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SAFETY AT SEA

A LECTURE

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Introduction

The evolution of ships during the past century from small sailing ships to modern liners of complex construction has brought many problems of safety in its trail.

Safety at sea is analogous to a chain in which each link has its own special function and where one weak link may cause disaster. It will, therefore, be obvious that safety precautions are indivisible and that all things, including the hull, machinery, equipment, cargo, and crew, have their own peculiar problems which require careful consideration and which have to be regulated by a central authority in order to ensure a sound chain.

One may ask what are the problems which require regulating by Parliamentary authority? Surely it is to the shipowners' interests to see that their ships are safe in all respects. In order to answer that question, the author proposes briefly to review some of the many milestones in the long struggle through the past century leading to the present massive sets of rules which ensure, as far as practicable, the relatively high standard of safety of life and property at sea which we have today.

About the middle of the nineteenth century, the appalling loss of life and property at sea quite rightly aroused public indignation and moved Parliament to pass Acts in 1850 requiring that the masters and mates, and subsequently in 1862, that marine engineers, should be suitably qualified. From the very beginning the human factor was recognized as one of the prime considerations in the quest for safety at sea: the author will return to this subject later.

The same Act in 1862 included the enlargement into something approaching their present form of the Regulations for Preventing Collisions at Sea.

The next outstanding milestone was undoubtedly Samuel Plimsoll's crusade to reduce the great loss of life which was taking place annually among our seamen in the so-called "coffin ships." As a result of his untiring efforts, Parliament passed the Load Line Acts in 1876.

The disastrous loss of the *Titanic* on her maiden voyage in 1911, focused attention on the possible deficiencies in the internal structure of ships and this problem was further emphasized by many tragic experiences during the First World War when so many ships became victims of submarine attacks.

The years after the First World War saw the beginning of the transition from coal to oil fuel, and this not only increased the fire hazards, but also created a problem of stability. Since then the growth in the size of ships, occasional losses by fire, lack of stability, cargo shifting and other causes, brought new problems to the forefront, and shipping casualties in the Second World War showed in these few epic years many further instances of deficiencies in safety precautions that would have taken a lifetime of experience under normal conditions.

During the last twenty years or so the advance of science has led to the development of radar and electronic equipment, which have proved invaluable as navigational aids.

The foregoing is but a brief review of some of the main features in the evolution of safety at sea and such is the stage now reached that it is difficult to visualize any further major progress. Constant vigilance and efficiency must, however, be maintained, because the sea is a relentless master, always searching for and finding physical or human weaknesses.

It must also be pointed out here that shipping is an international business and consequently there are the International Safety Conventions, which require all maritime nations to comply at least with the same minimum standards of safety.

The author will not develop that point, nor the history of events leading to the various Shipping Acts; these are the purely legal and administrative aspects of safety at sea which were fully dealt with by Mr. Denis O'Neill in his paper* presented to The Institute of Marine Engineers in 1951 and by Sir Gilmour Jenkins (Past President), who, in his Presidential Address† to the Institute, dealt very fully with the relationship between the State and the Shipping Industry.

The author will therefore confine himself to a simple review of the practical interpretation of some of these Merchant Shipping Acts and International Safety Conventions.‡

The Hull

(*a*) *Load Line*.—It is proposed to turn to the ship herself and say a word about the load line rules. These rules are for determining the position of the load line markings which regulate the maximum depth to which a ship can be submerged under the varying geographical and seasonal conditions. From an engineer's point of view, a ship is simply a floating watertight structure, which, when loaded to the Plimsoll mark, i.e. the statutory load line, has a sufficient reserve of buoyancy, strength for service at sea, and a safe working platform for the crew. It is not possible on this occasion to deal with such details as the deck erections, the deck camber and shear and their contribution to reserve buoyancy, or the means of closing deck openings on the freeboard deck. It is sufficient to mention that the rules cover all such matters and penalize ships which fall below the minimum rule requirements by increasing their freeboard. The load line rules, therefore, ensure as far as practicable, that no water will enter the hull, or enter through the freeboard deck which is generally the weather deck.

Special consideration is given to vessels engaged in the timber trade carrying deck cargoes and to tankers, as it is obvious the nature of these cargoes affects the reserve buoyancy and, provided

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* O'NEILL, D.: "Safety at Sea, 1850–1950," TRANS. I. MAR. E., Vol. 63, 1951, p. 21.
† JENKINS, SIR GILMOUR: "Shipping and the State," TRANS.I.MAR.E., Vol. 65, 1953, p. 249.
‡ See also DANIEL, G. (Member of Council I.N.A.) "International Conference on Safety of Life at Sea, 1948," TRANS. I.N.A., 1949, p. 257.

their structural strength is satisfactory, these vessels are allowed to load deeper, i.e. they are assigned smaller freeboards.

It should be added that the structural strength of a vessel implies a control of the physical properties of the materials used, their scantlings and of the methods of construction. This work is normally carried out by the surveyors of the Classification Societies. New methods of construction, such as welding, give rise to many problems. For example, inquiries into the cause of the failure of some welded ships built from steel, having the usual physical and chemical properties, could not be fully explained until the importance of notch brittleness was fully appreciated and this problem is still under investigation. This example is only cited to emphasize that the load line assignment is not a mere geometrical problem but one which takes account of the materials used, method of construction, closing appliances, and workmanship.

(*b*) *Sub-division.*—The load line rules make no provision for a vessel which has sustained damage below the waterline through which water can enter the hull; this is generally referred to as being bilged. Since the loss of the *Titanic*, rules governing the internal watertight structural arrangements of passenger vessels have been agreed. The object of these rules, which are known as the Sub-Division Rules, is to limit the flooding when a vessel is bilged. It might be of interest to mention that the *Titanic* had, in fact, a high standard of sub-division.

All passenger vessels are marked with a sub-division load line which may coincide with, or be below, the statutory load line and this mark must not be submerged when the vessel is carrying passengers.

If a little thought is given to the question of sub-division, it will be obvious that a honeycomb arrangement of watertight longitudinal and transverse bulkheads up to the bulkhead deck would provide an almost unsinkable ship. The bulkhead deck is the uppermost continuous deck to which the bulkheads extend. Boilers and machinery, however, require space and, as most ships are built for commercial purposes, cargo spaces are also required. A minimum standard of sub-division is, therefore, required which is governed by the conditions of service and according to the length of a vessel.

The sub-division rules, therefore, deal with the internal structure of a ship. They are mainly concerned with the number and position of transverse watertight bulkheads, which extend from the bottom or inner bottom when fitted up to the bulkhead deck. Double bottom tanks, when these are rule requirements, are constructed to extend from the fore peak to the aft peak bulkheads. They also deal with the protection of the bilges by determining the line of intersection of the inner bottom tank margin plate with the shell plating. The rules also require that any openings in the sub-divisional bulkheads which are necessary for the proper working of the ship, including those at the entrances to the tunnels, should be capable of being closed by watertight doors; this ensures that the integrity of the bulkheads can be maintained and flooding through bilging restricted without adversely complicating satisfactory inter-communication between different compartments of the ship.

To prevent inter-compartmental flooding through bilge pipes which may have been broken in the bilged compartment (due to their proximity to the ship's side), non-return valves are fitted at the open ends of the pipes in the holds or compartments which they serve.

It should be mentioned here that openings in the shell plating below the bulkhead deck for side scuttles, galley shutes, and discharges from spaces above and below the bulkhead deck, are all potential dangers and detract from the ideal conception which is a vessel with no openings in the shell plating or bulkheads below the bulkhead deck. One step towards this conception is the fitting of a sewage system, in some passenger vessels, with a common sewage tank fed by the sanitary service, thus avoiding numerous overboard discharges. Apart from enhancing the safety of the vessel, this system has the advantage of avoiding the pollution of harbours.

Means of escape from all compartments in which personnel may be trapped when the watertight doors are closed must be provided and a common example of this is the shaft tunnel escape fitted in all passenger vessels and practically all cargo vessels.

Looking at the geometry of the structure of a passenger ship it will be obvious that, at the maximum draught determined by the load-line rules, the distances between the bulkheads must be governed by the volumes of the compartments they enclose up to the bulkhead deck, so that in the event of the vessel being bilged, the loss of buoyancy and subsequent sinkage will not submerge the bulkhead deck at any position in its length. In practice it must not submerge an imaginary line, termed the margin line, drawn parallel to the bulkhead deck at the sides and 3 inches below the surface of that deck. The positioning of the bulkheads in practice, however, is not so simple, as one or more compartments may have to be longer than visualized above. It is then necessary to increase the freeboard, by reducing the maximum sub-division draught, to obtain the necessary additional buoyancy in order to compensate the effect of the longer compartment being bilged. On the other hand, the owner's operational requirements may require more and shorter compartments. This would give a higher standard of sub-division than required by the rules as no vessel is allowed to submerge the statutory load-line marks. Space does not permit more details, beyond indicating that a number of assumptions must be made, particularly about the permeability of the spaces below the bulkhead deck when the vessel is in the fully loaded condition. If, in that condition, one compartment is bilged and the vessel sinks to the margin line at any point in its length, it is said to have a one-compartment standard of sub-division; if two-bilged adjacent compartments do not submerge the margin line, the vessel is said to have a two-compartment standard, and so on.

So far the submersion of the margin line when a side to side compartment has been flooded has been considered, but a vessel may be bilged in way of an oil fuel side bunker tank which would cause the vessel to list. In this case the margin line on the low side must not be submerged. To limit listing, cross flooding pipes are frequently installed to deal with such cases of unsymmetrical flooding. These pipes are capable of reducing rapidly the list to a small angle after an accident occurs.

This listing when a ship is damaged raises another important consideration and that is the transverse stability in the damaged condition.

(*c*) *Stability.*—This does not appear to have been a major problem until the 1920's, when inquiries into the losses of certain vessels, principally in the coal trade, pointed among other things to the need for the shipbuilders to obtain the elements of stability of the ship and to supply that information when handing over the completed vessel to her owners.

So far as passenger ships were concerned in those days, the surveyors dealing with Passenger Certificates had to satisfy themselves about a vessel's fitness for the intended service and this at times included stability considerations. It is interesting to note that, by 1927, German vessels were required to be supplied with stability information; later in 1929, by International Safety Convention, all passenger vessels were required to be inclined and their officers supplied with sufficient stability data for the safe handling of the vessels.

The International Safety Convention of 1948 extended these earlier requirements to all ships, passenger and otherwise, and provided that comprehensive stability information should be supplied to all new ships.

There are no statutory requirements dealing with watertight bulkheads in cargo vessels, but the Classification Societies, which deal with the construction and survey of most of these vessels themselves, require a minimum number of watertight bulkheads to be fitted, according to the length of the vessel. All vessels are required to have at least one collision bulkhead, and after-peak bulkhead and a bulkhead at each end of the machinery space. The sub-division in many cargo ships approaches the one compartment standard; it will, however, be appreciated that some cargo vessels are built for special trades when one or two large holds are necessary. These vessels in way of their long holds will normally fall short of a one-compartment standard of sub-division, but this will vary with the permeability.

The foregoing gives some indication of the safety problems involved in ensuring that all ships have sufficient reserve buoyancy, structural strength and stability, and, in addition, that passenger ships have a standard of sub-division which will enable them to remain afloat after limited bilging with a sufficient margin of stability.

Cargoes

Now a few words on the subject of cargoes. Bulk cargoes can, and have, caused the loss of many ships. The commonest cargoes in this category are grain and coal. Dangers arising from bulk cargoes shifting were appreciated years ago in the grain trade, and vessels loading in certain ports abroad were required to fit the holds with shifting boards and feeders to prevent the cargo shifting and endangering the vessel's safety by causing her to list. Another example is coal cargo, which, unless carefully trimmed during loading, will allow empty pockets to be left under the decks at the sides of the ship. The coal may shift into these pockets when the vessel is rolling and cause her to take a permanent list, a situation which may well start a train of further mishaps and lead to the subsequent loss of the vessel.

The need to trim coal cargoes has led to the development of the self-trimming collier whose stability should not be affected by rolling in a seaway. Another type of vessel which has been developed for similar reasons is the ore-carrier.

In this modern industrial age, there are many products from industry which are regarded by the authorities as dangerous goods when in transit. They may be said to range from gun-powder to safety matches which, under certain conditions, may cause explosion or fire. These items of cargo must first be packed according to approved specifications before being offered for shipment and they must be stowed in the vessel according to the specification instructions, in some cases away from the heat of the boilers or in magazines, and so on.

These remarks on cargo are sufficient to show how some cargoes could jeopardize the safety of a vessel by loss of stability, explosion, or fire, while other items of cargo could endanger the health of the crew by giving off poisonous gases if not suitably packed.

Fire

The greatest danger to which a ship is more or less constantly exposed throughout her life is fire. The ever-present problem, therefore, is fire prevention, detection, and extinction. The author has already mentioned the care taken with the stowage of dangerous goods.

Coal and bale cotton are typical examples of cargoes which give rise to the risk of spontaneous combustion. Oil fuel, which is burned in the boilers or diesel engines of most ships, is another potential source of fire danger, while in passenger vessels carelessness in the passenger accommodation can cause fire.

The first indication of fire in a cargo hold may come from one of the hold up-draught ventilators. It may be a smell or it may be smoke. The first action in any vessel is to seal off the holds, since fires cannot burn without air. The smothering medium, steam or CO_2, can then be used, if necessary. In passenger vessels smoke detection and alarm systems are usually fitted. A typical system consists of an automatic smoke detecting unit in which a fan, situated above the unit, continuously draws air from each cargo space, storeroom or compartment, which has to be protected. The automatic alarm can be effected by a balanced photo-electric cell in conjunction with a beam of light within the case. When the air from the tube is clear, the balance of the circuit is maintained, but, should smoke emanate from a single tube, some enters the smoke detector and, by reflecting light from the beam, upsets the balance of the cell circuit and automatically operates a bell, or bells, in various selected parts of the ship. Each tube to the unit is fitted with a two-way valve to enable the unit to be isolated and the particular space connected to a battery of CO_2 bottles, which can be discharged into the space, if this becomes necessary.

Oil fuel fires often start in the machinery spaces where the engine-room and boiler-room staff should immediately become aware of the outbreak and bring into action the extinguishing equipment available. The proper action on these occasions must be left to the engine-room crew, but it must be prompt. Should the hand extinguishing equipment fail to put out the fire and it becomes necessary to abandon the machinery spaces, all supplies of oil fuel and air to the engine- and boiler-room, as the case may be, must be stopped. Arrangements for doing this vary in detail in different ships, but in all ships the oil fuel pumps can be stopped from outside the machinery space and the suction valves on the oil fuel tanks can also be operated by remote control arrangements outside the machinery spaces or adjacent compartment. The ventilators and funnel annulus have sealing flaps and when mechanical ventilation is employed, the fan motors can also be stopped by a remote control point. All other possible openings, such as watertight doors, must be closed. The main foam or CO_2 system can then be employed to extinguish the fire.

Oil fuel is a good servant when under control, but a danger when free. Hence every effort is made to limit its freedom, should it escape, by means of savealls under the boiler oil fuel burners, pumping units, and the gutters on the double bottom tank tops in way of the oil fuel bunker bulkheads. These gutters drain to the oily bilges. Hot oil pipes are arranged, as far as practicable, so as to be visible to the operators. The open ends of the air pipes, on deck, from the oil fuel tanks are fitted with wire gauze to prevent fire or explosion in the tank, should any escaping gas be accidentally ignited.

For safety in spaces where oil fuel is used, "cleanliness" is the watchword; cleanliness also usually spells efficiency.

Fires in the passenger accommodation are a frequent occurrence, although fortunately they are usually of a minor character. There have been, however, several major fires with loss of life during the past 25 years, in the *Asia* (1930), where 100 deaths occurred by drowning following a panic, *George Phillipar* (1932) when 40 lives were lost, *L'Atlantique* (1933) when 7 lives were lost, and the *Morro Castle* (1934) when 110 people perished. In post-war years the *Empress of Russia*, *Empire Waveny*, *Lafayette*, *Monarch of Bermuda*, *Prague*, and *Empress of Canada*, are examples of spectacular and disastrous fires.

To protect the accommodation in modern passenger ships, fire-resisting bulkheads are fitted above the bulkhead deck, frequently in line with the watertight bulkheads, and extending through the superstructure, thus dividing the accommodation into fire-containing sections or zones. The main stairways from deck to deck are enclosed and fitted with fire-proof doors at the deck level. These stairways provide in this way not only safe escapes for the passengers, but also means of access to fight the fire. They stop draughts and, in doing so, restrict the spread of fire from deck to deck. Passenger lifts and ventilating trunking, etc., to the zones are also provided with means of stopping the supply of air, thus preventing the spread of fire to other zones.

The problems of dealing with fire when ships are in port are often quite different from those which arise at sea. Frequently only skeleton crews are on board in port. Periodically, ships with only a small working crew are in the hands of the ship repairers for extensive refits, and on these occasions it is quite impossible to maintain the normal arrangements. Passageways become working alley-ways for air hoses, electric cables and other equipment of the repairers. Under these conditions the value of the fire-containing sections is destroyed, as watertight and fire doors and enclosed stairway fire doors are immobilized. Public rooms, state rooms and store rooms are, as far as practicable, kept locked, but they have frequently to be used as storage spaces while work is being done in other parts of the ship and, all too often, they have to be opened to allow access to some fittings. It is little wonder, therefore, that fire patrols are bewildered by the changing conditions; to meet these varying sea and port conditions, the British shipowners have placed their faith in the sprinkler system in order to protect such vulnerable parts as the passenger accommodation.

This system is familiar to everyone, be he seaman or landsman. Fitted in many public buildings, warehouses, and department stores, it is a constant watchman which automatically gives the alarm and leaps into action when there is an outbreak of fire. In many cases the fire is extinguished, or is at least under control, by the time the fire fighters arrive. Other systems for protecting passenger accommodation and store-rooms, etc., are favoured by the Americans and French.

Details of many fire-fighting appliances were given by Mr. Keenan in his address on this subject* in November 1954.

Machinery

With regard to the boilers and machinery, it can be said that safety problems are much nearer to being an exact science than many of the ship problems. The growth of technology in marine engineering and the development of better quality materials, together with knowledge gained from power plant ashore and the experience from the past, have enabled builders to manufacture more reliable machinery and boilers, which are normally free from mishap if operated and maintained in accordance with good practice.

Engineering, however, is a progressive science. New ideas are applied and new methods of construction introduced, all directed towards increased efficiency, which reduce the weight per unit of power or increase the power per unit of floor space. These advances bring their problems to those responsible for safety and reliability when there is no background of experience. Caution by the authorities on these occasions is often misunderstood.

To provide against mishaps due to any human weakness, operational irregularities or defective materials, it is essential that some items of the machinery and boilers should be protected by safety fittings. Commonly known automatic devices include safety valves on the boilers, superheaters and evaporators; relief valves on diesel engine cylinders, steam engine cylinders, and turbine casings; overspeed governors on turbines and main engines generally, alarm bells on the main lubricating oil systems; bursting discs in the h.p. air compressor cooler castings, and fusible plugs in the high-pressure air bottles and air receivers. These safety fittings, it should be noted, are not peculiar only to ship's machinery. One interesting marine example is the lubricating arrangements of emergency generators which must function satisfactorily with the ship inclined from the normal at angles up to 22½ deg. transversely and 15 deg. longitudinally. The requirements for the main generator sets are not quite so strict, being 15 deg. transversely and 10 deg. longitudinally, and, when rolling, up to 22½ deg. from the vertical without spilling of oil.

The survey staffs of the Ministry of Transport and Civil Aviation and Classification Societies are constantly examining the designs of new boilers and engines, etc., not only to confirm that they are strong enough for the intended service, but also to see that they are suitably protected in service against over-pressure, overspeed, or failure of the feed water or lubricating oil supply, as the case may be. All these safety fittings are surveyed and tested during construction and periodically during the life of the ship. Safety fittings themselves become out-dated by the development of the items they protect. For example, as boiler pressures and outputs increased, the direct spring-loaded safety valves became too large for convenience and this led to the development of the high-lift safety valve, which, in turn, is becoming out-dated by the full bore safety valves, the latter being more suitable for modern high-rated watertube boilers.

One more safety measure is the material used for ship's side valve chests in the machinery spaces. These valve chests were formerly made of cast iron but the experience of a number of collisions and ranging against dock walls showed how easily these castings could be broken, allowing the sea to enter the machinery spaces. Underwater explosions in the last war confirm the need for the modern practice of using cast steel chests, fabricated steel chests, or materials with similar physical characteristics.

Electronic safety devices are just beginning to find their way into ships' engine-rooms; one example is the electronic automatic controller for the overboard discharge of oil-free water from oily water separators.

Many of the safety fittings, however, can only be relied on if maintained in good condition. A well-trained engine-room staff, therefore, is the most important safety insurance.

Other Safety Equipment

Of the other essential safety equipment in modern sea-going ships, radio transmitters and receivers and direction finders are possibly the most important. Radio apparatus is a boon to navigators in many ways; it keeps them in touch with their owners and with world events. It also gives them time signals, weather reports, ice warnings, and medical advice when required, and, of utmost importance, enables them to call for assistance from other ships when in distress. While the radio requirements imposed on ships provide standards for the equipment and maintenance of the equipment in efficient condition, possibly the most important provisions are those related to listening for distress calls which ensure that the ships are always available to each other for mutual protection. In this respect, the auto-alarm device, which operates an alarm on receipt of an alarm signal, and thereby alerts the radio officer when not on watch, is an important item of equipment. Direction finders not only enable the navigator to fix his position from shore beacons but are most useful for homing a vessel which has sent out distress signals.

In addition to these essential equipments, there is, in most seagoing ships, other electronic apparatus such as radar, the Decca Navigator, and echo sounding apparatus, all of which contribute to safer navigation.

The navigation lanterns, sound and fog signals, also form part of the essential safety equipment, as do lights on a motor car. The first instructions to surveyors on this subject were issued in 1875 and they were very brief indeed. More detailed instructions were issued in 1912, but these still dealt with oil lights only. The growth in the number of ships fitted with electric lighting during and after the First World War, led to the investigation of the suitability of this new source of lighting being used for the navigation lanterns. New instructions in 1924 gave detailed specifications for both electric and oil lanterns. International

* Keenan, G.: "Fire Appliances," Trans. I. Mar. E., Vol. 67, June 1955, p. 209.

agreement on the particulars of lights, shapes, sound, and fog signals, was attained for the first time at the International Safety Convention in 1948. The International Regulations for preventing Collisions at Sea, agreed at the Convention, came into force on January 1, 1954, and now include the lights to be carried by seaplanes when on the water. This uniformity of practice among the leading maritime powers must have been welcomed by all navigators.

The final item to be mentioned in this section is the emergency bilge pump in passenger vessels, which is as far removed from the hand pumps in old sailing vessels, and the command "all hands to the pumps," as the echo sounding apparatus is from the hand lead line. The pumps are generally of the submersible type, the motor being connected to the emergency generator switchboard. The pump is frequently fitted in the shaft tunnel space, but it may be fitted in any similar space, which can be isolated from the machinery space in which the main bilge pumps are fitted, so that it may be brought into action as necessary should the machinery space in which the bilge pumps are fitted be immobilized by fire or flooding. The pump is connected to the main bilge lines and all the valves on the bilge lines can be operated from above the bulkhead deck by extended spindles or by a pneumatic-hydraulic system, so that the pump can draw from any compartment connected to the bilge pipe lines.

Life Saving Appliances.—In spite of all the safety precautions mentioned, ships do, on occasions, have to be abandoned by the passengers and crew. Their safety then depends on the equipment known as the Life Saving Apparatus which covers the lifeboats, buoyant apparatus, lifebuoys and life jackets. The author is sure that the present generation would think a passenger ship looked naked if she did not have on the upper deck a row of lifeboats along each side.

There is no doubt, of course, that the presence of lifeboats is of immense psychological value to the ordinary passenger, but in the author's opinion, it is doubtful whether lifeboats have the same practical value as, so often when required to fulfil their function in an emergency, the launching of possibly one-half of the boats is prevented by the list and movement of the vessel; and, of those that are launched, it is not uncommon to read of several being smashed against the side of the ship and rendered useless.

It will not be attempted here to detail the Life Saving Appliances requirements for the different classes of ships, but, instead, the evolution of some of the apparatus during the past forty to fifty years will be briefly dealt with. During that period the normal lifeboats have been standardized as far as dimensions, scantlings, strength, freeboard, stability, tankage, and equipment are concerned; they have grown in seating capacity to over one hundred persons, from wooden construction to steel and now aluminium alloy, which, in the not distant future, may be superseded by plastic materials when these prove to be reliable and economically attractive, and from oars to mechanical and diesel propulsion. The launching gear has developed from man-handled radial davits and manilla rope falls to gravity davits with power operated wire boat falls. It is felt that there is still scope for the inventive mind, at least so far as the design of davits is concerned.

Readers may be interested to know that certain manufacturers of inflatable rubber dinghies are pressing for their acceptance in place of the heavy rigid buoyant apparatus. As an experiment, two types of self-inflatable rubber dinghies have been approved for use in vessels on and around our coasts. These rubber dinghies are a post-war development of the dinghies used by the R.A.F., having a complete canopy to protect the occupants.* Developments in this sphere will continue as the records indicate that more people perish at sea by exposure than by drowning when a ship has been abandoned, and protection in an inflatable rubber dinghy seems preferable to hanging on to a life line of a piece of rigid buoyant apparatus in a cold sea. Progress is the motto of most people engaged in the shipping world and who can foretell future developments?

For disembarkation in darkness, passenger ships have emergency lighting systems independent of the engine-room main generators. The emergency generator or batteries supply the lighting to the passenger accommodation, the exits, the muster stations and overside in way of the lifeboats. Every conceivable contingency is thus provided for.

* See also Holt, W. J., R.C.N.C. (M.I.N.A.), "Recent Developments in Naval Life-Saving Equipment," Trans. I.N.A., 1955, p. 331.

Crew

All the safety measures just mentioned would be of no avail if the crews who man the ships are not highly trained and efficient in their duties. The navigating officers, wireless officers, and seamen must all be experts in their own departments, but their knowledge and the constructional safety arrangements in the ship can be set at nought if the machinery cannot at all times be operated as required by the master. The engineer officers therefore carry a great responsibility in maintaining all the machinery under their care in an efficient condition always ready for duty. The engine-room is the heart of the ship, and therefore engineer officers who have had practical experience and technical training second to none are required. The modern marine engineer must understand more than his predecessors, in fact he is becoming a technologist and possibly quite soon he will require to be also a quasi-physicist to handle the atomic steam generators of the future. That is why his skill, like those of the navigating and wireless officers, has to be tested by examinations to make sure he has at least the minimum of practical experience and of technical knowledge considered necessary for the safe operation and maintenance of the machinery.

One further point to remember is that a ship's crew is a team. They are limited in numbers and therefore to some extent they must be interchangeable in an emergency. Crew changes, partially or wholly, take place almost every voyage, hence it is necessary to have regular musters for boat and fire drills and the operation of watertight doors, etc., to familiarize the crew with the equipment and with each other.

Conclusion

It might be as well at this point to refer back to the question posed early in the paper: "What are the problems which require to be regulated by Parliamentary authority?" If the shipowners in this and other maritime countries were allowed the necessary freedom to provide their own standards of safety in their ships, the outcome, even with the best of intentions, would be chaotic. The resulting unfair competition would tend to create a uniform low rather than a high standard of safety. By having one Government authority which is responsible as in the present arrangement to-day, the best ideas of shipowners, shipbuilders, and other interested parties are co-ordinated to the advantage of the public, the shipping industry, and all concerned. Finally, by arranging regular international conferences, the ideas of all maritime countries are pooled, carefully considered, and, after agreement has been reached, rules are drawn up, which this paper has briefly touched on, and these tend to maintain a high and uniform standard throughout the world. The present-day British shipowners now rely on the authorities for guidance in many of these safety questions and are only too anxious to co-operate in every way.

The opinions expressed in this paper are those of the author and not those of the Ministry of Transport and Civil Aviation, which is responsible for the administration of the various Shipping Acts and Orders.