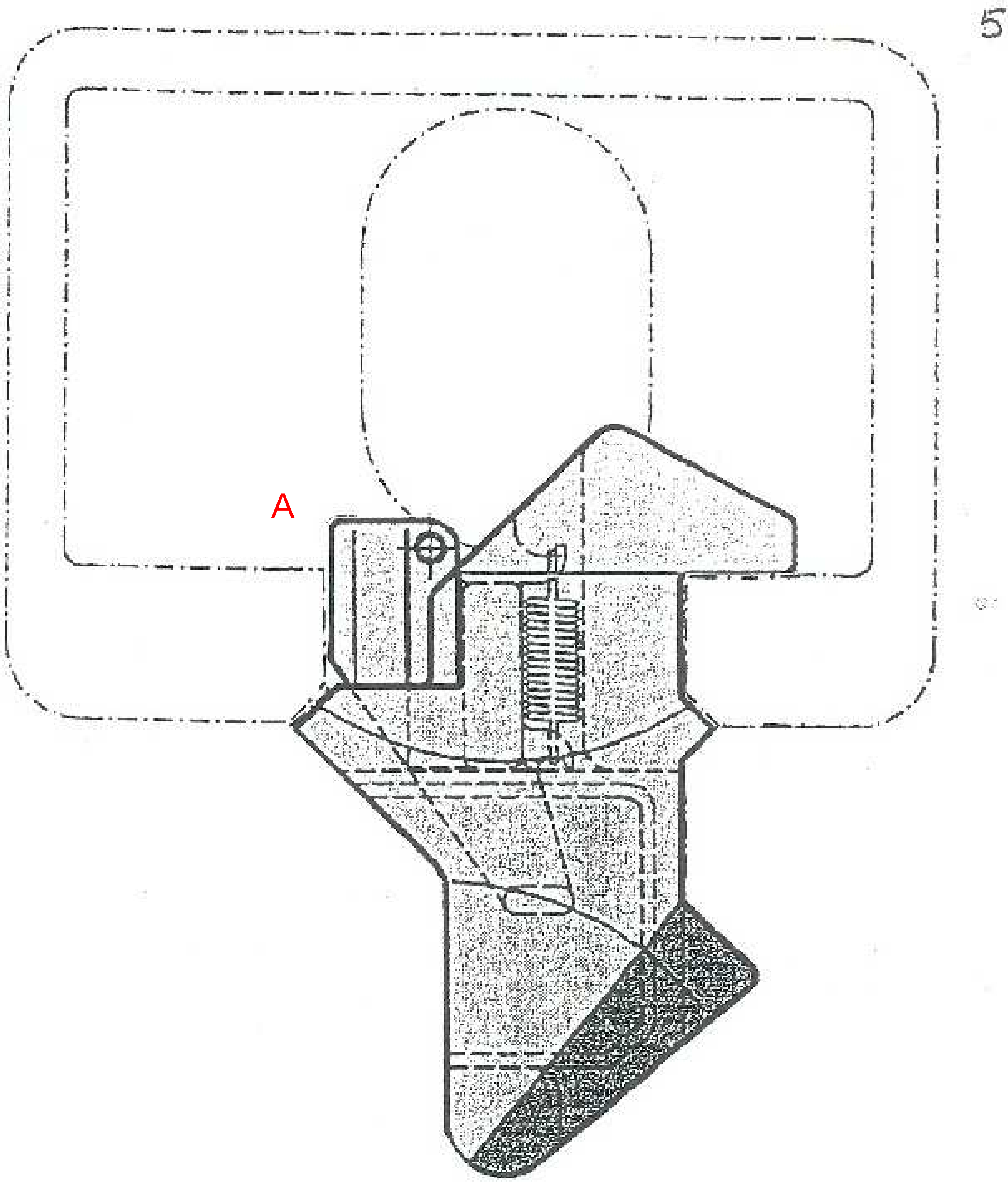
Idem, la pièce A ayant été effacée par le levier placé à l'intérieur.



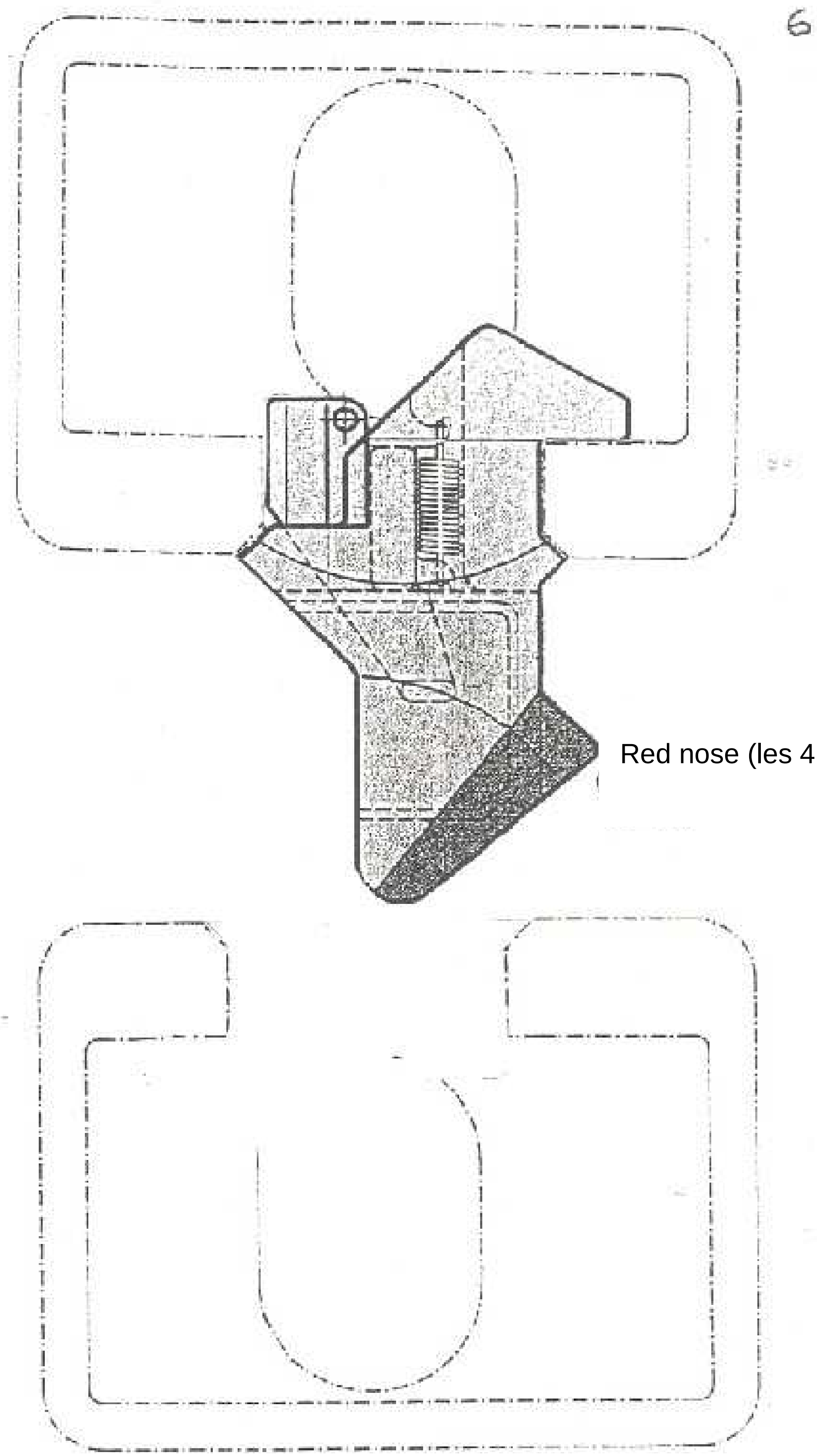
Présentation / introduction.



TA en place, le « loquet » B ayant été engagé par l'introduction de la glissière C.

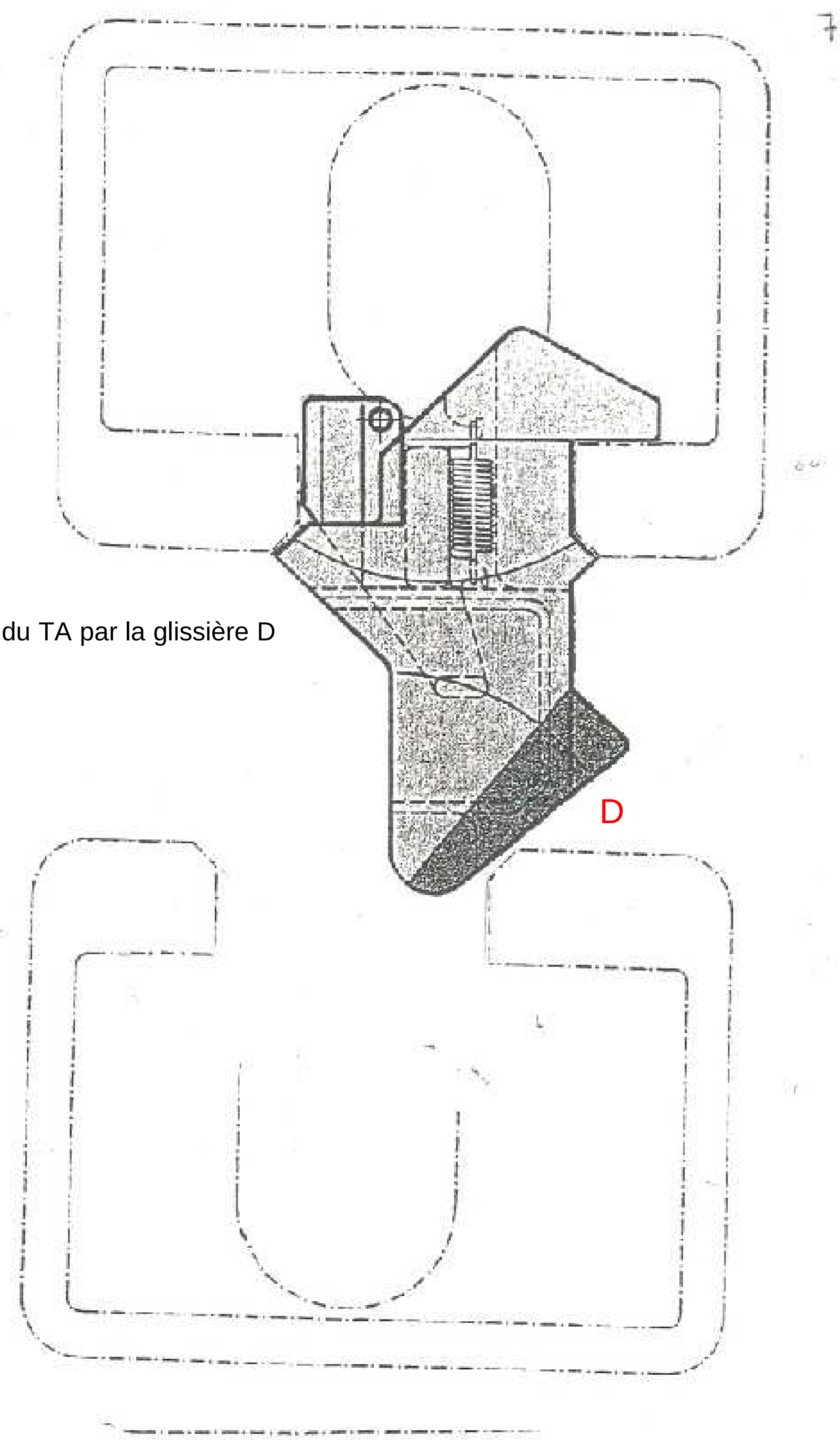


La pièce A, libérée, vient bloquer l'ensemble.

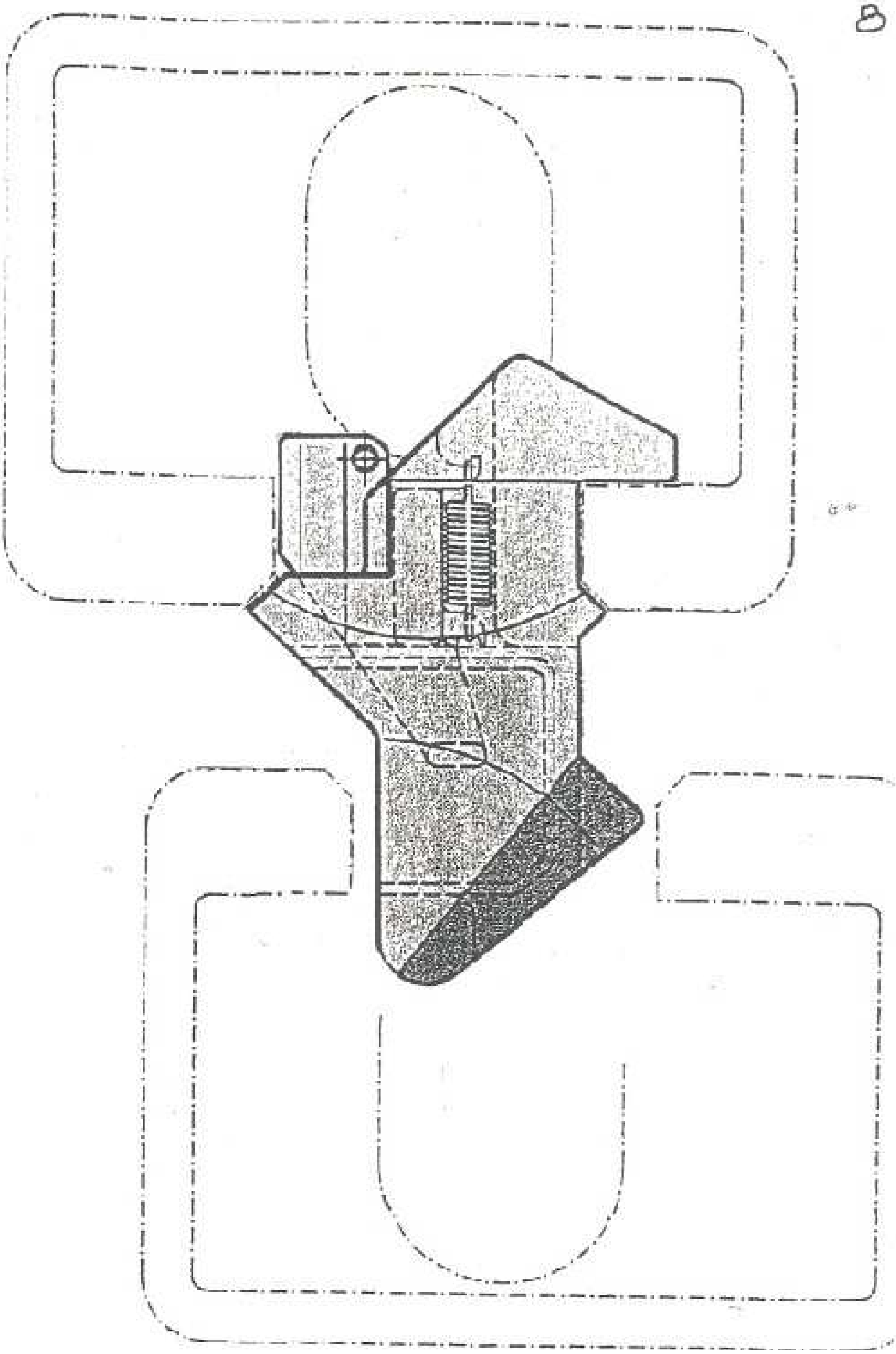


Red nose (les 4 du même côté).

Présentation du conteneur et du TA dans la pièce de coin du conteneur précédemment chargé.

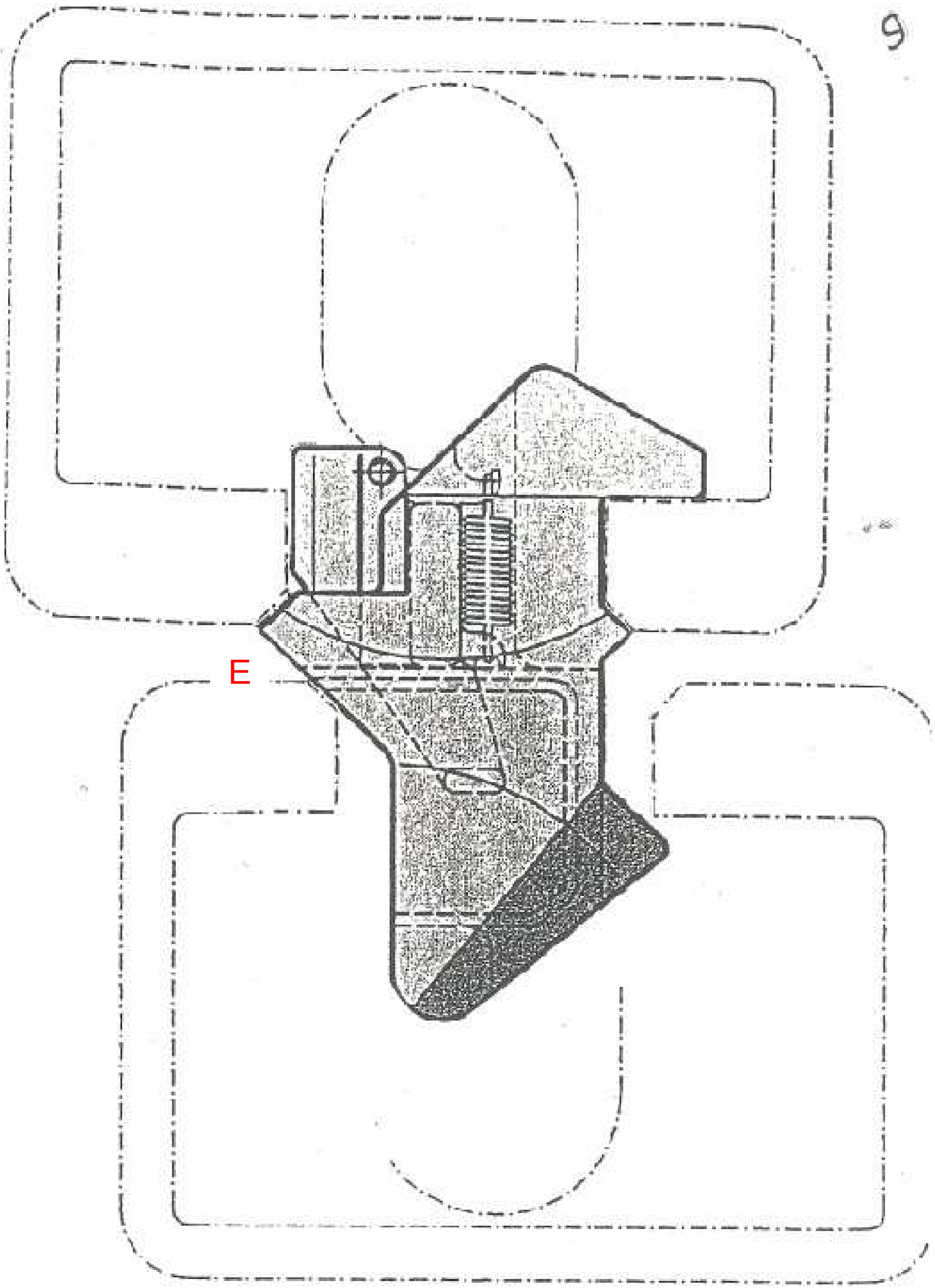


Introduction du TA par la glissière D (red nose).

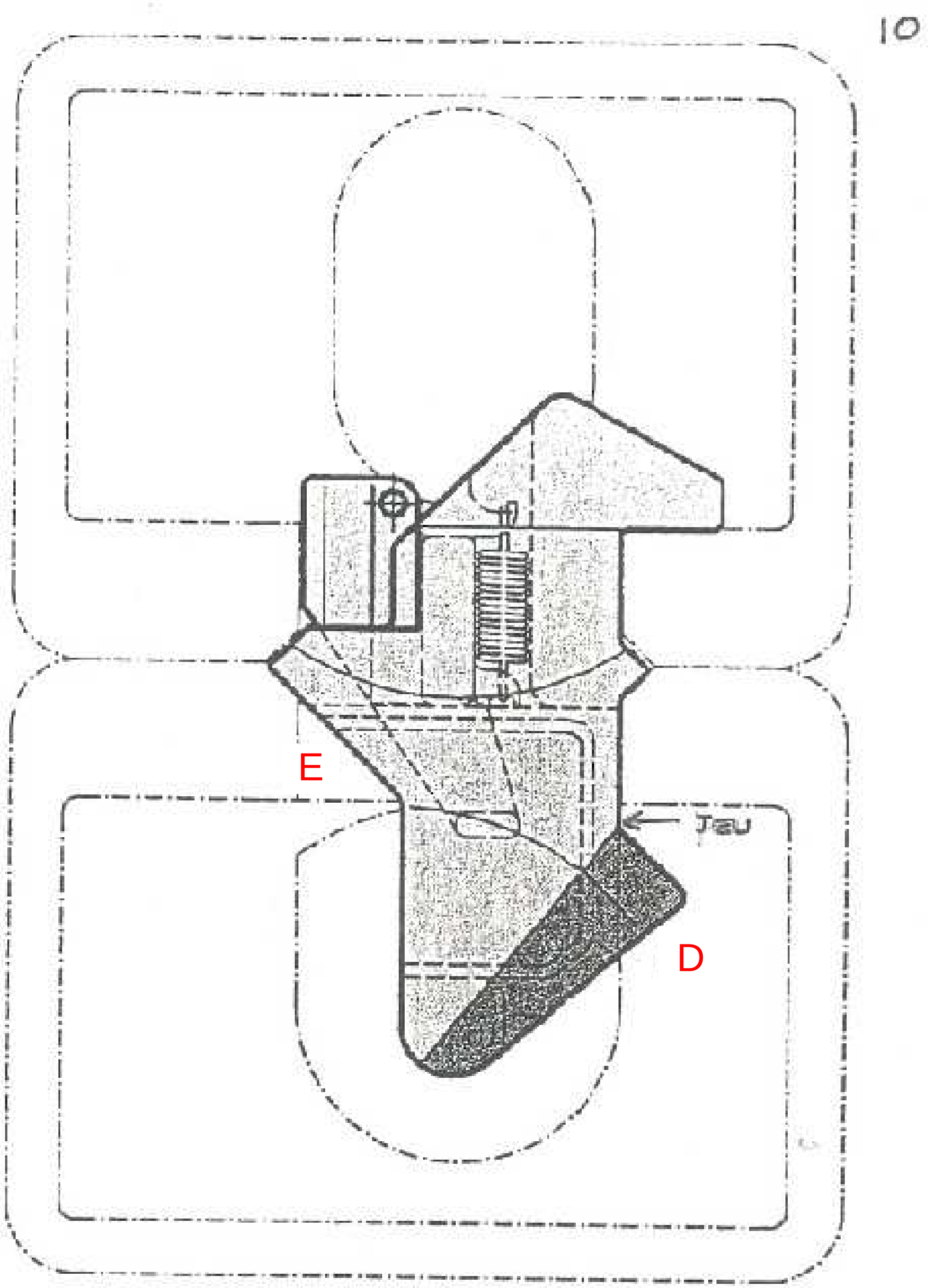


Suite…

(noter le décalage des deux conteneurs à cet instant).



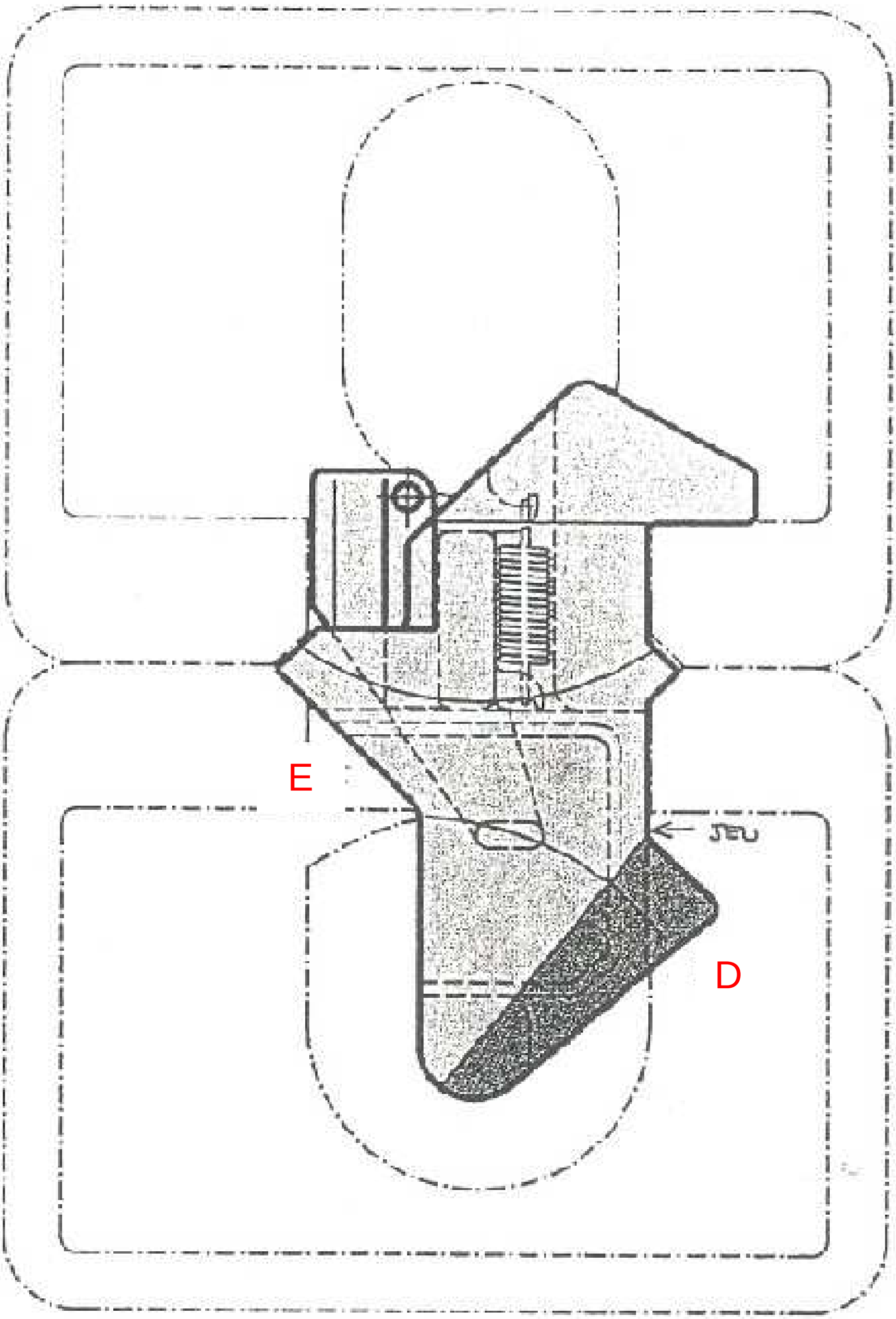
Intervention de la glissière (biseau) E pour la mise en place.



A poste, le « verrouillage », en fait le blocage transversal se faisant par la partie supérieure de la glissière D, repoussée par la glissière E arrivant elle même en butée.

A noter le jeu permettant d’amorcer la manœuvre inverse.

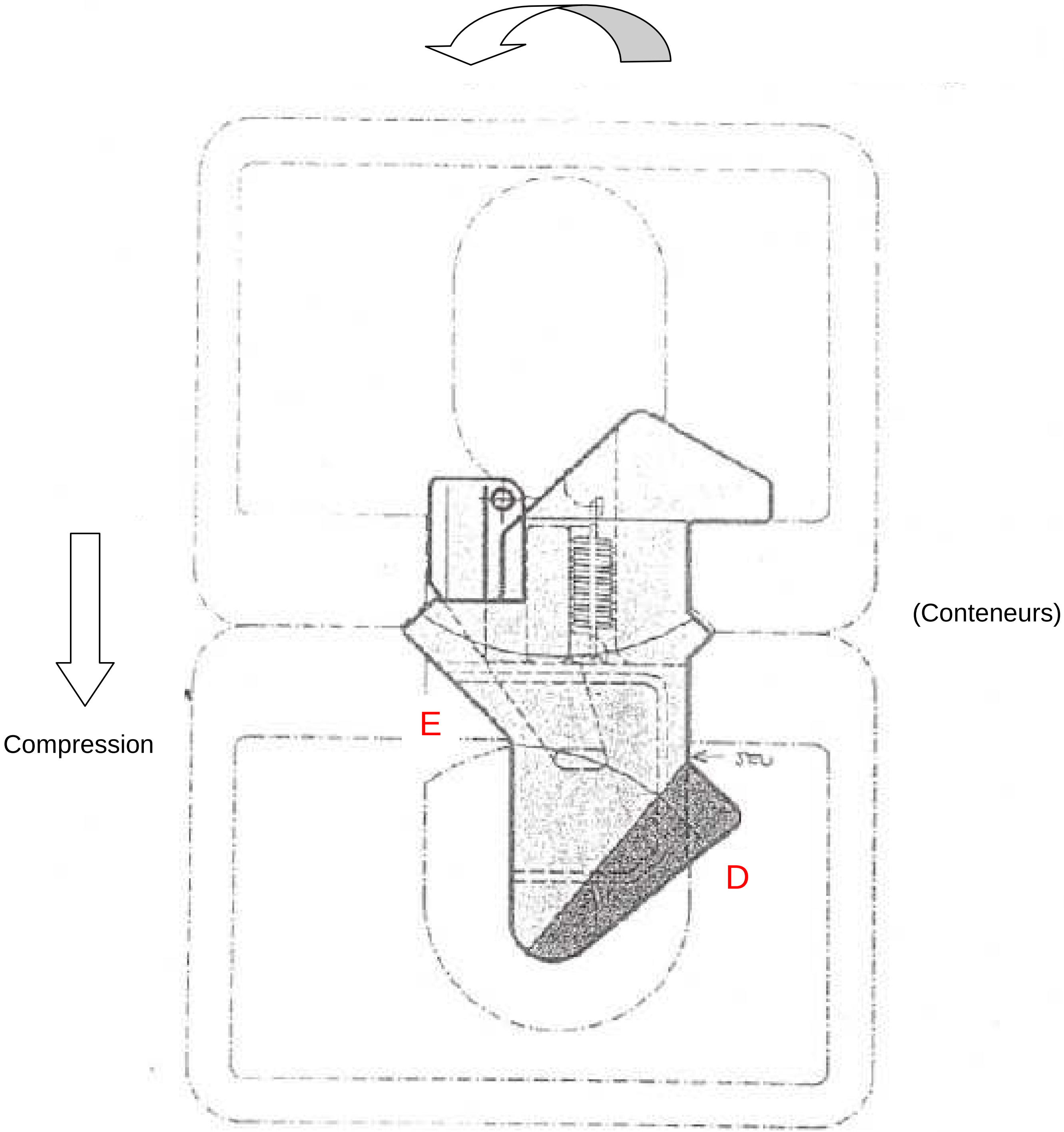
11



Au déchargement.

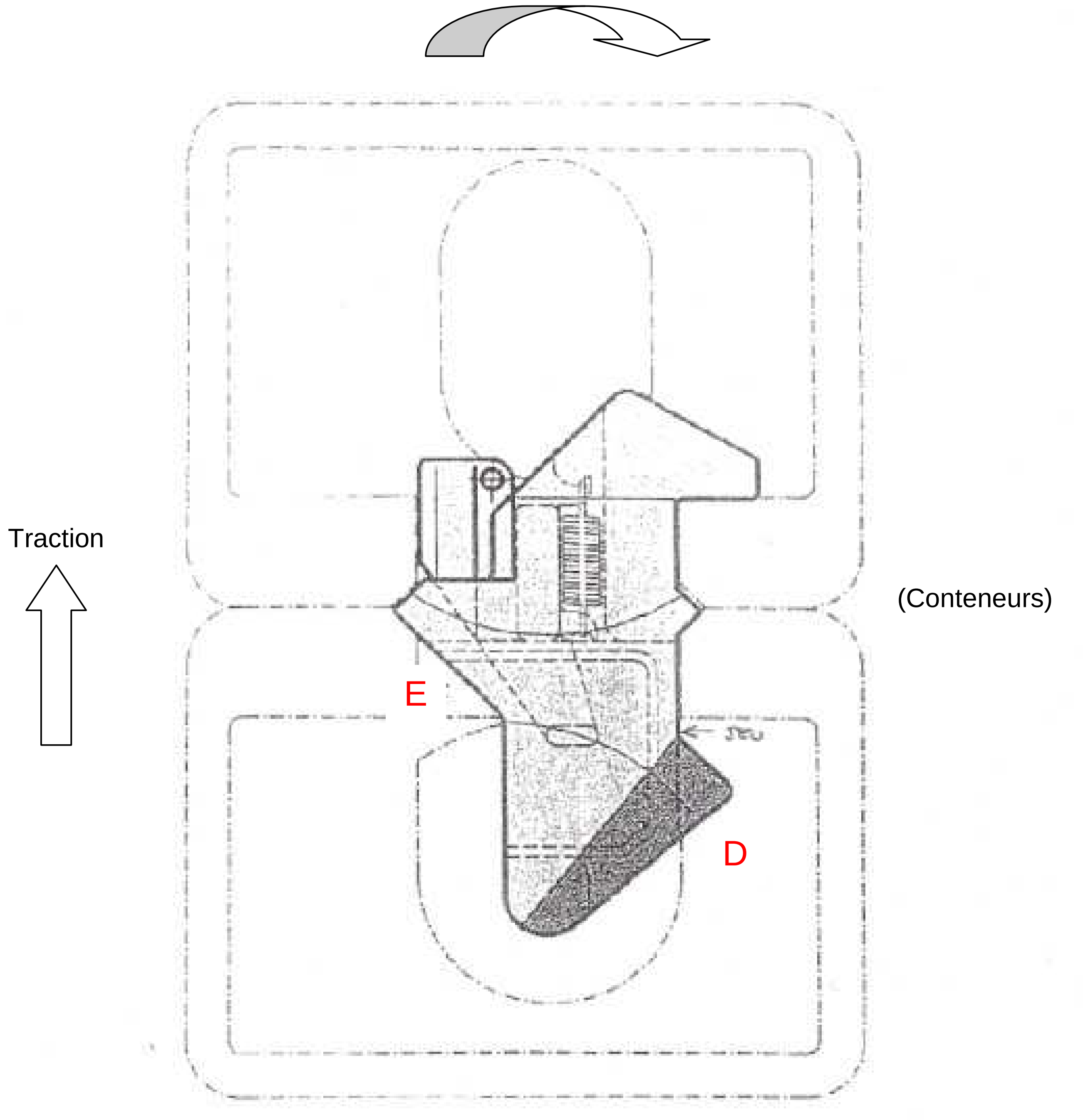
En exerçant la traction de levage, la glissière D remonte et la glissière E se désengage progressivement.

Fonctionnement à la gîte sur bâbord d'un TA dans des pièces de coin bâbord.



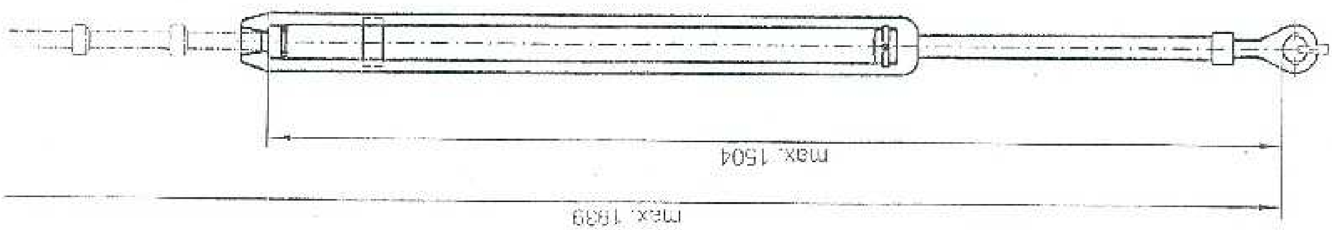
Travail à la compression : rien ne bouge.

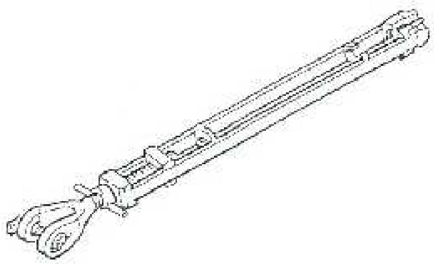
Fonctionnement à la gîte sur tribord d'un TA dans des pièces de coin bâbord.



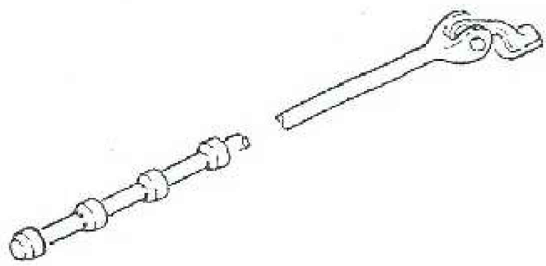
Travail à la Traction : le jeu, si faible soit-il, qui permet le déchargement, plus ou moins l'usure de la glissière E, autorisent un « début » de sortie, voire plus, de la partie inférieure du TA.

SAISINES, RIDOIRS ET BARRES



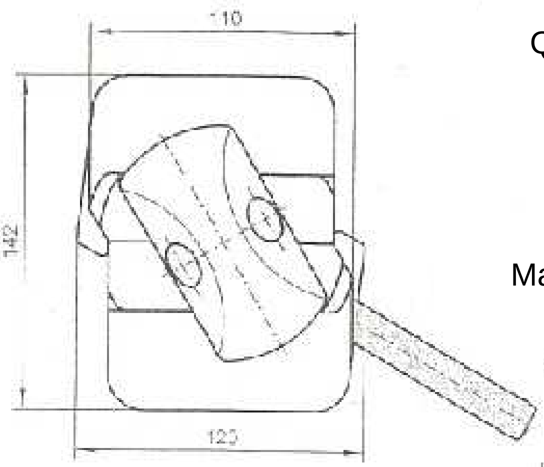


Turnbuckle

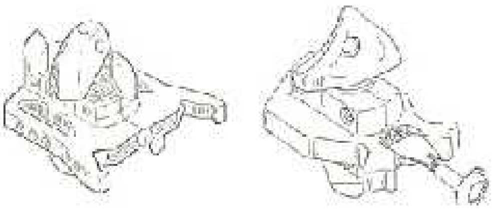


Lashing bar

QUELQUES SYSTEMES DE VERROUILLAGE



Manuel, 1ère couche sur panneaux.



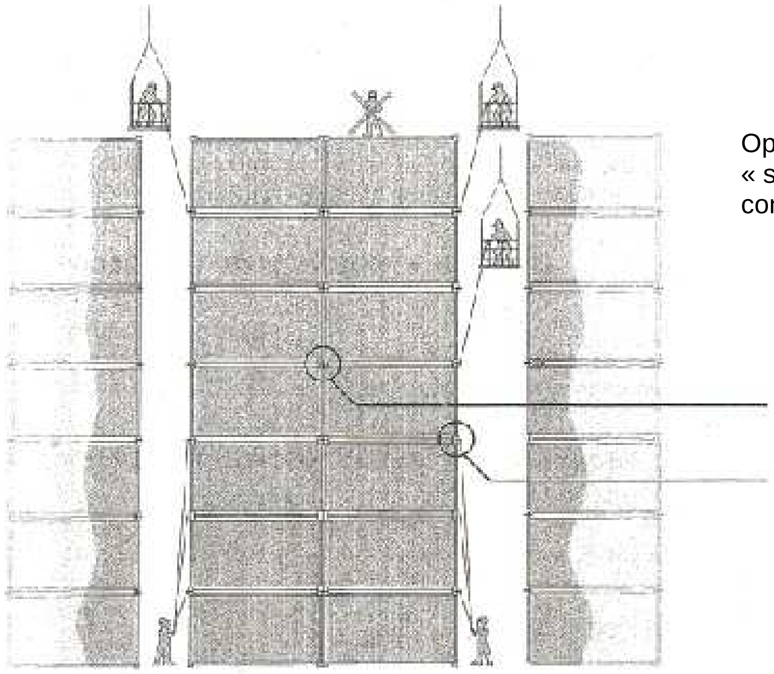
Semi-automatique

Dual Function Twistlocks

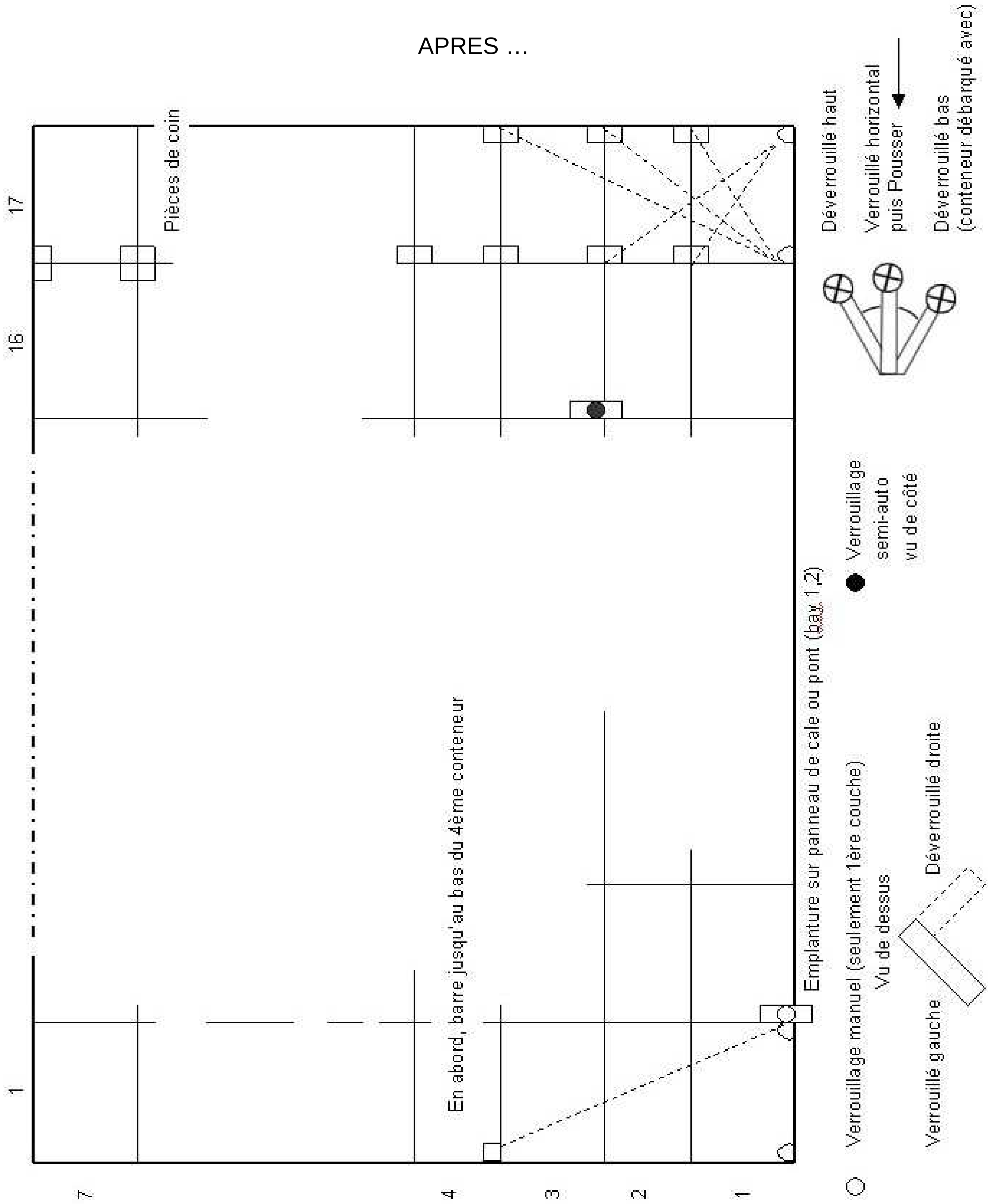
TA

Fully Automatic Lock

Opération de verrouillage des « semi-automatiques » sur le conteneur inférieur.



APRES ...



17
16
1
Pièces de coin
En abord, barre jusqu'au bas du 4ème conteneur
Emplanture sur panneau de cale ou pont (bay 1,2)
7
4
3
2
1
Déverrouillé haut
Verrouillé horizontal puis Pousser
Déverrouillé bas (conteneur débarqué avec)
Verrouillage semi-auto vu de côté
Verrouillage manuel (seulement 1ère couche)
Vu de dessus
Verrouillé gauche
Déverrouillé droite

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RÉPUBLIQUE FRANÇAISE

Ministère de l'Écologie, du Développement et de l'Aménagement durables

Bureau d'enquêtes sur les évènements de mer

Tour Pascal B 92055 LA DEFENSE Cedex
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bea-mer@equipement.gouv.fr