

(No. 187.)

“KING HARALD” (S.S.).

THE MERCHANT SHIPPING ACT, 1894.

In the matter of the Inquiry by Major A. COOPER-KEY, C.B., H.M. Chief Inspector of Explosives, being a person duly appointed by the Board of Trade under the Seven Hundred and Twenty-eighth Section of the Merchant Shipping Act, 1894, for the purpose of holding such Inquiry into the nature and causes of an explosion which occurred on or about the 12th October, 1917, on board the British steamship “KING HARALD,” of Grimsby, when she was in the vicinity of the Fish Docks, Grimsby.

Home Office, Whitehall, S.W. 1.

12th February, 1918.

SIR,

By virtue of my appointment dated 1st January, 1918, under section 728 of the Merchant Shipping Act, 1894, I held an inquiry at Grimsby, on the 24th of January, 1918, into the circumstances of the above mentioned accident and have now the honour to report as follows:—

Description of Vessel.

The “King Harald” is a steam trawler of 93 registered tonnage and 55 nominal horse-power. She was built at Selby, in 1899, by the firm of Cochrane and Cooper, and is owned by Mr. Frank Barrett of Fish Docks, Grimsby. Her official number is 110868, and she is registered at Grimsby. In consequence of the accident under report she is now in dock undergoing repairs.

Circumstances attending the Explosion.

In order to provide acetylene gas for the deck cabin, engine room and dan buoy lights a quantity of carbide of calcium was kept on board in a special carbide holder with a watertight top fitted in the tunnel recess in the engine room. This held about 2 cwt. The “generator” was also fitted to the port side of the engine room.

On 12th October, 1917, a drum containing 50 kilos. or about one cwt. of carbide was delivered on board at Grimsby by the Great Grimsby Coal, Salt and Tanning Company, Limited. This was deposited on deck just abaft the foc’sle hatch for the alleged reason that it would be out of the way and would not interfere with the working of the ship.

About 3 p.m. on the same date the “King Harald” left the docks for the fishing grounds and it was not until she had proceeded about half a mile down the river that Mr. Henderson the second engineer seems to have discovered the drum of carbide. This should no doubt have been stowed away in the holder provided for the purpose before sailing and the omission to do this, for which the engineers were responsible, was possibly due to the screened position in which it had been placed, as it could not be seen from the waist of the ship.

Be this as it may, as soon as the second engineer found that the drum had been left on deck he proceeded to remove it below. To do this he appears to have rolled it along the deck, dropping it from the foc’sle deck to the maindeck on the way, a height of about 1½ feet, until he reached the engine-room companion hatch. He then lifted it in his arms and started to carry it down the ladder. To do this he balanced the drum lengthways on his arms so as to leave his hands free to hold the ladder and went down backwards. When about half way down it seems to have slipped off his arms and to have fallen into the engine-room. Unfortunately, instead of falling on to the floor when it would possibly have been only slightly damaged it fell over the guard rail into one of the crankraces, and as the engine was running at the time it was crashed by the next

revolution of the crank and the whole of the carbide deposited in the engine bilge which contained about ten inches of water at the time. This would very quickly liberate a huge volume of acetylene gas and as an open oil lamp invariably hung on the guard rail it is obvious that an explosion was bound to follow.

Effect of the Explosion.

The second engineer, half way down the ladder, was killed on the spot, as were the chief engineer who was talking to the skipper at the time, and the cook who was standing at the door of the engine room. The skipper, Mr. Maguire, and two other members of the crew were severely injured. Two of the bodies were never found, having been either blown overboard by the force of the explosion or floated off when the vessel was subsequently beached.

The whole of the superstructure was blown upwards and outwards. The deck beams where the deck joins the bulwarks were severed, the cabin was entirely wrecked and the boat smashed. The effect was felt half way along the length of the vessel forward. About 180 rivets were started in the hold and the outside plating of the ship was rent for some distance. According to the statement of the owner the damage amounted to £6,000. The vessel in fact was in a sinking condition, but was taken in tow by another trawler and beached in shoal water, whence she was salvaged and taken into dock.

General Remarks.

1. According to the Board of Trade instructions to surveyors, drums containing carbide of calcium must be made of sheet metal of a thickness not less than standard gauge No. 23. A piece of metal sheeting recovered from the crankrace of the “King Harald” was measured in court and found to be appreciably stouter than the required gauge. A drum stated to be exactly similar to that delivered on board was also produced for my inspection and appeared to me to be of the recognised pattern commonly employed in the trade. These drums are very tough and will stand a considerable amount of very rough treatment without developing leakage. I have personally visited a carbide store containing at least twenty tons, all of which was packed in drums of this pattern and although the large majority of these had evidently been badly battered about, there was not the slightest smell of acetylene noticeable, a sure indication that all the drums had remained airtight. Even the moisture in the atmosphere is sufficient to liberate acetylene from carbide and the smallest trace of this gas in the air is easily detected by the smell. There is, therefore, no reason to suppose that drums of this pattern are not fully up to their work, and I am confident that if the drum had fallen on the engine-room floor instead of into the crankrace no untoward results would have followed.

2. By the owners instructions a shackle-bolt had been fitted inside the casing of the companion way for the sole purpose of carrying a line or tackle to facilitate the lowering of the drums of carbide into the engine-room and had this been used it is almost impossible that the accident could have happened. The witnesses examined were, however, unanimous in stating that they had seldom, if ever, seen this bolt used. The common practice seems to have been to sling the drum on a line and thus lower it steadily down the ladder, one man paying off at the top and a second supporting the drum from below, but previous instances were known of a single man carrying a drum down the ladder in his arms as was being done on the occasion in question. One witness (Cobley) stated in evidence that when passing the companion way he had warned the second engineer that if he were not careful he would drop the drum. The method adopted was in fact improper and dangerous.

3. The omission to remove the carbide below before the vessel sailed would also seem to call for explanation. According to the evidence of the superintending engineer there were standing instructions to engineers to put the carbide into the receptacle provided in the engine-room before leaving the dock. These instructions had been on

several occasions delivered by him to the engineers on board the "King Harald," and he had frequently had occasion to reprimand them for not obeying the instructions. That the second engineer was aware of these instructions would seem to be indicated by the promptitude with which he proceeded to remove the drum below as soon as he discovered it. The two engineers, who received special extra pay for looking after the acetylene lighting plant, were jointly responsible in the matter, and the only excuse that can be offered for their neglect of duty is the somewhat concealed position in which the drum had been deposited on the foc'sle deck where it was not visible from the waist of the ship.

4. The rough and ready manner in which the second engineer rolled the drum along the deck and dumped it over the break of the foc'sle would at first sight seem to point to ignorance on his part of the dangerous properties of the contents and of the paramount importance of the drum remaining watertight, but it was stated in evidence that it was by no means uncommon for a similar drum to be rolled directly from the quay to the deck of a trawler—a drop of some feet—and there is every probability that he had seen this done, possibly more than once, so that the method adopted by him for shifting the drum as expeditiously as possible is no real indication that he was not aware that if water came in contact with carbide a dangerously explosive gas would be generated. This is now a matter of common knowledge and there can be little doubt that this officer with his technical training would be well acquainted with this property of carbide. There is, moreover, the evidence of the superintending engineer that he had frequently impressed this point on both the engineers of the "King Harald."

5. The method adopted by the employees of the Grimsby Coal, Salt and Tanning Company in delivering the carbide is in my opinion decidedly open to criticism. Although in ordinary circumstances there is little danger attached to the handling and storage of this material there are certain conditions in which it may become very dangerous indeed, and that this is recognised is evidenced by the fact that in this and in most civilized countries, the traffic in it is subject to legislative restriction. This being so, to deposit a substantial quantity on the deck of a trawler and leave it there without a word to any responsible official, is a course which, to say the least of it, is far from commendable. Furthermore, to guard against this very contingency it is enacted that where any carbide of calcium is sent or conveyed by land or water between any two places in the United Kingdom, or is sold or exposed for sale, the vessel containing it shall have attached thereto a label in conspicuous characters bearing the words "Carbide of Calcium," "Dangerous if not kept dry," and with the following caution, "The contents of this package are liable if brought into contact with moisture to give off a highly inflammable gas." On the admission of the Company's representative no such label was attached to the drum in question, although since the accident a red label conveying a warning of a kind, but of quite different wording from that required by law, is now said to accompany each drum sent out.

6. Although the cause of the explosion is clear enough, the extent of the damage was remarkable and somewhat surprising. As a general rule the effect of the explosion of a gas is small in comparison with that of a liquid or solid explosive. This is of course only to be expected inasmuch as the disruptive action is largely due to the sudden conversion of the liquid or solid into vapours and gases occupying an enormously greater volume than the original material, this volume being increased by the high temperature produced by the chemical change, whereas in the case of a gas there is not necessarily any increase in volume other than that due to the high temperature of the reaction. Acetylene is, however, what is known as an endothermic compound, the heat of its formation being represented by many thousand calories, and this heat is liberated when the gas decomposes. Although at normal pressure acetylene alone is not explosive the admixture of a comparatively small percentage of air—about 20 per cent.—

is sufficient to form an explosive atmosphere, and the resulting explosion derives its force not only, as in the case of other combustible gases, from the combination with the oxygen of the air of the carbon and hydrogen of which it is composed, but also from the decomposition of the acetylene itself. According to a standard authority the explosion of acetylene and air at atmospheric pressure is with certain percentages more than three times as powerful as similar mixtures of coal gas and air, and, moreover, the time occupied in the complete development of the maximum pressure is considerably less with acetylene than with coal gas. Assuming therefore, that in the engine-room of the "King Harald" the most effective ratio of gas to air was reached before ignition took place the power developed by the explosion is by no means so extraordinary as would appear at first sight.

As pointed out earlier in this report it was the common practice to suspend an oil lamp on the guard rail in the engine-room and if this was present at the time of the accident it might be expected to ignite the gas as soon as it was generated and before the engine-room was completely filled with an explosive atmosphere. In an exactly similar case, referred to by the Superintending Engineer in his evidence as having occurred some years ago, the acetylene appears to have been immediately ignited by the lamp flame and to have burned away without explosion. It is possible, therefore, that in the case under report, no naked light was present in the engine-room and that the acetylene mixture, after attaining its maximum explosibility, was fired by the heat generated by the chemical action between the carbide and the water. According to the above quoted authority it is possible in this way to obtain a temperature of 800° C. or in special conditions even 1,000° C. which would be amply sufficient to fire the mixture. Even though the heat from the carbide actually under water in the bilge would be absorbed by the water a considerable portion of the carbide would no doubt remain above the surface and would at the same time be splashed with water—the very condition most likely to generate intense local heat.

7. In the course of the inquiry it transpired that no licence to cover the storage of the carbide on board the "King Harald" had been obtained from the Local Authority and that, moreover, it was not the custom to issue licences in respect of the carbide kept on trawlers. By Section 7 of the Petroleum Act, 1871, applied to carbide of calcium by an Order in Council dated 8th August, 1911, no carbide exceeding 28 lbs. in weight may be kept without a licence from the Local Authority as defined in the said Act. A difficulty undoubtedly arises owing to the carbide store passing from the jurisdiction of one Authority to that of another, as it is manifestly absurd to require a fresh licence to be taken out at each port of call. For this reason no doubt Harbour Authorities have tacitly agreed not to raise the point. It seems to me, however, that if these Authorities can adopt a uniform policy of countenancing a complete disregard of a statutory provision they might equally well adopt the principle that a licence issued by one Local Authority shall, in respect of a ship or boat, be accepted by all. A licence could then be granted to the owner or master of a vessel by the Harbour Authority having jurisdiction over her port of registration and not only would the spirit at any rate of the Act be thus observed but, since conditions could be introduced into the licence regulating such matters as the delivery of the carbide on board, there would be a distinct advance in the direction of safety.

I am now in a position to reply as follows to the questions submitted to me by the Board.

1. Q.—Was the drum of carbide delivered on board the s.s. "King Harald," at Grimsby, on the 12th October last, a standard pattern drum in good condition and strong enough for the purpose for which it was being used?

A.—Yes.

2. Q.—Was the "King Harald" fitted with proper appliances for lowering drums of carbide from the deck to the engine room and with a proper receptacle there for storing and keeping the carbide dry?

A.—Yes.

3. Q.—What instructions, if any, had been given by the owner or his superintendent to the engineers of the "King Harald" with regard to removing drums of carbide from the deck below before the vessel sailed from port?

Were such instructions, if any, sufficient?
Ought they to have been carried out?

A.—Sufficient instructions had been given to the engineers of the "King Harald" by the superintending engineer that the drums of carbide should be removed below before sailing and these should have been carried out.

4. Q.—Were the engineers aware of the risks to be guarded against in the handling of drums of carbide on board the vessel?

A.—Yes.

5. Q.—When the vessel left Grimsby on the 12th October last, was there a drum of carbide lying on deck? If so, did the second engineer afterwards attempt to remove it from the deck below, and were the means he adopted for doing it safe and proper?

A.—When the vessel left Grimsby on the 12th October, 1917, a drum of carbide was lying on deck. The second engineer attempted to remove it from the deck below but the means he adopted were unsafe and improper.

6. Q.—What was the cause of (a) the explosion which occurred on board the s.s. "King Harald" at or about 3.15 p.m. of the 12th October last? (b) the loss of life and (c) the serious damage sustained by the ship?

A.—The explosion was caused by the second engineer dropping the drum of carbide into one of

the crankcases of the engine, where it was crushed by the next revolution of the crank, precipitating the carbide into the water in the bilge and thus forming an explosive atmosphere in the engine room, which was fired either by the flame of an oil lamp on the guard rail of the engine, or by the heat generated by the reaction between the carbide and the water. The loss of life and damage to the ship were caused by this explosion.

7. Q.—Was the explosion an unavoidable accident and if not what measures, if taken, would have prevented it?

A.—The explosion was not an unavoidable accident and would not have occurred (a) if the carbide had been removed below before the engines were started, or (b) if proper means had been adopted to remove it below.

I have the honour to be,

Sir,

Your obedient Servant,

A. COOPER-KEY,

Major.

H.M. Chief Inspector of Explosives.

The Assistant Secretary,

Marine Department,

Board of Trade.

(Issued by the Board of Trade, Friday, 26th April 1918.)