INSTITUTE OF MARINE ENGINEERS

INCORPORATED.

SESSION 1916-17.

President: SIR JAMES MILLS, K.C.M.G.

VOLUME XXVIII.

Paper of Transactions, No. CCXXIII.

The Utilisation of Coal.

BY MR. J. D. McARTHUR (Member).

READ

Tuesday, November 7, 1916, at 7 p.m.

CHAIRMAN:—MR. F. M. TIMPSON (Member of Council).

DISCUSSION.

In accordance with a suggestion made on the evening of the reading of the paper the publication of the discussion was held over to give members an opportunity of contributing by correspondence.

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The CHAIRMAN: Mr. McArthur has given us a very interesting and instructive paper on a most important subject to this country. One item he speaks of is the utilisation of slack coal and a great deal may be done in the utilisation of small coal in the form of briquettes, of which I believe several forms are coming into regular use. In respect to efficiency tests, we have recently had the benefit of a very valuable paper from one of our members describing apparatus for testing the efficiency of steam plant; for such apparatus there is a growing demand owing to the necessity to lessen the many crude uses of our great national asset, coal, which is the basis of so many products of service in modern processes of manufacture and creation of power. I understand that prior to the outbreak of war, our friends the French were buying up the greater part of the output of benzol in this country, as produced in coal areas and at gas works, while there is no doubt this means of supply has been a considerable asset to our present enemies when cut off from oil producing areas in obtaining motor spirit; also other raw material required in the making of explosives, etc., British authorities are no doubt giving coal and its products attention and we may look for more research and information being available for engineers to deal with the matter. The subject offers good opportunity for discussion and those of our members present who may have special experience in regard to coal savings effected with steam plant in their charge, would add to the value of the paper, if they would contribute their views on the subject either this evening, or by correspondence, to be embodied in the transactions.

Mr. Jas. Shanks (Member): The paper is on such an interesting subject that I cannot resist the temptation to pass a few remarks.

Many years ago it was, I believe, the practice in Scotch collieries to use the "graip" in loading the trucks in the pits, and as long as this practice was continued there was a great waste of small coal, but I think the author will find that at the present time the bulk of the small coal is now brought to the surface and utilised for all manner of purposes. With the present-day appliances for washing and utilisation of by-products, it would be a disgrace if it were otherwise. The author's remarks on the wasteful type of engine often kept at work, is no exaggeration. Brought up as I was in early life among collieries, I know only too well that clearances in cylinders is often found as great as Mr. McArthur draws attention to and it recalls to my mind a pumping engine I re-erected 40 years ago—and it was then 50 years old—where the clearance exceeded 2ins. at each end. Two years ago I saw this engine still at work and wondered what its consumption per I.H.P. would be. To a marine engineer the waste appeared almost criminal, and I agree that too little attention is still being paid to more economical motive power in many industries. I agree with Mr.

Beckett that the Diesel engine must not be set aside as a secondary consideration; as soon as oil can be procured at a price to compete with coal, there is a great future for it and it has been the means of arousing marine engineers to the necessity of improvements in design with increased economy of the steam engine.

I was especially interested in Mr. Anderson's remarks with regard to coke ovens. I gather that the most modern type, even in this country, are of German design, erected under the supervision of German experts and that a stipulation was made that Germany was to get all the benzol extracted from the by-products. This may account for an incident in the war, which occurred in connection with a benzol works in the North of England some time ago.

The paper has brought before us many things which we, as marine engineers, must strive to improve upon, if we intend to maintain our supremacy on the seas.

Mr. B. P. Fielden (Member): It is not my experience that ships are supplied with all lump coal, in fact, quite the reverse —a large percentage of it is slack and firemen complain that they have not enough large pieces to set their fires away after cleaning the fires. In regard to the comparative costs of coals and oil quoted, when the former is used for generating steam and the latter is used in a Diesel engine, the comparison should include the differences in weight of cargo carried, as well as space, because the Diesel engined ship of same dimensions carries more cargo per ton of fuel than the coal burning ship. In two 6,500 D.W. ships of equal dimensions now running, the difference in weight of cargo carried on a U.S.A. voyage is approximately 500 tons in favour of the Diesel ship, for the principal reason that the Diesel ship leaves port with one quarter of the weight of fuel that the other takes. When one considers the present freight charges, the gain in favour of Diesel engines is quite an item and when it is possible for a ship to take sufficient fuel in the East to bring the vessel to England without delay for coaling purposes and considering the present high cost of coal in the Mediterranean ports, then it appears to me that the Diesel engine is the one which those interested in shipping in this country should develop. Another big loss of fuel takes place on coal burning vessels when laid at anchorages and raising steam in port. In a Diesel engine there are no such wastes, for the reason that as soon as the engine is stopped so is the consumption of fuel. In port, steam winches are un-economical machines and the fires have to be banked at night, whereas with a Diesel engine driving a dynamo and using electric winches the comparative value of oil versus coal appears to be about 1·7.

Mr. F. O. Beckett (Member): I have much pleasure in adding my testimony in the discussion on this very valuable paper. In the first part, I find that we stand at the same old place with that bugbear, "professional jealousy," be it from the engineer or the chemist. When the time comes that we can pool our resources without setting up antagonism, the millenium will have arrived. Engineers with chemical endowments, as well as chemists with engineering sympathies, will then be in a position to work hand in hand for the utilisation of power to the best advantage and to national economy. The advantages of the carbonisation at low temperature with the residue of useful power is a step in the right direction. But long ago—and I have no doubt many members will remember and respect him—one William Murdoch was the originator of gas. He also won the Romford Gold Medal of the Royal Society of Arts for illustrating his production of gas, in describing which he mentioned tar. He tried to use it in making aniline dyes and a dye for protecting ships' bottoms from corrosion and barnacles. These schemes simply remained in the archives till now we are gaining in the by-products of coke. Speaking of coke, owing to war necessities, one plant to my knowledge was producing one million to a million and a third in peace times. To-day it is producing 28 millions. The consequence was that a huge cinder heap of coke was formed and to show how engineers as a body have answered the call of their country in its trials, experiments were made with a few land boilers to reduce this excess storage of a by-product, and I am told that many trials were made and were successful in burning coke that went through a 2in. mesh and not through a 1in. mesh, and found that where there was a good draught—that is the limiting factor—there must be a good draught—the coke kept the steam up as well as the coal. Of course I am speaking of hand stoked fires and not of mechanical stokers.

Turning in thought back to the early days of vegetable and chemical dyes, and I am of opinion, though what we state here is privileged, that this country has not treated her pioneers as well as other countries have. We are too insular. The manufacture of aniline dyes is a dirty occupation, and it seems to me very much discouraged here, and I fear that is one of the reasons why Germany holds the monopoly, to the cost of our vegetable dyes, especially woad or indigo.

The author speaks of the Diesel engine as one of secondary importance. I fear I part company with him here. What is particularly wanted is an engineer who understands the engine. Many breakdowns, I regret to say, have been caused through want of proper knowledge of the engine. The engineer is to be blamed, not the engine. Talking about the gas engine for ship propulsion, I am inclined to say that the writer omitted the increase of bunker capacity for coke over that of coal, though for grate areas per hundred break horse-power 3·5 square feet as against 10 or 12 feet for coal of the steam engine. Marine engineering has to be brought up to date, and I suppose in time and in the near future we shall get internal combustion engines as well as steam engines pure and simple.

As the pioneer marine engineers of nearly a century ago overcame insurmountable difficulties, so I suppose in this new coke-gas driven engine, men worthy of this Institute will be found to solve the difficulties, especially of circulating water in the Red Sea at 94 degrees, without overheating the pistons. I appreciate the worthiness of this paper to-night and trust the engineering world will see our Institute keeping well abreast of the times. I am glad the Research Committee are getting to work and that the country's Treasury is backing up a want long felt in our engineering laboratories to develop the individual as well as collective knowledge on this important subject of national economy.

Mr. O. B. Richardson: Our thanks are due to-night to Mr. McArthur for his excellent paper. Like Mr. Shanks, I was brought up among collieries, and can endorse all that he has said about the use of the "graip"; also the enormous waste at some collieries carrying on with out-of-date machinery. At other pits, coal washing plants are installed and Scotch washed peats on chain grates give the best possible results. The linking up of power stations and the abolition of small plants in factories would do much towards the economy of fuel. In Tyneside district there is not a firm or factory but what derives its power from the central station. The use of Crosthwaite furnaces would also prove economical in many instances, at the present moment I am burning coke breeze and slack with excellent results. The general adoption of mechanical stokers in power stations is proving a great saving in enabling small coal to be burnt, a large percentage of which was previously wasted. I believe the day will come when we shall see mechanical stokers in use on board ship. As to the competition of German coal I don't think there is anything to be feared, as what I have burnt had no body in it and was gone as soon as fired.

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Mr. S. G. Marthew has forwarded as a contribution on this subject a copy of the reply he gave to a discussion on "Solid Fuel," which was the outcome of a paper he read before the Association of Engineers-in-Charge, on "Solid Fuels."

Trinidad pitch is the unevaporated residue of liquid fuel. The most up-to-date method of drying peat is to convert it into pulp, when it can be very thoroughly dried, the peat being reduced to one-fifth of its original volume. In its powdered form peat is used on Swedish locomotives, the fire-box being arranged with refractory walls. As with pulverised coal, the refractory lining must in every case be of very good fireclay or similar material, which will not run easily, and special precautions must be taken to ensure that the injected fuel will impinge on a non-metal surface or upon one free from steam pressure.

Until recently, at any rate, it was not thought commercially practicable to bring to bank the whole of the coal mined, which includes dust, dross, etc. This would explain the allusion in the paper to the 25 per cent. left in British collieries. At this time of stress, it is a national duty to extract it wherever possible. When converting a plant to consume coke, many means have been tried. First of all coke, without any special furnace fittings, was tested, the fire-bars suffering, and a lot of clinker, very difficult to remove, being left. It having been established, after careful inquiry, that a constant supply of suitable coke could be obtained by insistence on the right quality and unremitting attention to that supplied, the steam-jet appliances were installed in the boilers, which, when examined later, exhibited no signs of having been adversely affected by gases introduced through the steam on the boiler plates. Locomotives, however, equipped with copper fire-boxes, and boilers fitted with brass tubes, suffer when by-product fuel is used. The effect of the small particles of coke and breeze seems to be to set up what ultimately develop into perforations of the non-ferrous plates or tubes. To the main boilers in each furnace there were two rows of hollow fire-bars, plugged with fireclay, each containing 17 bars $1\frac{1}{2}$ in. wide, with $\frac{3}{8}$ in. air spaces. An improvement to this was effected by removing one bar from each row, thus increasing the air spaces to nearly $\frac{1}{2}$ in., which worked satisfactorily. The holes in the gunmetal nozzles of the steam jets were enlarged from the original $\frac{1}{16}$ in. to $\frac{1}{8}$ in. diameter. These jets prevented accumulation of clinker, and when deposited was more easily removed, by reason of their action, and the life of the fire-bars was thus consequently considerably prolonged.

Owing to variation in the loads of the plant, there is not always a sufficiency of the by-product fuel, so that at times steam coal only may be used, and coke and breeze alone on other occasions. The costs for a week early in December, 1916, on the plant referred to are as follows:—

	£	s.	d.
25 tons steam coal, at 36s. ton	45	0	0
12 tons coke, at 30s. ton	18	0	0
6 tons breeze, at 15s. ton	4	10	0
	£67	10	0

During this time the total estimated quantity of water converted into steam was 97,000 gallons, giving cost of evaporation as just under 14s. per thousand gallons. In order to obtain a proper comparison with the corresponding week of 1914, it must be assumed that prices were the same; therefore the cost during that period, when 45 tons best Welsh smokeless steam coal were consumed, was: 45 tons, at 36s. ton, £81, giving a difference in favour of present practice of £13 10s., which works out at 16·6 per cent saved for the week. It might, therefore, be stated that the £750 quoted represented an economy of roughly 20 per cent., as beside the five main Lancashire and Cornish boilers there are a number of domestic fireplaces and other consuming agents. The percentage of ash, necessarily higher than that of high-class Welsh coal, came out at about 12 per cent. of weight of coke when it alone was consumed. There is no doubt that the quality of coke may vary greatly, according to the supplier, who depends largely upon the delivery from the colliery.

Pitch as a fuel possesses greater potentialities, although, as is likely with coke, its adoption on any tremendous scale would cause a prohibitive increase in its cost. The logical method of producing power is, of course, to have a large station preferably at the pit-mouth. The coal would be brought up and distilled, its by-products, including materials for dyes and explosives, oils, etc., extracted, and the gas distributed for power and lighting purposes.

Calorific value is almost a fetish with some people. If the calorific value is somewhat low, it by no means follows that the fuel will not be satisfactory for steam-raising when suitably managed, and arrangements made to suit the circumstances.

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*It is with regret that Mr. McArthur finds he is unable, on account of illness, to deal further with the subject. He desired that attention be directed to the following as illustrative of the reference in the paper to gas producers:—

Wolverine Marine Engines in Combination with Marine Gas Producers.

The Marine Gas Producer is a well-built, strong, substantial, and carefully designed device that will withstand the hardest usage during the life time of any gas engine. In design, it is a radical departure from the usual land-producer which has been tried repeatedly for marine work, but which has been found too heavy and bulky for practical use.

A Marine Producer Plant consists of the *Generator*, made of heavy steel plates lined with special high grade fire brick behind which is a special heat resisting and insulating material. The Grate is of such design that it allows of cleaning easily.

The apparatus, other than the Generator and Scrubber, consists of a Plunger Pump for supplying water to the Scrubber and Fire Tools for cleaning the fire.

Fuel is supplied to the producer while the engine is in operation by means of a special form of coal hopper on top of the producer.

The *Scrubber* is a device for cooling and drying the gas and removing from it ashes, tar, or any other substances that should not pass through the engine valves. A series of glass tubes, acting as gauges, shows at all times the exact condition of the scrubber device. Should any part need attention, the glasses will indicate it and give ample notice before the satisfactory working of the plant would be interfered with.

* Our sympathy is extended to Mrs. McArthur, from whom intimation of her husband's death has been received as this issue was in course of being printed, very much to our regret.

Reliability, Durability, Low Fuel Consumption, and Low Attendance cost are the features of the marine producer in combination with the "Wolverine" Engine.

The fire in the producer once lighted does not require being withdrawn for a considerable length of time. Plants have been run for six months and more without ever drawing the fire, and it was then still in as good condition as when first lighted.

Heat from the gas producer is in no way objectionable, even in tropical climates, as the generator is air-tight and insulated with a heavy fire-brick lining backed with a special heat-resisting material, and further moisture is automatically introduced with the intake of air below the grate to prevent high temperatures in the fuel bed. This at the same time prevents the formation of clinkers and enriches the gas.

Method of Operation.—A fire is kindled in the Generator and supplied with the fuel that is to be used—anthracite coal, coke, or charcoal, and the gas is generated by means of a hand or mechanically operated fan until such time as the gas can be lighted at a place provided on the generator or alongside the engine. After the engine is started on the gas and is in operation, the plant works automatically, the draft through the fuel bed being maintained by the suction of the engine pistons which draw the air through the fire, forming a gas and carrying it through the scrubber into the mixing valve alongside the engine, at which place it is combined with the proper quantity of air, by means of electric spark in connection with the "Wolverine" mechanical igniter.

The time required for building a new fire in a producer and getting gas of sufficient quantity and proper quality for operation will not exceed one-half to one hour, after which the fire can be maintained for periods as long as six months or more, in good condition. The time required for starting the plant, after a considerable lay-over, is from ten to thirty minutes.

In operation, the producer requires fresh fuel at intervals of one to three or four hours, depending upon the service in which the boat is engaged.

The producer can be filled and the fire allowed to remain for periods as long as one week without attention if the boat is not in use.

There is no pressure on the gas anywhere outside of the engine as the apparatus works under slight vacuum. The danger from explosion, therefore, is absolutely eliminated.

The consumption of fuel in the producer when not in operation is practically nothing as it is only what is burned by natural draft through a small pipe with practically all air to the producer cut off.

Fuel.

Kind of Fuel Required.—The Marine Gas Producer will operate equally well at sea or in river service, and practically any anthracite coal, pea-size, lumps about ½ inch (13mm.), gas-coke or charcoal can be used as fuel.

Fuel Consumption.—The fuel consumption of pea-size anthracite coal, working at full load, is only about one to one and one-quarter pounds (450 to 550 grams) per actual Horse Power per hour, thus providing the *cheapest motive power in existence.*

Cost of Operation.—Under actual working conditions, an operating cost equivalent to the cost of oil fuel at 3 cents (1½d.) (15 centimes) per gallon has been obtained, using anthracite coal costing $7.50 (£1 11s. 3d.) (Frs. 39) per ton of 2,000 pounds (910 kilos).

Economy.—The saving in fuel cost is such that the difference in first cost of installation is soon made up, and the saving then becomes a large return on the original investment.

Demonstrated Practicability.—This device has been successfully operated, without the employment of skilled attendants in commercial service in connection with the "Wolverine" Engine since 1911 both in commercial fisheries at sea and in freight transportation at sea and on rivers, thus proving it to be entirely practical.

Flexibility of the Engine.—The control of the "Wolverine" Engine in connection with the producer is very flexible, and can be varied at the will of the operator. The engine, in fact, has all the niceties of control of a steam plant, and the manœuvring qualities are extraordinary, due to the proper design and suitability of the "Wolverine" Engine.

Twin Screw Outfits.—Installations can be furnished either for single or twin screw, in single units from 18 up to 175 actual H.P., in twin screw units up to 350 actual H.P.

Where twin screw units are used, one producer only is necessary. The engines are built right and left hand, so that the controls are brought together in the centre, between the engines. The same great flexibility and manœuvring qualities are maintained with twin screw installations as are found in single screw installations.

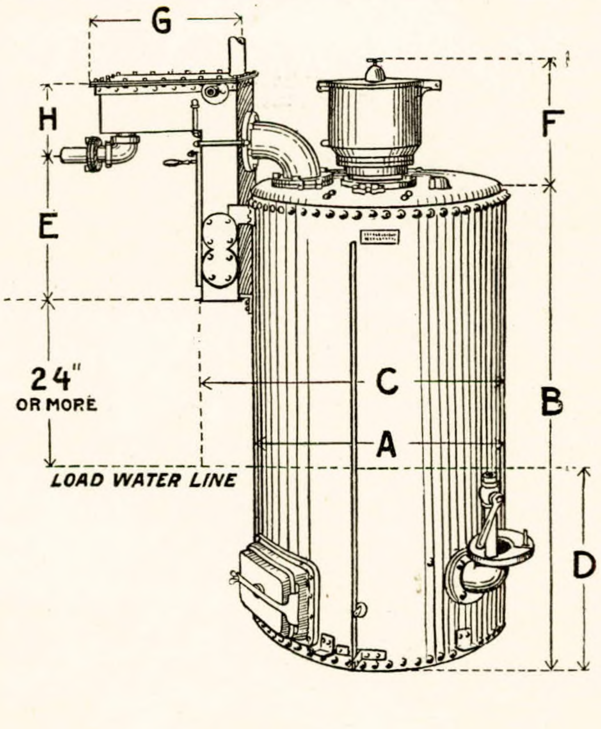
Guarantee.—The guarantee covers economy, reliability, safety, and satisfactory operation when instructions are followed, and further covers a full load fuel consumption not exceeding one to one and one-quarter pounds (450 to 550 grams) of clean pea-size anthracite coal per actual H.P. per hour.

Further particulars will be gladly furnished upon application.

"Wolverine" Engine and Marine Producer Installation.

DIMENSIONS—MARINE GAS PRODUCERS (in inches).

H.P.	18	27	40	50	65	75	100	150	200	250	300	350
A	31	35	41	45	49	55	61	73	79	91	97	103
B	62	62	63	63	75	75	75	87	87	99	111	111
C	41	45	51	55	59	65	71	92	98	110	117	122
D	This varies and depends on the boat installation in each case											
E	36	36	36	36	48	48	48	50	50	55	55	55
F	18	18	18	18	18	18	18	18	24	24	24	24
G	28	28	28	28	30	30	30	40	40	42	42	42
H	12½	12½	13	13	13	13½	14	22¼	7	7	8	8



WEIGHTS.

H.P.	18	27	40	50	65	75	100	150	200	250	300	350
Export Measurement ... ... (Cubic Feet)	75	110	130	175	200	224	290	405	540	675	840	995
Net Weight ... (Pounds)	1800	2500	3500	3900	5400	6000	7000	11250	15000	18750	22500	27000
Gross Weight ... (Pounds)	2400	4025	4200	4800	6150	7500	8500	14600	17000	21800	26500	32000
Weight of Coal Capacity ... (Pounds)	330	472	750	950	1400	1760	2300	4600	5550	8850	9300	9900

The output of coal in India is also of interest, quoted from *The Iron and Coal Trades Review* :—

Mineral Production of India in 1915.—In the *Review* of October 13th last an abstract of the annual report of the Chief Inspector of Mines in India was given, comprising particulars of the output of coal and some other minerals in that country in 1915; the returns, however, were confined to the work under the Indian Mines Act only. In a recent issue of the "Records of the Geological Survey of India," the Director of the Survey (Mr. H. H. Hayden) submits details of mineral output during the same year as applied to the country as a whole, from which the following extracts are taken:—

Coal.—Of the eight leading industries only one, namely, coal, shows a decrease in the value of its output; at the same time, the actual quantity produced has increased considerably and has risen from a little under $16\frac{1}{2}$ million tons in the preceding year to over 17 million tons. This, of course, means that there has been a considerable fall in the price of coal, the direct cause being the scarcity of steamers and the consequent restriction of shipments from Calcutta to other Indian ports. The substantial increase in the output combined with the lack of seaborne transport resulted in a considerable fall in the pit's mouth value in the chief producing areas, the price falling in the Bengal fields from about 5s. 2d. per ton in 1914 to about 4s. 6d. in 1915, and in Bihar and Orissa from about 4s. 3d. to about 4s.

The following table gives the output of coal in the various provinces in 1914 and 1915:—

INDIAN COAL OUTPUT IN 1914 AND 1915.

Province.	1914.	1915.
	Tons.	Tons.
Assam	305,160	311,296
Baluchistan	48,234	43,607
Bengal	4,424,557	4,975,460
Bihar and Orissa..	10,661,062	10,718,155
Burma	—	25
Central India	152,906	139,680
Central Provinces	244,745	253,118
Hyderabad	555,991	586,824
North-West Frontier Province ..	94	60
Punjab	54,303	57,911
Rajputana (Bikaner)	17,211	17,796
Total	16,464,263	17,103,932

The output of the Gondwana coalfields was nearly 97·5 per cent. of the total Indian output in both years. The relative proportions of the output contributed by the Jharia and the Raniganj fields respectively were slightly different to that of recent years, the output of the Jharia field having fallen slightly in 1915, whereas that of Raniganj rose by over half a million tons; the respective percentages of the total output of India as regards these two coalfields were—Jharia, 53·44 and Raniganj, 32·07 in 1915, as against 55·55 and 30·04 per cent. in the preceding year.

The following table shows the exports of coal and coke from India to the various places of destination in 1914 and 1915:—

EXPORTS OF INDIAN COAL AND COKE.

Destination.	1914.	1915.
	Tons.	Tons.
Ceylon	340,289	554,885
Straits Settlements (including Labuan)	111,024	99,363
Sumatra	83,698	64,263
Other countries	42,933	33,290
Total	577,944	751,801
Coke	1,802	1,241

Exports from Bengal to Ceylon rose considerably, while those by sea to Indian ports fell from the normal figure of over 2,000,000 tons to a little over 1,000,000. As might have been expected, the imports of coal were insignficant, amounting to a little over 173,000 tons. The following table shows the total imports of coal, coke and patent fuel in each of the two years:—

IMPORTS OF COAL, COKE AND PATENT FUEL.

Countries whence Derived.	1914.	1915.
	Tons.	Tons.
Australia (including New Zealand) ..	33,419	28,106
Japan	32,232	18,069
Natal	39,140	15,292
Portuguese East Africa	58,742	52,312
Transvaal	40,355	26,448
United Kingdom	156,863	30,149
Other countries	39,612	3,075
Total	400,363	173,451
Coke	12,729	10,241
Patent fuel	5,666	6,962
Government stores	54,738	12,379
Total	473,496	203,033

There was a steady rise in the total number of persons employed in the industry, this now amounting to 160,086; the output per person employed, however, was again less than in the preceding year, having fallen from 108·76 tons in 1914 to 106·84 tons in 1915.

From a paper read before the International Railway Fuel Association by Mr. R. G. Bailey, the following is quoted from *The Engineer and Coal Trades Advertiser*:—

Fuel Analysis.—Before the International Railway Fuel Association E. G. Bailey read a paper on "Fuel Analysis," in which he said:—The purpose of a test on coal or any other material is to arrive at definite conclusions by a short cut, and yet with sufficient accuracy that the results of the test may form the basis of comparison for the purchase or use of the material tested. There is no test, nor can there be any test, that will replace results obtained from actual practice. But it is impossible to burn two coals under the same conditions at the same time, and it is unnecessary to state that in actual practice conditions do vary, so that comparisons based upon actual service results alone are often unfair to one coal or the other, or at least they lead to indefinite conclusions. Another kind of test where the operating conditions are more nearly under control is a road test where a great many data covering operating conditions are accumulated in addition to the consumption of coal per ton mile, so that should the conditions vary from one test to another certain allowances can be made. No criticism can be made of carefully conducted road tests, but they require time, and are very expensive, and it is desirable to have some quicker and cheaper method of checking up the comparative values of different kinds of coal or different shipments of coal from the same company. For this purpose, the chemical analysis of coal has been very widely used during the past ten or twenty years by practically all coal consumers in the country. The purpose and value of coal analysis should be better understood. The chemist, as a rule, passes his figures on to the purchasing agent or superintendent of motive power with little or no comment or interpretation. The man who is responsible for the buying or burning of the coal is most interested in making a comparison of it with other coals which are available. He accepts the figures from the chemist for the purpose of such comparison, and proceeds to draw certain conclusions as to the relative value of the two coals, based upon one or two constituents, such as the percentage of ash, sulphur, or B.T.U., according to his own ideas of what the chemist's figures really mean. Very often these conclusions are not borne out by the practical road tests or the actual use of the coal in regular service. Theory and practice do not always agree. But theory and practice should and do agree when they are both right. It is regretted that too often the results of the chemical analysis are wrong, not by insignificant fractions of 1 per cent., but by several per cent. or several hundred B.T.U. Very frequently the trouble is in the sampling, where the original sample is not large enough to be truly representative, or else it may not have been properly reduced and pulverised. The sampling question is of much greater importance than it has usually been considered. In the case of coal used for the generation of steam, the primary factor is the heating value of the coal. In other words, all coal for these purposes has as its principal object the generation of heat to evaporate water. The matter of primary consideration is to evaporate a given amount of water at the lowest cost; and it should be remembered that the cost of fuel alone is not the entire item, for the character of the fuel has a great deal to do with the cost of repairs to grate bars, furnace linings, and arches; and of very great importance in the case of locomotive practice is the question of capacity which can be obtained. With the introduction of calorimeters for determining the heating value of coal, many chemists considered that the whole question of fuel value was summed up in the one item of B.T.U., and consequently comparisons were drawn between different coals upon their B.T.U. basis, allowing no consideration for their other characteristics. It was soon learned, however, that such results do not always agree with results of practice, consequently many practical men have become sceptical of the value of coal analysis for giving them the dependable information which they desire.

The following is quoted from an article contributed by Mr. J. H. Anderson (Member) to *The Grays Co-operative Society's Journal*:—

"From coal we obtain a host of material other than heat, which is necessary for different manufactures and processes. The gas companies require coal for the manufacture of gas; steel and iron makers use it in the form of coke for the making of steel or iron; electricity companies use it for the generation of steam. The same applies to the various manufacturing concerns, and, finally, there are the domestic users of coal as fuel. Practically all these users of coal waste something that the other requires, and the useful heat extracted and applied may only be 2 per cent.—and rarely 15 per cent.—of that in the fuel, irrespective of the by-products, the value of which in some instances amount to almost as much as the price of the fuel. Practically all these users of coal shift and trans-ship it probably half a dozen times, or even more, from the time it leaves the colliery until it is consumed; the last operation in many instances being done by horses and carts, or by manual labour—carrying it in sacks and putting it into the most awkward places imaginable. Then, again, each of them contribute a great deal to the unsightliness of our towns and villages by polluting the atmosphere with filth and soot The quantity of coal brought into the London district runs into several millions of tons per annum. This coal is distributed among electric supply companies, gas companies, merchants who distribute it for domestic use, and also for manufacturing purposes. At any rate, apart from the millions who use raw coal for domestic purposes, there must be thousands of works using coal for the generation of power for some purpose or other, from the largest electricity generating station down to the humble plant consisting of a small boiler that one could almost carry away in their arms. Suppose, now, that we could get the gas companies, electric supply companies, manufacturers, and all the present users of coal to work in harmony on a co-operative basis. We secure a piece of land at the river edge where there is water deep enough to bring modern colliers alongside laden with coal, this coal to be discharged by machinery directly into the place where it will be consumed. We first extract the by-products, which are so essential; then we make the gas, and finally we utilise the coke at the same place—all for power purposes or gas making. There will be nothing left but the ash or clinker, which probably could be used for the manufacture of some useful material, such as paving-slabs, brick making, or if treated with some of the by-products we previously obtained we could use it for road making. We thus get everything possible from the coal, and, owing to the concentration of the plant and the economical use made of the fuel, we shall be able to have both gas and electricity at unheard-of prices; so much so that no manufacturer, or even domestic user of coal, would dream of using the solid fuel, because of getting their power or heat by either gas or electricity from the central source, where they recover practically the price of the coal from the by-products alone, it stands to reason that competition would be out of the question. For domestic purposes we could use either gas or electricity for heating. Each house could have a central heating arrangement of hot pipes, probably heated by gas, and the temperature of the rooms could be automatically controlled if necessary. For lighting or cooking we again have the choice of both methods. The cheap production of electrical power by centralisation will no doubt do away with a certain amount of labour of a kind, but on the other hand it will be an attraction for many new industries that are now carried on abroad, and which would create a greater demand for labour than that displaced by centralisation. As a matter of fact, we import a considerable amount of material from various countries owing to the cost of manufacture being less, due to cheap power production. Wages is a small item in comparison with efficient power production. Another point is our towns would be much more healthy and cleaner than they now are, owing to no smoke or soot polluting the atmosphere. For domestic use we may obtain to-day probably 2 per cent. of the heat value from coal, the remainder going up the chimney. If the price of electrical current was not prohibitive, the ideal way to heat a room would be by this means, because there is not the need for any air for combustion; therefore, taking a bedroom as an instance, a radiator could be switched on, say, half an hour before the room was required, all the doors and ventilating arrangements could be closed, therefore all the heat would be used to warm the room. It does not need anything from my pen to let you know what would happen if you tried this with coal, or even to a lesser extent with gas. Of course, if it were possible to do this with coal there would be no need for us to write on this subject; so, until we can get our centralised plant, and while we are compelled to use raw coal, let us get as near as possible to the above result with coal without its inconvenences. First of all, coal must be scientifically brought by those who are in charge of its local distribution, a coal being secured that gives good results from a heating and financial point of view. I mention this because it may not be generally known that some coals give out more than twice the heat of others for the same weight of coal, they are not usually the same proportion in price. When satisfied with the quality and the assurance of a constant supply, the rest remains with the consumers, who can greatly assist to reduce the distribution costs of fuel. The consumers should order their coal in as large a quantity at a time as possible.

The ordering of coal should be done by leaving or posting a card to the Central office even if only for a quarter of a ton. Supposing every one was to do this it would make a considerable reduction in the cost of delivery, which, of course, would be credited to the consumer. Having got the coal, it must be stored in as dry a place as possible. Sprinkling water over coal is a mistake; it takes heat to evaporate the water away."

The following article is from *International Marine Engineering*:—

Common Troubles with the Marine Gas Engine.—While it is almost impossible for one to enumerate all the conditions which will interfere with the efficiency of a marine petrol engine, it is the writer's purpose in this discussion to consider the most common causes of trouble, and give practical suggestions for determining and remedying same,

The first point to be considered is the amount of compression obtainable in the engine cylinder, for upon this depends the successful and economical operation of the engine. Different fuels require different compression pressures, the average compression of an engine using gasolene (petrol) being between 65 lbs. and 70 lbs. per square inch, while for an engine using kerosene (paraffin) it should be in the neighbourhood of 50 lbs. The amount of compression may be determined by inserting a pressure gauge in the spark plug or priming cup opening, and turning the engine over briskly by hand. In cases where the compression is found to be too little, and it is positively known that no compression leaks exist, the following methods are available for increasing same: (*a*) Adding liners between the connecting-rod brasses. (*b*) Fitting a longer connecting rod. (*c*) Lowering the position of the piston pin in the piston. (*d*) Fastening plates to the top of the piston or under side of the cylinder head. (*e*) Decreasing the gasket between the cylinder and cylinder head, or between the upper crankcase and the bedplate. It is upon the fit of the piston and rings, more especially the latter, that compression mainly depends. The piston should fit the cylinder bore with but little looseness, the general practice being to allow about 0·005in. clearance at the top and about 0·003in. at the bottom. The piston rings should possess sufficient elasticity or springiness to press uniformly against the cylinder walls, and should be so located in the piston that no two joints come in line with each other. The rings should slide freely in their grooves, but should have no perceptible side movement. The importance of having the compression exactly right should not be overlooked, and it is therefore essential that the engine be tested frequently for leaks. This test may be made by turning the engine over against compression, and holding it at that point where compression is at its maximum. Should there be any leakage, the effort necessary to hold the engine in this position will gradually decrease. For multiple-cylinder engines this procedure should be followed on each individual cylinder, the compression being relieved on all cylinders except the one under test. While the engine is running, compression leakage at any accessible part, such as the cylinder head joint, spark plug, etc., may be determined by squirting a little lubricating oil around the place where the examination for leakage is to be made, and if a leak exists, bubbles will appear in the oil. A dark discoloration along the outer circumference of both piston and rings is a positive sign that the hot gases of combustion have been leaking by them and steps should be taken immediately to locate and remedy the trouble. Often it will be found that the rings are stuck, due to a gummy deposit in the grooves caused by excessive lubrication or a poor grade of lubricating oil. If such is found to be the case, they should be first loosened by soaking in kerosene (paraffin), carefully removed, and the grooves thoroughly cleaned of all deposit. To remove a piston ring, three pieces of tin or sheet brass about $\frac{3}{8}$in. or $\frac{1}{2}$in. wide by 6in. long should be provided. By slipping one piece under each end of the ring and one under the middle, the ring can easily be removed. Examine the rings to see whether they possess sufficient elasticity to function properly. A weak ring may sometimes be improved by lightly peening it on its inner surface, the outer surface resting on a hard, smooth foundation. This operation, which tends to expand the ring and cause it to press harder against the cylinder walls, must be carefully performed, due to the fact that the rings are generally made of cast iron, which is very easily broken. If the piston-rings work around in their grooves so that their joints come in line, compression leakage is very liable to result. To avoid this trouble, fasten the rings in their proper location by means of small pins, taking care that these pins are securely held in the piston and are of ample size, so as not to shear off. Shiny spots at the joint and diameterically opposite indicate that the ring does not fit the cylinder bore properly. In manufacturing piston rings, they are made slightly larger than the cylinder bore, and then split in order that they may enter the cylinder. After being split, the rings should be pressed together, and the outer surface turned or ground to a true circle, otherwise they will assume an elliptical form when placed in the cylinder, and not fit the bore properly. Perfect-fitting rings should show bright all around the outer circumference. A piston that is worn will permit the charge to leak past, and thereby cause a loss of power. When worn to a considerable degree, the piston will make a slapping noise against the cylinder bore. In this case the only remedy is to fit a new piston. In replacing a piston in a cylinder having its head cast integral, care must be taken not to slide it in too far, as there is danger of the top ring sliding past the counterbore, or the enlarged diameter of the combustion cylinder. If this happens, the ring will instantly expand over the edge, and prevent the piston from being returned to its proper position. Should compression leakage be traced to the piston, the trouble, if caused by the rings being stuck, can often be overcome by pouring about half a cup of kerosene (paraffin) into the cylinder through the spark-plug opening or priming cup, and allowing it to stand for several hours. The kerosene (paraffin) cuts and dissolves the gumy deposits, and allows the rings to move freely. After the rings have been freed in this manner, rinse out the cylinder with more kerosene (paraffin), and well lubricate it before again starting the engine. A cylinder that is scored or scratched, or one that is worn out of round, is often the cause of lost power and overheating. A scored cylinder may be the result of overheating, broken piston rings, or a loose piston pin. In cases where the scoring is only slight, a small quantity of graphite mixed with the lubricating oil and fed to the cylinder will fill in the scratches and make the cylinder bore perfectly smooth. If this procedure should not prove satisfactory, regrind the cylinder, and fit new rings in the piston. Where the cylinder is found to be worn out of round, or to be deeply scored, the only remedy is to rebore it, and fit a new piston of larger diameter. Compression leakage can often be traced to the joint between the cylinder and cylinder head, and if this cause cannot be remedied by tightening up the studs that hold the head in place, a new gasket must be provided. This gasket should be about $\frac{1}{32}$ in. thick and of a material that will withstand a high degree of heat as well as pressure. In removing a cylinder head for the purpose of fitting a new gasket, do not hammer it or insert a chisel between it and the cylinder. After removing all the connections and the nuts that fasten the head in place, turn the engine over against compression, and the pressure will loosen the head and make its removal easy. Carefully scrape the bearing surfaces of both cylinder and head of all traces of the old gasket. Cut the new gasket, taking care that it does not project into the cylinder, and that there is sufficient clearance around the stud holes to prevent it from buckling and thereby preventing the head from seating evenly. Coat the surface of the gasket that comes in contact with the cylinder head with a mixture of tallow and flake graphite. This will prevent the gasket from sticking to the head, and permit of its removal without destroying the gasket. When the head is in place, first tighten up all the nuts with the fingers; then using a wrench tighten up each nut a trifle at a time, going round the cylinder three or four times, and exerting the same pull for each nut until they are all as tight as it is possible to get them. Never apply full pressure to one nut before the others have been tightened, as such a procedure will tilt the head, and make a perfect seating impossible. After the engine has started and thoroughly warmed up, go over the nuts again, and tighten them up still further. In the case of the two-cycle engine, loss of power can often be attributed to a leaky crankcase, due to defective gaskets or worn crank shaft bearings. Remedy this trouble without delay, for it must be borne in mind that no two-cycle engine can operate efficiently unless the crankcase is absolutely tight. The amount of crankcase compression should be in the neighbourhood of 6lbs. per square inch. The valves and their operating mechanism are a prolific cause of compression leakage, and particular attention should therefore be paid to these parts. For efficient operation, the valves and valve seats should be perfectly smooth, and free from grooves or pitting. Often a particle of carbon or grit will lodge between the valve and its seat, and prevent the valve from seating properly. This can usually be dislodged by rotating the valve on its seat. The intense heat in the cylinder, and the action of the gases on the valves, not only cause them to warp, but also cause the seating surfaces to become rough and pitted, thereby causing compression leakage and loss of power. The most trouble in this respect is due to the exhaust valves, which are surrounded by hot gases during the exhaust stroke. Leaky inlet valves are usually indicated by back-firing or explosions in the carburetter and intake manifold, due to the flame leaking through the valve and igniting the fresh mixture in the intake. Leaky exhaust valves will cause misfiring or loud explosions at the exhaust outlet, due to part of the combustible mixture escaping through the valve into the exhaust pipe and being ignited by the succeeding exhaust of the engine. Valves which are found to be worn or pitted should be ground without delay, otherwise the trouble will soon increase to such an extent that the only remedy will be the fitting of new valves. To regrind a valve, first lift it from its seat. and apply a mixture of lubricating oil and fine emery, or any good valve-grinding compound, to the seating surfaces. Now replace the valve, and applying just enough pressure to ensure contact between the two seating surfaces, rotate the valve back and forth, lifting it from its seat occasionally to prevent grooving and to redistribute the abrasive. When both valve and seat present a smooth, even surface, the grinding is complete, but for accuracy the following test should be made: Spread a little Prussian blue over the valve seat, return the valve, and, applying a slight pressure, give it a fraction of a turn. If the surfaces have been perfectly ground, the blue will show uniformly spread over the seat; otherwise, bare places denoting high spots will be seen. When grinding valves in place on an engine, take care to prevent any of the grinding compound from gaining access to the cylinder bore by stuffing up all openings with waste. After grinding, wash the valves, valve stems, and guides with kerosene (paraffin) in order to remove all traces of the grinding compound, which, if permitted to remain, would cause wear and cutting. Weak or broken valve springs will prevent the valves from seating properly. Weak springs which have lost their temper due to excessive heat may be detected when the engine is running by inserting the end of a screwdriver in the spring and pressing it against the collar on the valve stem. This increases the tension of the spring, and if the engine now operates better it is a sign that the spring is too weak to function properly, and should therefore be replaced. When the valves are closed there should be a clearance between the valve stems and their operating mechanisms, for if these parts were continually in contact the valves would not be able to seat properly, and leakage would be the result. The amount of clearance depends on the size of the engine, and varies from the thickness of a visiting card for small engines to about $\frac{1}{8}$in. for large engines. Wear on the valve seats and regrinding decreases the clearance, and care must therefore be taken to keep it the same as it was when the engine was new. Excessive cooling of the cylinder walls is another cause of lost power, due to the fact that a great amount of heat which otherwise would be transformed into mechanical energy is absorbed by the cool walls. Regulate the volume of water delivered to the jackets so that the temperature of the discharge will be in the neighbourhood of 140° Fahr. Insufficient cooling will cause rapid wear of the cylinder and piston rings, due to the excessive heat destroying the lubricating oil. Faulty carburation will greatly reduce the power and efficiency of the best engine. It is essential that the mixture be exactly correct, neither too rich nor too lean, for in either case loss of power and irregular operation will be the result. A mixture that is too rich is indicated by the engine gradually slowing down or misfiring badly, with black smoke issuing from the exhaust outlet, while a lean mixture is indicated by the engine backfiring and coming to a sudden stop. If the trouble named is noted when the engine is running at low speed, see that the air valve is seating lightly but firmly, and regulate the amount of fuel by means of the needle valve. If the trouble is noted at high speed, and the carburetter has been properly adjusted for low speed, increase or decrease the tension on the air valve spring as the occasion may require, *i.e.*, if the mixture is too rich, decrease the tension; and if too lean, increase the tension. If this does not remedy matters, it will be necessary to regulate the fuel by means of a slight adjustment to the needle valve. Endeavour to make all adjustments for high speed by means of the air valve, for any change in the needle valve will interfere with the low-speed adjustment. There are numerous types of carburetters on the market, but for marine purposes the float feed type is generally used. With this type of carburetter the most probable cause of imperfect carburation is the failure to maintain the proper level of fuel in the float chamber, and consequently at the spray nozzle. If the level is too high, the mixture will be too rich; and if too low, the mixture will be too lean. This trouble may be caused by particles of dirt lodging between the float-controlled valve and its seat, thereby preventing the valve from seating properly, and allowing too much fuel to enter the float chamber, or it may so constrict the opening as to prevent sufficient fuel from entering. Often it will be found that the float has become heavier by absorbing the liquid fuel, in which case too much fuel will be admitted to the float chamber. If a particle of dirt lodges in the spray nozzle it will prevent the passage of sufficient fuel to ensure proper mixture. Air leaks between the carburetter and the engine are to be avoided, as the air will dilute the mixture and cause loss of power. The ignition system is more susceptible of derangement than any other part of the engine, and is perhaps the greatest source of trouble to the average motor-boat owner. Troubles are indicated by the same symptoms as are troubles with the carburation system, and for this reason it is sometimes very difficult to determine which system is at fault. When the engine has been operating irregularly, or misfiring, look first to the source of energy, if a battery system is employed. Go over the wiring, and see that there are no broken leads or loose connections. Examine the timer for defects, and make sure that no short-circuits exist. If, in addition to misfiring, the engine occasionally back-fires, and it is known that the trouble is not due to faulty carburation, examine the timer and vibrator adjustment or the magneto contact points. Misfiring will also be caused by spark plugs having broken insulation, or too wide spark gaps, the latter cause being particularly noticeable when high-tension magnetos are used. Loss of power will be caused by weak batteries and under-pseeded or dirty magnetos, or by running the engine with the spark retarded or advanced too far. If a dry battery is used, test each cell separately, and if any are found to be weak or exhausted, replace with new ones. For efficient operation, a dry cell should show not less than six amperes. A storage battery that shows loss of capacity should be carefully examined. This may be caused by insufficient or impure electrolyte, sulphated plates, sediment in the bottom of the cells, or short-circuits in or between the bells. For testing dry batteries an ammeter is preferable, but for storage batteries a voltmeter must be used. A spark that is retarded too far will not ignite the mixture until after the piston has completed part of its power stroke; consequently, combustion will be slower, due to the decrease in compression, and a great amount of heat that would otherwise be transformed into mechanical energy is lost through the cylinder water jackets. In addition to lost power, a retarded spark will cause overheating and back-firing. A thumping or pounding sound in the cylinder is an indication that the spark is advanced too far. Dirty spark plugs are the most frequent cause of misfiring, and for this reason they should be frequently examined and cleaned. Plugs with cracked or oil-soaked insulators should be replaced. See that the sparking points are not too widely separated. For batteries, the gap should be $\frac{1}{32}$ in., while for high tension magnetos it should be about $\frac{1}{64}$ in. Improper vibrator adjustment is the cause of much trouble and expense, as it uses up the batteries and wastes fuel. Adjust vibrator by first setting the spring rather stiff and running the engine at full speed until it is thoroughly warmed up. Then slowly and gradually decrease the tension of the spring until the engine begins to misfire, at which time slowly increase the tension until misfiring stops, and the correct adjustment will be the result. The vibrator contact points should be kept clean and smooth. The question of lubrication should be given the utmost consideration, for without efficient lubrication the best of engines work badly, and will soon be worn out. The chief aim of all lubrication is to prevent an immediate metallic contact of parts that glide upon each other; by introducing a film of oil between them, friction is diminished and the heat carried off better. In regard to the lubrication of the cylinder, there are special points to be considered, for it must be remembered that the cylinder walls stand alternately in communication with the piston and the hot gases of combustion. The greatest care, therefore, should be taken in the selection of the cylinder oil, and nothing but mineral oils capable of withstanding the excessive heat should ever be used. Never use machine oil or steam-engine cylinder oil, as they are of low fire test, and will burn instantly, leaving a deposit in the cylinder. The lubricating oil must be free from acids and other constituents, such as sulphur, which attack the surfaces and cause damage. If the lubricating oil which drops from the cylinder is of a brown and dirty colour, it is a sign that something is amiss. Lubricating oil may be tested for free acid by inserting a piece of litmus paper in the oil. The presence of acid is denoted by the paper turning red. For the lubrication of bearings any good grade of acid-free oil can be used. Excessive lubrication or a poor grade of lubricating oil will result in the formation of carbon deposits in the cylinder and combustion chamber. This carbon is to be found in two forms, one being soft like soot, and the other hard like coke. The soft carbon mixes with the gummy residue of the lubricating oil and clogs the piston-ring grooves, thereby causing the rings to stick. It also fouls the spark plugs and causes short circuits. Particles of the hard carbon which usually form at the hottest part of the engine often become incandescent when the engine is working under a heavy load, and, by igniting the incoming charge, cause back-firing. Yellow or blue smoke at the exhaust outlet indicates that too much lubricating oil is being fed to the cylinders.

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DISCUSSION ON

High Pressure Stop Valves.

Tuesday, December 12, 1916, *at* 7 *p.m.*

CHAIRMAN : MR. A. H. MATHER (Hon. Treasurer).

After the paper a demonstration by means of models was given.

The CHAIRMAN: You have now heard the paper read, and have had an opportunity of examining the models and discussing some of the details with Mr. MacNicoll, to whom we are much indebted for presenting his subject in the form chosen and with the models for illustration. The author indicates very clearly the special points requiring attention in the design and construction of stop valves to meet the severe conditions of modern high pressure steam installations. There is no doubt that the introduction of turbine machinery afloat has largely increased the importance of the work or duties required of the steam stop valves in the control of large volumes of high pressure steam. This is especially the case in warships, owing to the amount of subdivision into watertight compartments in the construction of the vessels. In the examination of the models, I think a great many points other than those actually referred to in the paper must have occurred to members present, and which no doubt they would like to have explained.

Mr. W. E. FARENDEN: Sometimes difficulty is experienced with valves giving either " too much " or " too little " steam when the engines are going dead slow. Is there a special type of valve which claims to obviate this effect? I believe there is some kind of toothed arrangement of valve, and, if so, what effect would this have on the valve seats owing to steam rushing across the face in so many separate jets when the valve is rising off the face.

With regard to the Controlled Regulator and Throttle Valve shown in Fig. 7 of the paper, I would like to know which way the hand-wheel is to turn—to the right or the left, to manipulate the control valve; and is the screw at the top of the control rod right of left hand? Also, when the double-beat valves have been opened by the hand-wheel, I apprehend it is possible to shut them by the hand and governor control rod. Suppose the index plate on hand-wheel shows the valve to be " full open," and then the valve is closed by the control rod, will not the index plate still show the valve to be open, whilst it is in reality positively closed? In what position must the lever joining the governor control rod be in when moving the engines, so that the double-beat valve can be worked by the hand-wheel. I understand that this lever must be in a certain position for working the double-beat valve. This Controlled Regulator and Throttle Valve appears very ingenious and carefully designed. There is certainly a considerable number of levers and pins to keep in repair with this type of valve when compared with the ordinary style of valve; but I take it that it has been made fool-proof, so that anyone can operate it, and that there is no danger of anything going wrong.

Mr. F. O. Beckett: With superheated steam, at a temperature which gives about 125 lbs. of steam by gauge, according to the University of Birmingham, cast iron at that temperature begins to disintegrate; still, I would allow no cast iron whatever over 120 lbs. pressure, so that however well the chests may be designed, they ought to be scrapped for the reason that the cast iron—due to the high temperature of the steam—becomes a source of danger, more especially when you have saturated steam mixed with superheated, when a radical change takes place in the internal surfaces of the metal. The proportioning of cast steel in regard to the strains on the upper part of the valve chest, especially in conjunction with the flanges, requires careful consideration. In the casting of such a chest, the top or jacketed part should be placed in such a position so that when the cooling of the metal takes place the strains will be the least possible; for instance, there would be a readier flow of metal with all the corners rounded with varying radii, especially in conjunction with the flanges, than when the sharp edge comes up to the flanges where heavier bases are cast on for cooling purposes. It has been found that with cast iron we could not allow a stress of more than three tons, but with cast steel it may be safely accepted at 25 tons, which withstands the superheat. Up till now I have not seen any disintegration take place in cast steel with superheated steam. I am thankful for the points raised in regard to the centre of the valve beat and the demonstration. When looking through the paper, at first glance there seemed a disproportion between the top seating and the bottom, but this has been overcome by means of webs. We know that with castings, the cooling stream is more on the inside than the outside. I think this is due to the want of an even design or smoother radius, so that the cooling action of the metal is rendered easier all round. I examined a jacketed cylinder once, and every web was cracked. The experience on that ship was that the engines never ran smooth until the webs were all cracked. In the earlier days of double-beat valves, there was trouble in keeping this type of valve tight. Engineers should use the metals Nature provides and experience justifies. I suppose it is possible to get some higher-class metal for seatings, another for spindles, and another for valves, so that you can get a better area of expansion, especially for superheated steam, even when you wish to close down quickly. I wish to thank the author for his paper, and also for the demonstration we have had to-night, as it has greatly assisted in making the details clear.

Mr. R. H. Dalton: We have to thank the author for his very interesting paper, which deserves careful consideration.

With regard to the statement that cast iron is suitable for 200 lbs. pressure, I do not agree with this; in fact, it is a general rule, now recognised by the various insurance companies, that for any pressure over 120 lbs. cast steel should be used. No doubt the cause of cast iron being used so extensively in the past for high pressures was due to the difficulties in obtaining the steel, but this has now been overcome, and it is practically as easy to obtain cast steel as it is cast iron.

I agree with the author, independent of pressure, wherever superheat is present cast steel is essential, but do not altogether agree with his statement that bronze should be the material for the internal fittings, as from experience I know that this is not satisfactory under superheat, and prefer valve-heads and seats to be made of nickel alloy.

In Fig. 1, I should like to ask the author whether the large diameter of the top cover of the valve is not a weak point, and it seems to me that by altering the shape of the body of the valve the reduced size cover could be used, therefore greatly strengthening the valve.

Regarding the seats, this is the trouble experienced in almost all valves, but the renewable-seated valve is very good from a selling point of view, but for actual working conditions I consider the solid seat and solid head, made of good hard metal such as nickel alloy, is far more satisfactory, and has much longer life. No matter what type of renewable seat is adopted, you are bound to get unequal expansion owing to the different thicknesses, which sooner or later means leaky valves.

With respect to Fig. 2, whereby the author adopts springs on the columns to take the strain and stress of the expansion of the spindle, it seems to me that there is a likelihood of these springs not being in equal tension, which would cause the jamming of the spindle, consequently making the valve difficult to operate.

The last speaker touches on the point of Isolating Valves, and I do not think that there is a greater difficulty in adopting Main Steam Isolating Valves for sea-going purposes any more than there is for land work, and from experience it is advisable always in adopting Isolating Valves to have one that is automatic, that is, that the valve must not be able to be operated externally, for, if it does, you must have a gland for the operating spindle, and if that gland is kept tight the valve itself naturally requires more steam to operate it, and therefore it is not sensitive enough. On the other hand, if the gland is loose, steam will be blowing all the time, therefore the Isolating Valve should be absolutely automatic.

Whilst on the subject of valves, I think that the Institute of Marine Engineers would be doing a very useful thing if it were possible to bring about a committee for the standardisation of all flanges for marine work. There should be no more difficulty in arranging this amongst the shipbuilders, and the advantages would be much greater to the shipowners than it is to the owners of works in land practice.

At the present time almost every ship and engine builder has his own standard of flanges and drilling, consequently when a ship comes into a strange port, and wants a new valve to replace one on the pipe, it is necessary to have one specially made, owing to the odd sizes of flanges, etc., whereas if flanges and drillings were standardised it would be a simple matter to obtain a new valve from any maker's stock.

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THE AUTHOR'S REPLY TO THE DISCUSSION.

The Demonstration Referred to after the Paper was read was on a Model of a Positively Controlled Combined Regulating, Throttle and Emergency Valve.

A scale model of an 8 in. positively controlled combined regulating throttle and emergency valve was on view operated by compressed air. The action of the valve under regulation and throttle conditions was shown. It was demonstrated that from any point of regulation the valve could be shut in the throttle capacity and opened up again to the amount of lift given to it by the regulating screw. During this demonstration it was shown that the movement of the handwheel did not interfere with the throttling action of the valve—that is to say, the condition of supply of steam to the engine and the indexing was similar to the arrangement where separate regulating and butterfly throttle valves were fitted.

It is most gratifying that the subject is of such interest to the members as has been evidenced by the animated criticism that has followed the reading of the paper.

In Mr. Farenden's introduction to the discussion he touches upon a feature present in many designs of balanced stop valves, particularly of the double beat variety, viz., the valve giving "too much" or "too little" steam. This is a feature that to appreciate its cause requires a most intimate association with stop valve design. I would refer Mr. Farenden to page 214, starting at the second line, where the whole matter is most carefully gone into. It is claimed that the valve shown in Fig. VII. obviates this undesirable effect, and experience confirms this. This valve has the toothed arrangement Mr. Farenden refers to, and in passing it might be mentioned that there is no indication of scoring of valve and seat faces from its adoption, but as this design was one which would be affected by wear and tear of pins, etc., it was abandoned by my firm for that shown in Fig. VIIB. I would mention that through, I suppose, a typographical error, Fig. VIIB. has not been figured. This is the figure shown at the end of the paper, p. 229. Mr. Farenden also refers to another important consideration, viz., the rotation of the handwheel when opening and closing.

This, of course, is generally referred to as the rotation to close the valve, and when mentioned in specifications, states: "The valve to close with a right hand or clock-wise motion." This really is a somewhat misleading statement.

I have already referred on page 215, paragraph 5, to what has been found to be common practice, and the Chairman's remarks in this connection are further evidence. I think specifications should be most explicit, and allow for no dubiety in connection with rotation of handwheel for opening and closing; not only so, but as I have already stated, handwheels should always be clearly marked with arrows for opening and closing directions of rotation. In support of the extreme importance of this, where there is a departure from common practice, I would cite an extract from an article entitled, "The Story of the Severn Tunnel," Volume I. of the Engineering Wonders of the World. As is generally known the engineers of this great undertaking had many problems to solve, and the greatest trouble they experienced was the flooding of the workings. Prior to pumping operations a diver had been sent down to close a 12 inch sluice valve that cut off a part of the tunnel where the burst had occurred. After continuous pumping no diminution in the water level had taken place, and on investigation being made it was discovered in the words of the author, "That the sluice valve had for some unknown reason been fitted with a left-handed screw, so that the diver, instead of closing an open valve had actually opened a closed one."

My reason for referring to the direction of rotation when looking on the handwheel with the spindle or extended spindle receding from same, will be appreciated when the following case is considered. Let it be supposed that a specification merely called for the valve to shut with a clock-wise motion when looking on handwheel. Then in an engine stop valve with the wheel about the height of a man's waist, the handwheel would be turned to the right, necessitating a left-hand screw in the crosshead—if screw is screwed through crosshead; now, assume the handwheel to have been fouling some gear in this position, and it had to be shifted slightly above the man's head, the rotation would then be in the opposite direction, necessitating a right-hand screw. Better still, take the case of a tall and a short engineer on the same ship, and the handwheel so situated that the tall engineer is looking on one side and the short engineer on the other, and we have at once the unquestionable necessity of referring to the rotation of handwheel relative to position of spindle.

To return to the question in Fig. VII., the handwheel can be arranged to rotate in either direction to open or close the valve, the screw being handed accordingly. I have indicated common practice, and it is highly desirable that this should be universal in Marine work, so that engineers will not have to think what the particular Company's requirements are in this connection. Again, in Fig. VII. Mr. Farenden refers to the indexing of valve, suggesting—as one valve only is employed—the possibility of confusion. This only exists in theory, one might say, and not in practice. The valve has been arranged to be what Mr. Farenden terms "fool proof," although I do not think that such a harsh term should be used in connection with Marine engineers. I would state that the valve in connection with regulation and throttle indexing has been designed with the particular object in view, that an engineer, not knowing that it is a special type of valve, can handle the engines. For instance, let us take the case of the valve in Fig. VII. being opened a certain amount by the regulating screw—the index will show the amount. The index for the throttle lever will also be in the open position. Now it is desired to shut the valve with the throttle lever: this is done—the valve is shut—the throttle lever index shows this, as it also does in a butterfly type. The index on the regulating screw still shows the valve open, as is also the case when separate valves are fitted.

Again, take the position that might be suggested of the throttle lever inadvertently being put in the shut position and not noticed. The engineer meanwhile opens the regulating screw and gets no response—the question of wrong indexing relative to the valve as a regulating valve is of no concern, because neither would there be response with a butterfly valve until the throttle lever was put into the open position; and, further, with the valve as shown in Fig. VII., as soon as the throttle lever was put into the open position, the valve, as a regulating valve, would open up to the amount indicated on the regulating screw index. To operate the valve as a regulating valve by handwheel the hand and governor control must, of course, be in the open position. In connection with the number of levers and pins to be kept in order, there are no more than in any type of valve where levers are employed and fitted with a butterfly throttle, and in this connection I would refer to the latest design of this type of valve as shown in Fig. VIIB., where on page 215, paragraph 4, it is stated that a point of particular importance has been observed, viz., that wear and tear have no effect on the efficiency of the gear. Specially does this apply to the question of close regulation.

It is of interest to note that the valve, as shown in Fig. VIIB., page 229, has been adopted for the new standard vessels at present being built.

Mr. F. O. Beckett raises an interesting question when he states that with super-heated steam at a temperature which gives about 125 lbs. steam by gauge cast iron begins to disintegrate. He at once states that for pressures over 120 lbs.—and with him in this connection Mr. R. H. Dalton is associated—cast iron should be abandoned for cast steel. Mr. Dalton further states that this is in agreement with the finding of the various Insurance Companies. How can this be reconciled with the fact that for a far greater variety of design and larger size of valve, and much more severe conditions than ever obtain in land work, there are at present in our Mercantile Marine thousands of vessels with pressures of 200 lbs., and many with 215 lbs., and yet there is no question with such bodies as the Board of Trade, Lloyds, and British Corporation, as to the necessity of adopting cast steel. I so far venture to say, in view of Mr. Beckett's statement, that he, in conjunction with Mr. Dalton and the Insurance Companies, have associated a super-heated steam temperature of 352° with a saturated steam temperature of 352°.

There is no question that there are properties in super-heated steam which adversely affect cast iron that are not present in the same temperature of saturated steam. That these properties are not present in any detrimental sense in much higher temperature of certain other gases is evidenced by the fact that cast steel has not been found suitable for internal combustion engine work, and at present cast iron is giving satisfaction.

Subjoined is a sketch showing the reinforcing of flanges, where the thinner section of the branch metal meets the heavier section of the flange. This assists the flow of metal when casting, and also helps contraction stresses.

Mr. R. H. Dalton further states that it is as easy to obtain cast steel as cast iron. This is quite contrary to fact. There has been a great improvement of recent years in this connection, but whenever a more or less standard design of valve, say such as Mr. Dalton's firm turn out, is departed from, trouble is often experienced.

There is passing under my observation from two to three tons of steel valves per week, in sizes often ranging from 2 in. to 20 in. diameter, of every variety of design, and while Mr. Dalton may have experience of as high or higher tonnage being produced per week, I feel confident in stating that there is presumably much more uniformity of design.

If Mr. Dalton refers to page 210, he will notice that it is stated towards the end of the top paragraph, that for superheat a high tension bronze should be adopted, not simply a bronze; at present a high tension bronze, called "Immadium," has been found quite suitable for superheated steam. Further, I stated that a nickel alloy is preferable.

Mr. Dalton, in referring to Fig. I., indirectly suggests that the large diameter of cover is a weak point; and, further, that by altering the shape of the body of the valve a reduced size of cover could be used. The diameter of cover is generally determined by the diameter of seat, and no alteration to the form of valve can affect this. However, I have already referred to the weakness of the section at "A" in Fig. I., quite independent of the diameter of the cover, or more particularly the diameter of the opening, and my remedy is put forward in the adoption of a design such as shown in Fig. IV. On page 212, the first feature that attention is drawn to in this design is the method employed, so that the cover may take up a share of the bursting pressure.

Mr. Dalton states that a renewable seated valve is very good from a selling point of view, and in addition, from my experience, it is the only type of valve that my firm have found to satisfactorily meet the exacting demands of present day requirements.

From a practical point of view a valve seat than can readily be renewed if damaged is much to be preferred to one of the driven in type. I can state emphatically that from the number of valves I have come in contact with of all sizes, for all pressures, and every variety of design, for saturated and superheated steam, that a renewable seated stop valve is a thoroughly reliable fitting.

Mr. Dalton thinks there is a possibility of difficulty in operating the valve as shown in Fig. II., through unequal tension of the springs jamming the spindle. I would point out that the springs can be adjusted independently, so that each one is taking up its share of the load. There has been no experience of jamming in this fitting.

When Mr. Dalton alluded to Mr. Beckett's remarks in connection with isolating valves, I think he quite misunderstood the sense in which the latter gentleman used the term "isolating." There is, of course, more than one type of isolating valve. From his remarks, Mr. Beckett undoubtedly referred to a valve which would shut with a burst occurring on the outlet side of the valve, whereas Mr. Dalton is referring to an isolating valve between boilers that shuts when a burst occurs on the inlet side of the valve. It is, of course, highly desirable to have a valve that is automatic in this connection, but the valve in Fig. VII. and VIIB. are not intended for a purpose of this sort. They could, however, be arranged to act automatically in the connection Mr. Beckett suggests, say with the bursting of an h.p. cylinder.

I beg to differ with Mr. Dalton when he states that it is advisable in adopting isolating valves to have one that cannot be operated externally. I agree that when the valve is called upon to act automatically that no such possible prevention of movement should be present, as is instanced in the friction of the gland, but that means should be provided to, at any rate, push or pull the valve open if same should stick, is unquestionable.

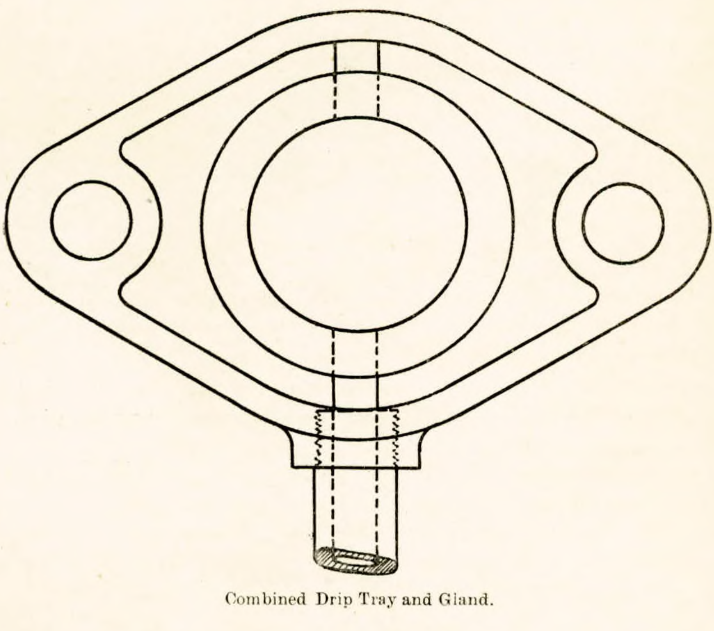
Subjoined is a figure showing an automatic shut off valve which acts when a burst occurs in the piping, either on the inlet or outlet side. This fitting is only of value when connecting two or more boilers. There are four non-return valves, two so arranged to supply steam from inlet and outlet to top of piston, and two to exhaust steam from under piston. With steam all over the system, if a burst occurs on the outlet side, steam supply non-return valve connected with the top of the piston, and the inlet side lifts and supplies steam to the top of the piston and the non-return valve connected to the bottom of the piston and the inlet side shuts down. On the outlet side the steam supply non-return valve prevents steam from getting from top of piston to outlet side, while the non-return valve connected with the underside of the valve, and the outlet lifts and exhausts steam from underside of piston. The main valve is thus effectually closed. The same "modus operandi" takes place if a burst occurs on the inlet side.

Lastly, Mr. Dalton touches upon the question of standardisation of flanges in Marine work. This is highly desirable. Unfortunately in the past it has not been found practicable. However, with the advent of the Standard Ship there are distinct possibilities in this connection.

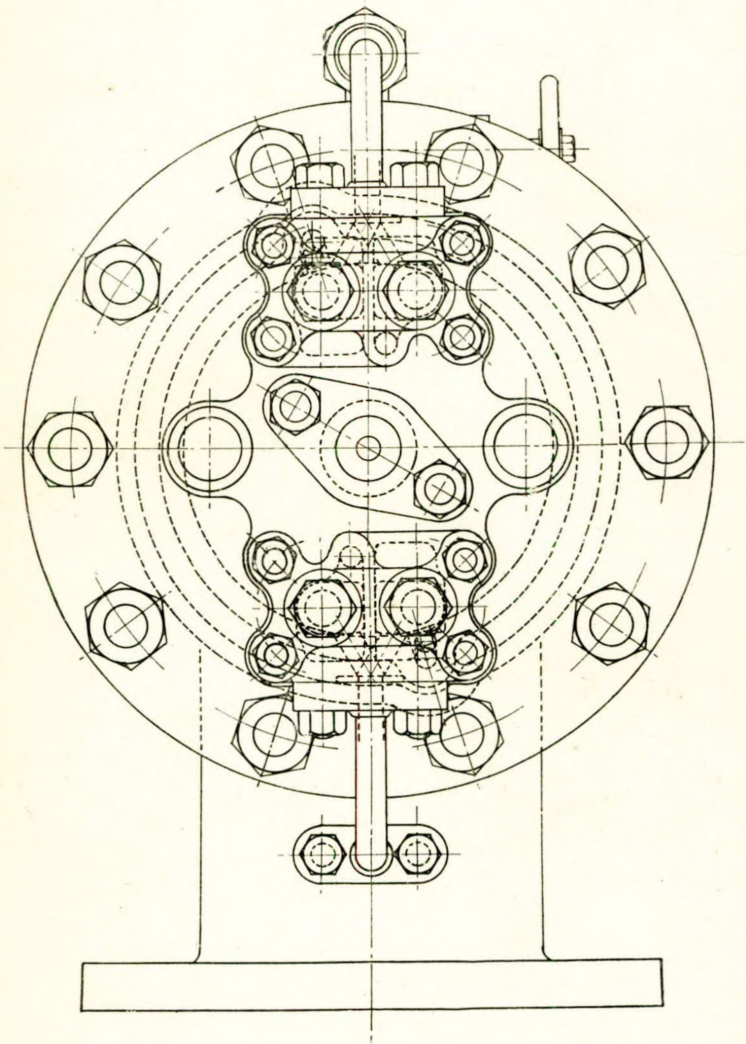
In conclusion, I must propose a very hearty vote of thanks to Mr. Mather, who has so ably officiated to-night as Chairman.

I must also thank the members for the appreciation of the paper. Someone mentioned that the attendance was smaller than was hoped for. I must say that, under present conditions, and the particularly strenuous times that Marine engineers are having just now, it is a wonder to me that there should be any attendance at all.

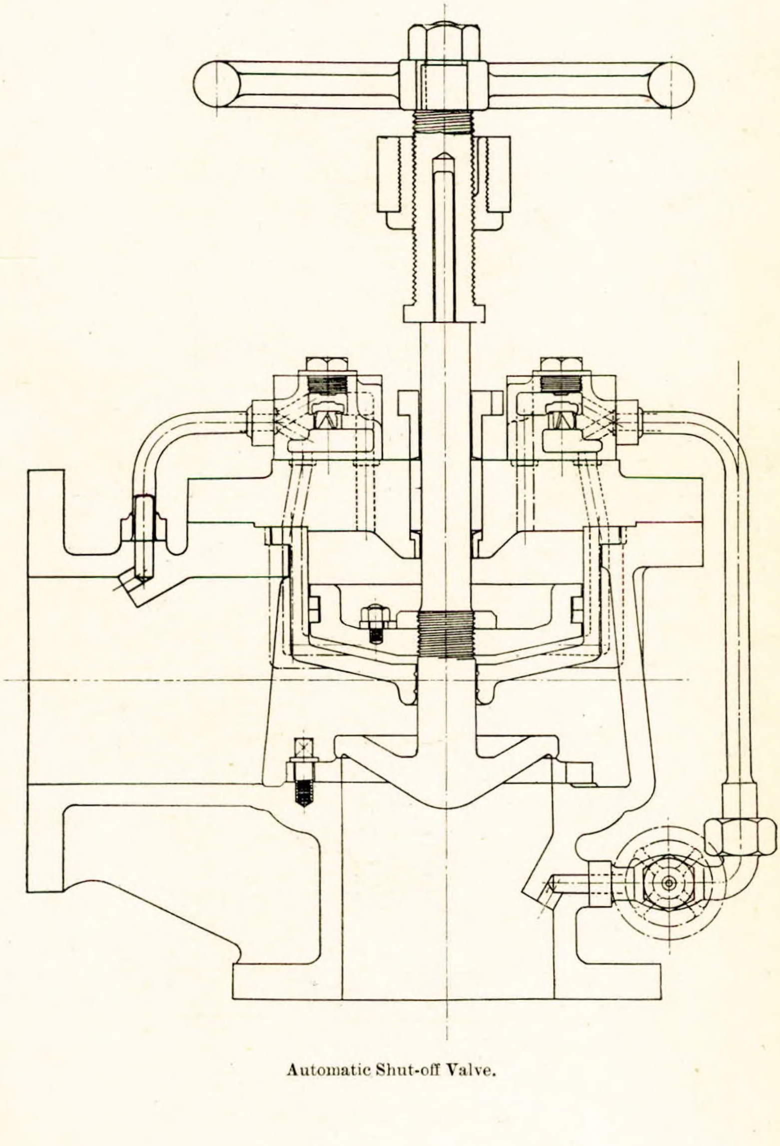
The CHAIRMAN: Referring back to the point raised in the discussion regarding the direction of rotation of the hand-wheel for opening or closing a valve, a case occurred to me while Mr. MacNicoll was speaking just now. A number of stop-valves were being made to suit the requirements of a shipping firm, who insisted that they were to be constructed with a loose nut revolving in the bridge, and having the hand-wheel keyed to the nut, the spindle being prevented from revolving by a sliding feather, instead of the more common form where the screw thread is cut in the bridge and the hand-wheel keyed to the spindle. No mention was made as to direction of rotation required to open the valves, and the spindles were threaded with right-handed screws. A good many of the valves were delivered, when it was noticed that to open the valves the hand-wheels had to be turned right-handed, or with the clock, which was, of course, the opposite direction to ordinary practice. The result was that they all had to get new spindles and nuts with left-handed screws to obtain the usual direction of rotation for opening and closing.



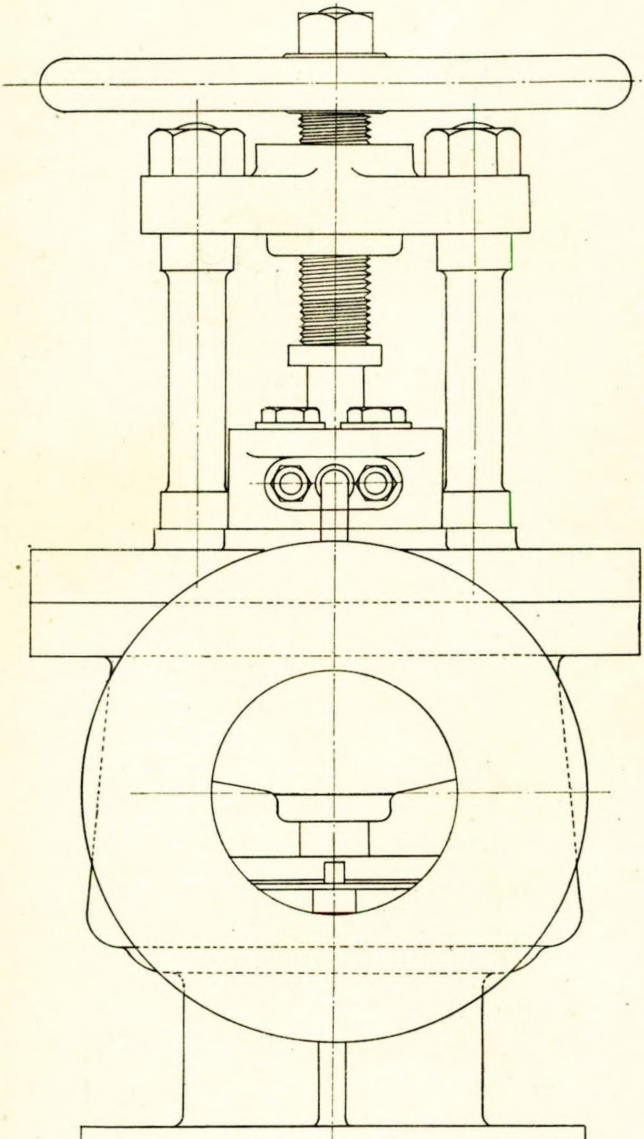
Combined Drip Tray and Gland.



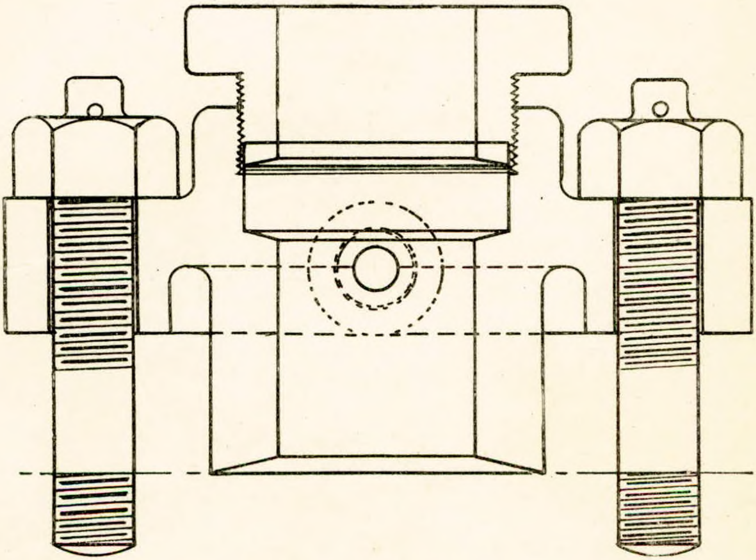
Automatic Shut-off Valve.



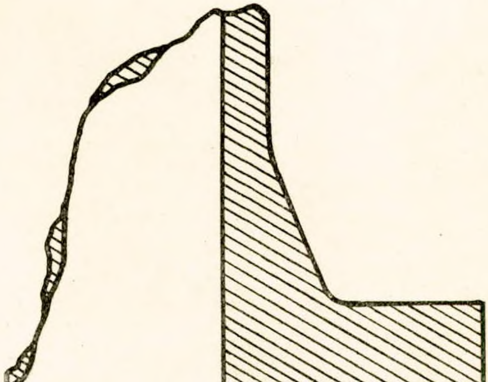
Automatic Shut-off Valve.



Stop Valve showing Drip Gland.



Combined Drip Tray and Gland.



Re-inforced Flange.

TITANIC ENGINEERING STAFF MEMORIAL FUND.

It has been suggested to make known more widely the existence of this Fund, to give an opportunity to members and friends to contribute towards it, with the object of rendering greater assistance to cases which come under its scope. The following is a draft copy of a letter and memorandum which have been sent to the Editor of the *Daily Chronicle* on the subject. The initiation of the Fund with copy of some of the correspondence will be found in the *Titanic Memorial Booklet* published in June, 1912:—

You may remember that with your beneficient help a Fund was raised to commemorate the heroism of the engineering staff of the *Titanic*, and that a sum of £3,136 was raised. Of this, £300 was donated towards the handsome memorial erected at Southampton, and £80 was expended on a bronze memorial tablet in our new premises here, the balance being invested to be used for benevolent purposes.

We made an arrangement with the Royal Merchant Seamen's Orphanage by which, on payment of £80 per annum, we can nominate an orphan for direct admission to the Orphanage. The balance remaining as interest on our investments we use by assisting the Royal Caledonian Orphanage at Bushey and the Wanstead Infant Orphanage, also the Royal Scottish Corporation, as we have been in a position to assist many of the dependents of Marine Engineers through the medium of these benevolent institutions. Should it be desirable to help any cases direct, we still retain a small balance.

These remarks are made to you with a view to call attention to the enclosed, in the hope that you will kindly consider it and place the subject before your readers, with a view to augment the funds so that we may cope with the cases that arise owing to the conditions now ruling on the seas surrounding our shores—conditions which our seafarers have to face day by day. All honour to them. They are worthy of our praise.

Yours faithfully,

JAS. ADAMSON,

Hon. Secretary.

TITANIC ENGINEERING STAFF MEMORIAL FUND.

This Fund in connection with the Institute of Marine Engineers is available to assist the families of members of the engineering staff who have lost their lives in the execution of their duties, and, as many engineers have given their lives in their country's cause, the present is an opportune moment to call attention to it with a view to application being made on behalf of the widow and orphan.

The privilege of placing one child each year in the Royal Merchant Seamen's Orphanage at Snaresbrook rests with the Committee administering the Fund, under the auspices of the Institute of Marine Engineers, by an annual payment. The Committee is also in touch with other benevolent Institutions by whose instrumentality help is given where necessary. The capital of the Fund is invested and the interest is used as indicated. At the same time, owing to the many claims upon all funds of this character at the present moment, it is desirable to augment the amount available by contributions from all who are interested and who can afford to help in any degree those who cannot help themselves, whose mainstay indeed has been lost to them in the war storm; sacrificed in the cause of the Nation. The heroic devotion to duty on the part of the engineers of the *Titanic* has been repeated on many occasions. The words of Virgil: *aqua involvens navemque virosque*, have a special appropriateness for those on watch down below, as upon them depends largely the saving of the many or few.

———o———

Education of Marine Engineers.

The Council of the Institute of Marine Engineers, having considered the subject of the future supply of Marine Engineers for the Merchant Service, and also the qualifications of men to fill the higher and more responsible positions, realising at the same time the important part the Marine Engineer must play in the development of the British Mercantile Marine, is of opinion that these questions require the earnest consideration of State Departments and all parties directly interested in the Shipping Industry, and that immediately after the restoration of peace, steps should be taken to ensure that the Marine Engineer of the future will be trained so that he may be thoroughly qualified to meet any calls demanded by his profession.

The views of the Council are embodied in the following Report:—

(1)

We are of opinion that the present system of education is capable of considerable improvement, and the Board of Education or other Educational Authorities should be urged to take steps to improve it.

(A) By giving boys at the ordinary schools, up to the age of 14, a sound training in arithmetic, mathematics, drawing, elementary physics, electricity and chemistry.

(B) By providing an increased number of junior technical or day trades-preparatory schools at which boys between the ages of about 14 and 16 years preparing to enter on a mechanical career may attend and where the elementary teaching of the subjects cited above, and their general education, including languages, may be further developed.

(C) By encouraging and giving facilities to boys during their apprenticeship to attend classes in mathematics, mechanics and engineering, so that this period of their lives will be devoted to a combination of their practical and theoretical education.

(D) By the provision of scholarships so that boys of exceptional ability may, after serving for a period of say three years or more in the workshops, continue their studies in the more advanced technics of engineering, subject to the approval of their employers.

(E) It is suggested that in large centres of industry it should be required that employers provide facilities during working hours for the technical education of at least a proportion of their apprentices.

(2)

The examinations of marine engineers for first and second class certificates should embrace the technical subjects specified above and their application to practical engineering, and candidates should be required, as part of their qualification, to submit certificates or otherwise demonstrate that they have attained a certain standard of proficiency in mathematical and scientific knowledge.

(3)

The local or other Educational Authorities in all the large seaports should be urged to provide facilities in existing technical schools, or provide additional marine schools at which the course of study should be specially adapted for Marine Engineers preparing for their certificate examinations.

The requirements of 1st and 2nd class engineers' certificates should be of a more exacting character, both as regards sea service and range of subjects set for the examinations, and a period should be set for the introduction of this higher standard.

Simultaneously with the introduction of the higher standard of qualification a third class Board of Trade certificate should be introduced.

(4)

The qualifications for examination for the third class certificate should be that the candidate should have the usual workshop training or its equivalent as now required for the 2nd class certificate, together with one year's service at sea on regular watch, and the nature of this examination should be similar to the present examination for a second class certificate.

For a second class certificate the candidate should have a further sea service of twelve months in a qualifying capacity.

For a first class certificate the candidates should have a further sea service of eighteen months in charge of a watch.

(5)

Further to the proposals contained in the preceding paragraphs we are of opinion that when the additional third class certificate is issued the numbers of certificated engineers carried on the articles of all steamers should be revised.

(6)

We are also of the opinion that the qualifying period of pprenticeship should be at least five years.

No time before the age of sixteen should be counted except in the case of Junior Technical Schools, where time after the age of fourteen may be allowed at an appropriate value.

Where the workshop service is performed in works where engines and boilers are made or repaired the following requirements are suggested:—

Not less than $2\frac{1}{2}$ years should be spent at fitting, erecting or epairing engines and/or machinery, either in the works or outside. The remaining $2\frac{1}{2}$ years may be made up of time spent (1) at fitting, erecting or repairing engines or machinery; (2) at one of the other trades described below; (3) at an approved technical college.

Time so spent to count as follows:—

Fitting, Erecting, Repairing or Turning	Full time.
Working in Drawing Office ...	Full time up to two years, provided that an adequate period has been previously spent in the workshops, and beyond two years, half-time.
Pattern Making	Full time up to twelve months, beyond twelve months, half-time, with a maximum allowance of two years.
Planing, Slotting, Shaping and Milling	Full time up to a maximum of one year.
Boiler-making or Repairing or Smith's Work	Full time up to one year, beyond one year, half-time, with a maximum allowance of two years.
Coppersmith's Work	Full time up to a maximum of six months.

Brass or Iron Moulding ...	... Half-time up to a maximum allowance of one year.
Attendance at an approved Technical College ...	... Two-thirds time: equivalent allowance to be made for attendance at Junior Technical Schools.

In the event of the apprenticeship time being extended to six years or more, five years at turning, followed by one year at fitting or erecting, may be accepted as qualifying.

Where the workshop service is performed wholly or in part in works where engines and boilers are not made or repaired, it may be accepted if it is considered useful training for an Engineer, but in such cases additional service must have been performed either in a Marine shop or at sea, as enacted in the present Board of Trade Regulations.

It has been suggested that Licenses should be granted to "Handymen" to enable them to take charge in low powered steamers or to take charge of a watch in larger vessels.

We are of the opinion that this is not desirable.

In this Report, under paragraph 1, the education and training of the Marine Engineer have only been considered in a general sense.

It is our opinion that this important matter should form the subject of consideration b fore a joint National Committee representative of all the various interests.

The under-noted is quoted from *The Glasgow Herald* of March 23rd:—

Glasgow School Board, at their meeting yesterday, had an offer before them by an engineering firm, Messrs. Barr and Stroud, to co-operate in the education of their future apprentices by means of scholarships. In their letter the firm stated that as they were of opinion it would be to the advantage of apprentices that they should stay at the day schools until they were at least 15 years old, the firm, provided the year spent at school from 14 to 15 was devoted to subjects specially suitable for and interesting to engineering apprentices, had resolved to institute scholarships on the following conditions:—(1) The scholarships would be ten in number, tenable for one year, of the value of

£10 each; (2) they would be awarded to boys of the age of 14 recommended by the headmaster of certain selected schools, certified as medically sound, and approved by the firm; (3) they would be tenable at a school in which a course of instruction in mathematics and practical physics suitable for engineer apprentices could be followed; (4) the boys, before taking up the scholarship, would sign an agreement to serve five years apprenticeship with the firm to the trade of instrument-making or of engineering.

The Chairman (Dr. Dyer) proposed that the letter and offer be remitted to a special committee for consideration and report.

Mr. Hardie said the proposal would result in what they objected to in the Germans. The boys were to become magnificent machines or minders of machines, but the educational side of their lives was to be entirely blank. That was one great defect of German education. There was a great difference between educated pupils and instructed pupils.

The Rev. Mr. Cameron said one difficulty he saw in regard to the scheme was that it would encourage boys not to go on to the Higher Grade School, but to become ear-marked for a firm.

The Chairman differed from Mr. Hardie regarding the neglect of the educational side by employers. He said that several large firms on the Clyde took an interest in the continued education and the welfare of their boys. Some of them had a system of special bonuses for those apprentices who passed their examinations in continuation schools. Messrs. Barr and Stroud had taken a special interest in the matter, and were keen on the educational as well as the instructional side. The point regarding the agreement to serve the firm for five years would require consideration.

The proposal to remit the offer to a special committee was adopted.

LUBRICATION.

Mr. A. H. Mather's remarks, page 253, para. 2. In order to make clear the meaning desired to be conveyed, the piston rings referred to as "outermost" should have read "innermost," or those nearest the top end of the piston in a vertical engine, and the period of inlet for the lubricant is when the piston is at the bottom or outer end of the stroke.

ELECTION OF MEMBERS.

Members elected at a meeting of the Council held on Tuesday, March 13th, 1917 :—

Harry Brodrick, 37, Wellington Street, Hull.

Robert Reed Gray Chisholm, 43, Tower Lane, Rock Ferry, Cheshire.

George Henry Geen, "Avoca," Brynmill Crescent, Swansea.

John F. King, 3, Wellington Terrace, Grattan Hill, Cork.

John McMenemey, c/o 202, Conway Street, Birkenhead.

J. Parsons, c/o The Chinese Government, Salt Revenue Offices, Peking.

Clifton Pout, "Glenshian," West Cliff, Whitstable, Kent.

Francisco Vidal, Puerto de la Luz, Grand Canary.

Arnold Hampden Travers Wagg, 37, Queen's Gate Street, The Boulevards, Hull.

Associate Member.

Cyril Brookhouse Hollingsworth, 93, Grimesthorpe Road, Pitsmoon, Sheffield.