In accordance with the terms of the contract the *Moosehead* was standardized over the Boothbay mile with the following results:

STANDARDIZATION TRIAL. S. S. MOOSEHEAD. BOOTHBAY MILE

No. Run.	Direction.	Revolutions.			I. H. P.			Speed.	Slip.
		Port.	Starb'd.	Mean.	Port.	Starb'd.	Total.		
1	N	115.3	113.4	114.35	174	176	350	12.46	4.1
2	S	105.7	99.4	102.55	159	141	350	11.25	3.8
3	N	109.5	135.6	122.55	98	283	381	13.38	4.
4	S	150.3	153.9	152.1	382	478	860	15.96	7.69
5	N	156.2	161.3	158.75	447	544	991	16.95	6.
6	S	170.3	170.9	107.6	605	649	1254	17.65	11.66
7	N	178.3	185.8	182.05	717	899	1616	18.83	8.65
8	S	183.8	189.4	186.6	827	967	1794	18.75	11.57
9	N	194.6	195.4	195.	1131	1127	2258	19.65	13.1
10	S	196.7	198.0	197.35	1143	1124	2267	19.38	31.6

Immediately after the standardization trial a four-hour run at full speed was maintained with the following results:

FOUR-HOUR TRIAL. S. S. MOOSEHEAD.

	Port.	Starboard.
Pressures:		
H. P. chest, pounds gage	167.	167.
I. P. chest, pounds gage	74.6	51.7
L. P. chest, pounds gage	10.56	10.6
Vacuum. inches	25.75	25.75
Air in fireroom, inches	1.	
Revolutions		
Main engines	200.55	201.75
Average	201.15	
Air pump	37.25	
Circulating pumps	469.	416.
Average	442.5	
Feed pump	21.25	
Forced draft blower	525.	
Speed, statute miles per hour	19.75	
Slip, percent	13.5	
I. H. P. total, main engines	2341.	

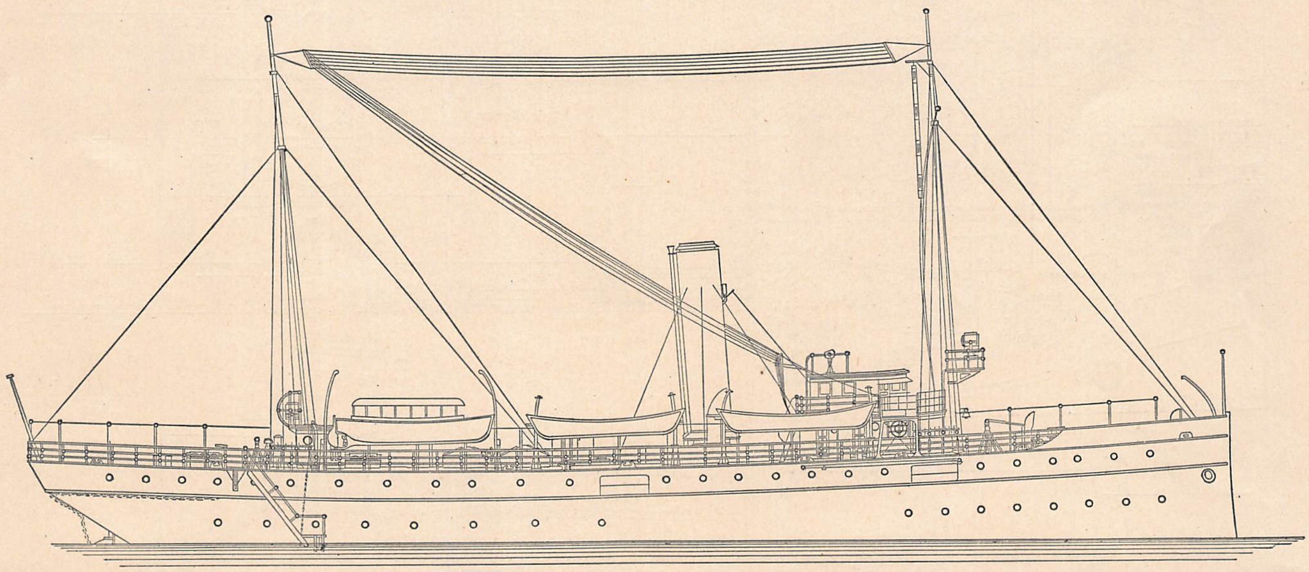
The *Moosehead* was to be delivered under her contract on May 15, and was finished ahead of time. She has been at the railroad company's wharves at Rockland, Me., being outfitted for service into which she entered on June 26.

During the fiscal year ended June 30, 1,527 vessels of 302,391 gross tons were built in the United States and officially numbered by the Bureau of Navigation, compared with 1,502 vessels of 347,025 gross tons for the fiscal year ended June 30, 1910. The decrease is due to a falling off of 65,000 tons in shipbuilding on the Great Lakes, anticipated in Secretary Nagel's report last year. The year's construction comprised 1,123 steam and motor vessels of 246,540 tons, 85 sail vessels of 11,398 tons, and 319 unrigged barges and canal boats of 44,453 tons.

TWO NEW REVENUE CUTTERS.

At the last session of congress an appropriation of $250,000 (£51,400) each for two new revenue cutters was made. Plans have been prepared and specifications drawn for what is considered will be two of the finest ever constructed for this service. The ships will be duplicates in every particular, primarily to reduce the cost of construction, and, secondarily, in order to produce uniformity in the vessels of the first class.

The work of assisting vessels in distress and in searching for and destroying derelicts has grown to such an extent that these duties were given paramount consideration in deciding on the general type of vessel to be constructed. To that end there has been evolved a design of vessel which will give great seaworthiness, large steaming radius and, in general,



DESIGN FOR THE NEW UNITED STATES REVENUE CUTTERS.

to provide all usual appliances for the assistance of vessels in distress.

The principal dimensions of the new vessels will be:

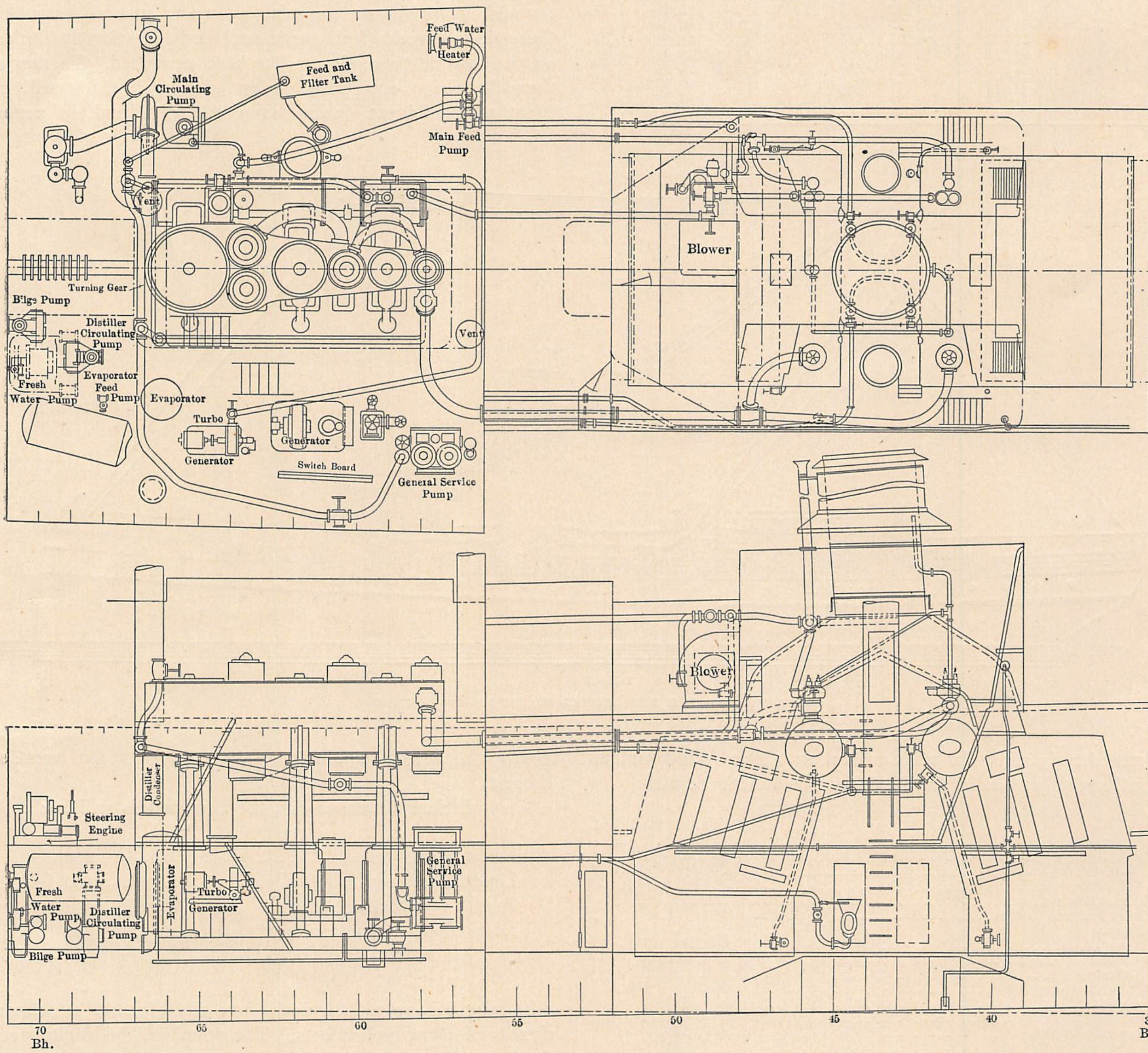
Length over all	200 feet.
Length between perpendiculars	180 feet.
Breadth of beam, molded	34 feet.
Displacement at mean load draft	1,324 tons.
Draft, aft	15 feet 6 in.

Each will have a flush deck, fore and aft, and be schooner rigged with two pole masts. The stem will be slightly ram-shaped and the stern will be of the overhanging, elliptical type. There are two complete decks, the berth and spar decks, and outside of the machinery space at each end of the ship a partial berth deck. A double bottom extends under the fireroom, which will be utilized for boiler feed water. The only houses on the spar deck will be the pilot house and a small structure around the mainmast for an entrance to the cabin. The living quarters for the captain and the wardroom officers will all be on the main deck, aft; the warrant and petty officers will have staterooms forward on the same deck, while the crew will be berthed in galvanized iron pipe berths, instead of in hammocks, as is usual.

The new cutters will carry six boats, including an up-to-date surf-boat, all of which will stow between the two masts, thus leaving a clear quarter deck where towing lines may swing without obstruction. A large pair of towing bitts and a steam winch will be fitted just aft of the mainmast, as in the work of the revenue cutters it is frequently found advisable to tow derelicts or disabled vessels into port.

A large magazine, aft, abreast of the shaft alley on the starboard side, will provide safe stowage space for the ammunition to be used in the main battery of four 6-pounder rapid-fire guns and for the gun-cotton mines to be used for derelict destroying.

The new vessels will have a very complete electric installation, consisting of one 20-kilowatt main generating set for purposes of lighting, and one 8-kilowatt turbo-generator for the wireless telegraphy and emergency set. There will be one 24-inch and one 18-inch searchlight, an Ardois signaling apparatus and a 2-kilowatt wireless telegraph set of the latest type.



MACHINERY SPACE OF THE REVENUE CUTTERS.

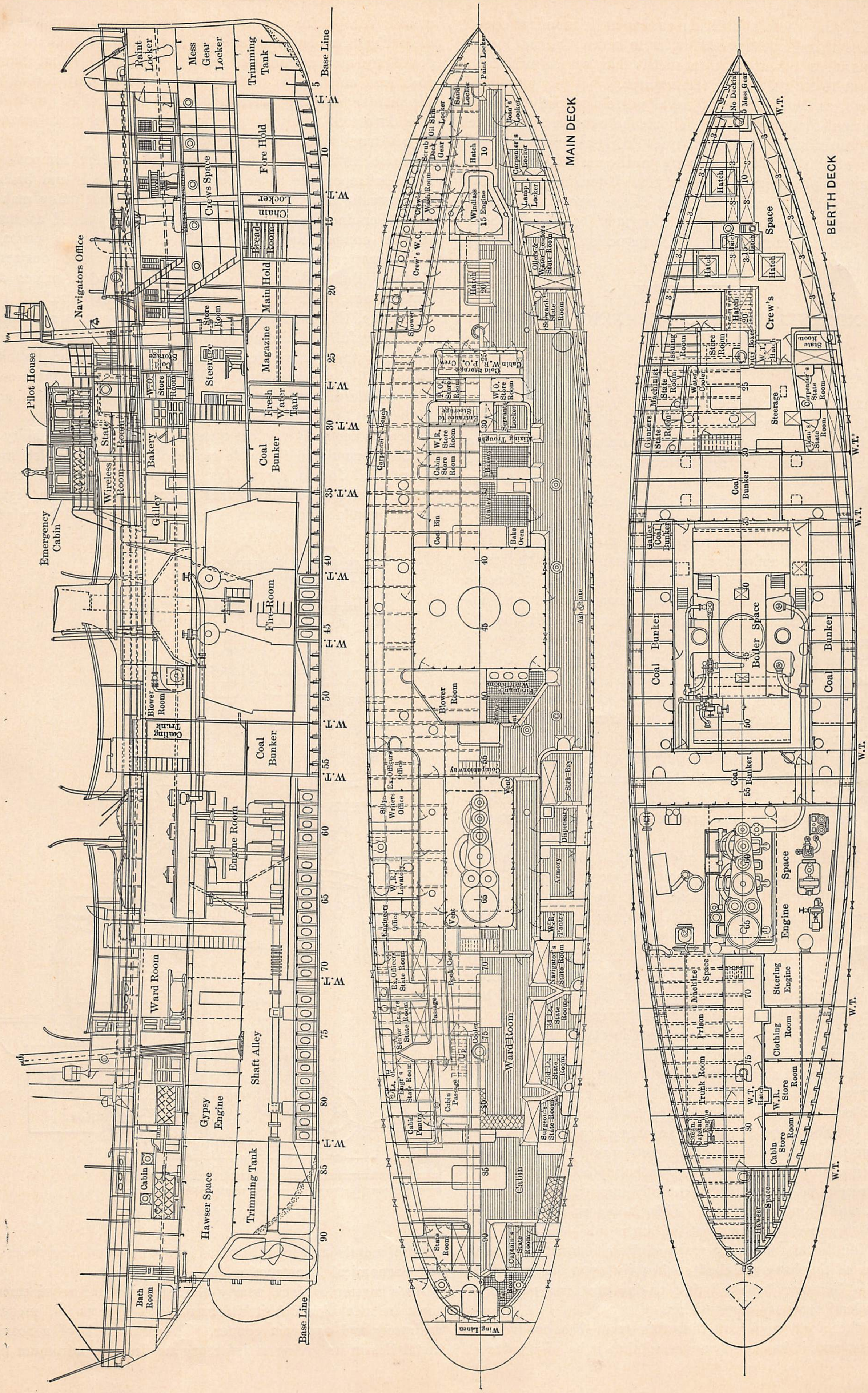
The propelling machinery will consist of two straight-tube watertube boilers, each containing about 90 square feet of grate and 3,150 square feet of heating surface, which will furnish steam at 200 pounds pressure for the main propelling engine. This will be of the vertical, direct acting, inverted, triple-expansion type, having cylinders 20 inches, 32½ inches and 54 inches in diameter, respectively, with a common stroke of 36 inches. All main valves will be of the piston type and it will be noted that their design is such as will reduce the volumetric clearance to a minimum. The surface condenser will be of the ordinary cast type, forming a part of and built in with the back columns of the engine.

A feature of the design is what is presumed to be the first auxiliary condenser ever designed to work in conjunction with the main condenser circulating apparatus. From the design it will be seen that the auxiliary condenser is of the same general section as the main condenser and forms a part of the housing of the high-pressure cylinder. In port, when the auxiliaries only are in use, the main circulating pump will circulate water through the auxiliary condenser by means of pipes connecting the water chests of the main and auxiliary condensers. This avoids the installation of two circulating pumps with the necessary complication of sea valves, pipe connections, etc. The main feed pump will be utilized as an auxiliary air pump and will discharge directly into the feed tank.

There will be a feed water heater, a wrecking pump, ash ejector and, in general, all the accessories necessary for the requirements of a revenue cutter.

It is estimated that the main engine will produce 2,000 indicated horsepower, at the extreme, which should give the vessel a meximum speed of about 15 knots.

The very large bunker capacity for this size of vessel (300



INBOARD PROFILE AND DECK PLANS OF THE NEW UNITED STATES REVENUE CUTTERS.

tons) will give them a cruising radius at economical speed of not less than 5,000 nautical miles, a much desired factor for long cruises in search of derelicts. The vessels will each carry about 16,000 gallons of fresh water.

Congress, as in the case of naval vessels recently authorized, required that these vessels should be built in accordance with the provisions of the 8-hour law. Proposals were solicited for ships of this design, but owing to the restrictions of the 8-hour law shipbuilders refused to bid. Upon modified plans for smaller vessels, embodying most of the essential features, the Newport News Shipbuilding Company has finally been awarded the contract for their construction at a cost of $244,000 (£50,000) each.

MISUNDERSTANDINGS CONCERNING BABBITT METAL.

BY A. A. GREENBURG.

The manufacture and sale of Babbitts has long been a prolific field for the impostor. He has invariably taken advantage of the prevalent ignorance of the purchaser and has done incalculable damage to the reputable manufacturer. The business, in fact, years ago came to such a point that firms who valued their reputation hesitated before entering this field of competition.

There is perhaps at the present time no term in the mechanical world so ambiguous and so misused as the term "Genuine Babbitt." It is popularly believed that "Genuine Babbitt" is the composition originally compounded and invented by Isaac Babbitt, to whom we are indebted for the invention of making soft metal linings for bearings. In United States patent No. 1,252, July 17, 1839, granted to him, a suitable composition is mentioned consisting of fifty parts tin, five parts antimony and one part copper. Now, what his patent specifically covers, and what he claims in the same, is simply the method of application of a soft lining in bearings. The formula given was for the purpose of making his specifications complete for patent office requirements. The value of his invention in his own mind related to the construction of bearings rather than to the production of an anti-frictional metal.

Later, Mr. Babbitt gave the question of the composition of his alloy some thought, and he realized that the hardest alloy consistent with other requirements was the best for him to use. The formula for his favorite composition, which, some years later, he sold to a Mr. Phillips, an American manufacturer, was quite different from that first mentioned in his patent, in that it contained ten parts tin, one part antimony and one part copper. At the outset, Mr. Babbitt himself had no exact composition he used for his linings; wherefore the term "Genuine Babbitt" cannot be used in the sense that it is Babbitt's original composition; and, further, it is impractical and cannot be used as a definite specification.

Still greater uncertainty is brought out by chemical analysis of the different metals sold under the trade name of "Genuine Babbitt." If the term ever meant anything at all it was simply this: that the preponderant constituent was tin and that its two other constituents were were antimony and copper.

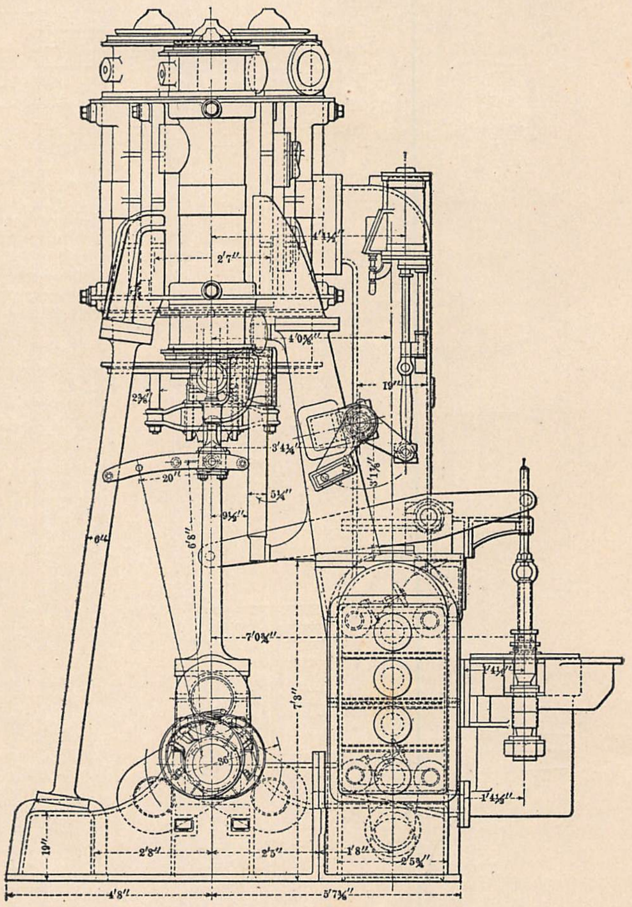
Until recent years the term generally implied that the composition was free from lead. This, however, is no longer the case, because the low cost of antimonial-lead as a by-product for the last fifteen years, and the constant increase in the price of tin, have weighed so heavily upon the manufacturers of "Genuine Babbitt," that to-day the term no longer excludes lead from its composition.

It is, therefore, apparent that this term has outlived its usefulness, and it has been suggested that it be given decent burial in recognition of the respect in which the term was once held. Engineers and machine builders realize that there is no such thing as one universal bearing composition that can be considered as the best and most serviceable alloy for all requirements. Bearing metals should be specified with the same degree of care and precision as any other metal used in the construction of modern machines.

Manufacturers offer alloys of widely different composition, and it is impossible to rely upon fanciful labels and brands. An illustration of this is found in the fact that many makers offer "Genuine Babbitt" of several brands and of as many different compositions. The greatest difference is probably in the matter of price, so that the buyer who desires a "Genuine Babbitt" may choose various grades, prices and compositions; still, they are all classed as "genuine."

Ethically, this is ridiculous, but practically it is not necessarily harmful. While apparently there should be only one "genuine," there is no reason to believe that Isaac Babbitt's formula of fifty years ago, if taken as a definitely exact composition, should apply to the completely altered bearing conditions of to-day.

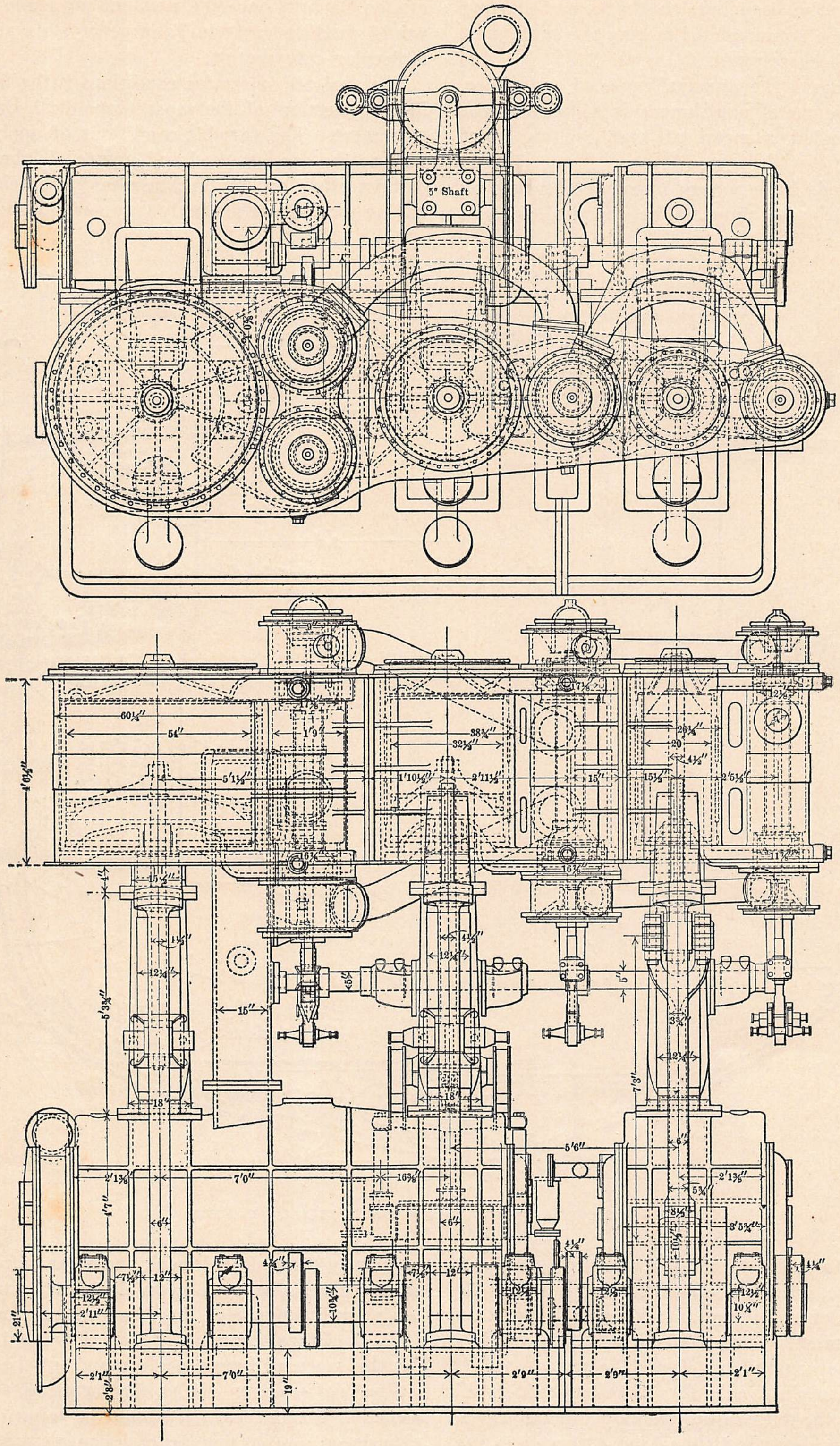
There is certainly a great question as to the adaptability of any one formula to the wide range of conditions which must be provided for in these days, so that there is justification for the intelligent manufacturer in departing from any established formula; such action is due to an increased knowledge



END ELEVATION.

of the metals and metallurgical processes and the necessity for economical construction.

As a matter of fact, nearly all bearing metal requirements could be met with Babbitt's formula of ten parts tin, one part antimony and one part copper. The real merit of a bearing metal lies in its giving satisfactory service at a minimum first cost. There are, on the other hand, many service conditions where 87 percent lead and 13 percent antimony will answer just as well, and it is a sheer waste of high-priced material to use the former when the latter will do. This illustrates forcibly the extremes of Babbitt compositions. There are also a greater number of intermediate conditions where a very considerable loss is occasioned either by the use of a composition more expensive than is necessary or one that does not have the necessary mechanical qualities to meet the requirements. The metal should be hard enough so that it will not flow or be distorted under service conditions, and at the same time it should not be so hard as to be brittle in case the bearing should be subjected to pounding or unusual strains.



SIDE ELEVATION OF THE MAIN ENGINES OF THE REVENUE CUTTERS.

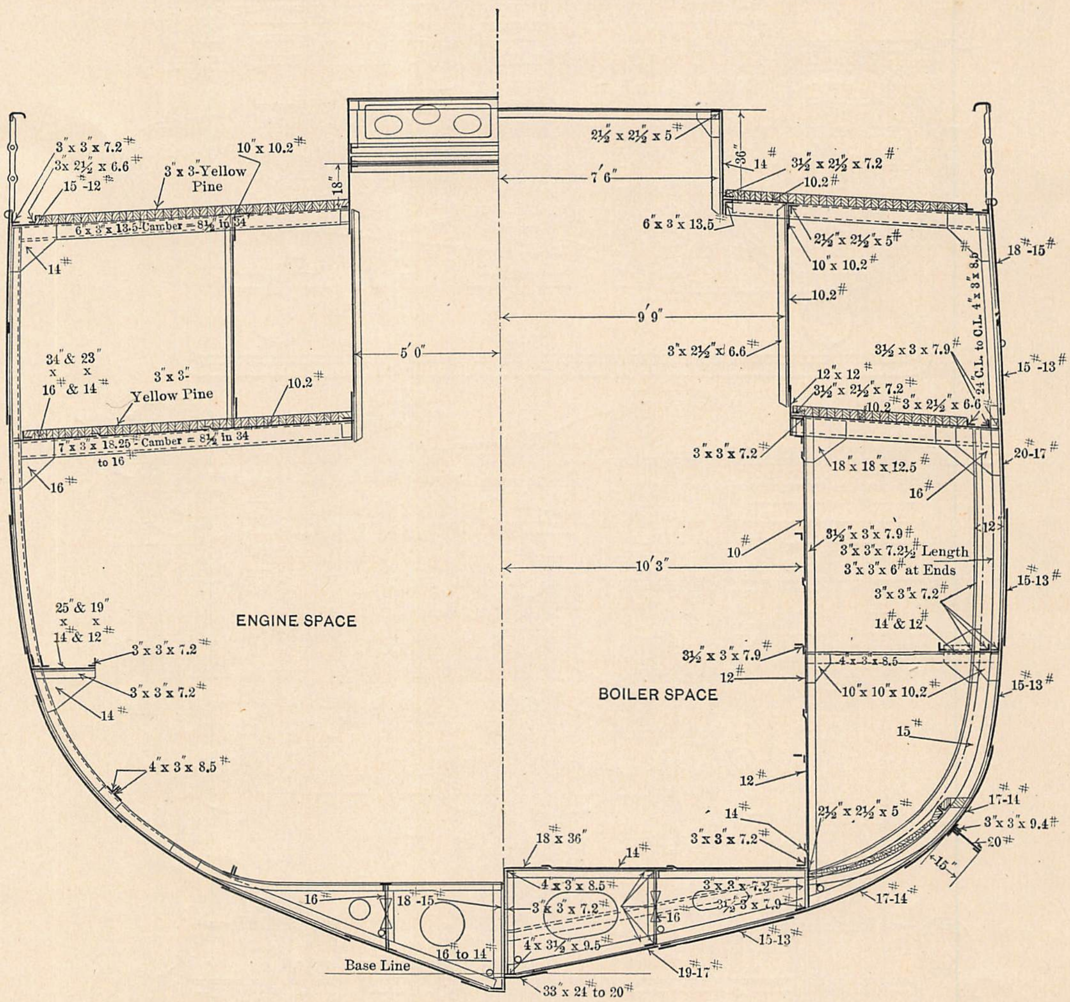
The efficiency of the alloy, therefore, depends upon the quality of wearing surface that can be produced and maintained under service. A properly selected metal carefully applied, both as to design and workmanship, produces a bearing which with proper lubrication has no metallic contact while running. That is, the journal and its bearings are separated from each other by a film of oil which mantained in operation; as soon as the movement of the journal is stopped the film of oil is gradually squeezed out and the metallic surfaces are brought into contact. Therefore, in selecting the metals for a bearing they should be sufficiently dissimilar, so that when starting the machine there will be no danger of scoring the shaft until the oil firm shall have been restored.

The heating of bearings is the principal cause of annoyance, and in cases where the metal punishment is so severe that heating cannot be avoided a metal of high melting point should be selected.

Manufacturing methods have a very important bearing on the serviceability of different alloys. The chemical analysis of a Babbitt, giving the constituents and their relative proportions, is, of course, of some value in determining the quality of Babbitt under consideration; but more important still are certain fundamental, chemical and metallurgical laws according to which the constituents should be united, and if these laws have not been observed a very inferior product will be the result. It is not the purpose here to give a metallurgical treatise but to suggest ideas that should be observed in the handling and applying of lining metals.

In general, these metals should be melted in an iron vessel, and kept covered as much as possible in order to prevent excessive oxidation. They should be heated considerably above their melting point before using, but must not be kept in a molten state at a high temperature longer than necessary. Overheating should be carefully avoided, and a good rule for general practice is to heat the molten Babbitt to a point where it chars a pine stick, at which temperature it casts perfectly. In cold weather the housing and mandrel should be warmed. However, it is not desirable to have the housing as hot as the molten Babbitt, since the slow cooling made necessary thereby would produce excessively large crystals and an undesirable molecular construction.

The analysis of service conditions is the first important step in the selection of the most economical Babbitt for any requirement. The variable conditions of applying a bearing, as well as the care, method and nature of lubrication, all have a distinct effect on the final results. A bearing properly fitted, having the journal perfectly true and polished and the surface accurately scraped, will work under far more severe conditions than could be imposed upon the same bearing if fitted carelessly or inaccurately; the same is true for poor lubrication. It is, therefore, impossible to lay down a definite set of rules for the exact maximum performance of the different alloys.



MIDSHIP SECTION OF NEW UNITED STATES REVENUE CUTTERS.

The final selection of the bearing metal, the design and construction of the bearing, should be left to one who has had experience, but a few general considerations of the subject should not fall amiss.

Where the service conditions are severe owing to great pressure, a metal having considerable compressive strength is necessary, regardless of what the speed may be, and this condition would require a relatively high percentage of tin. Where there is high speed and the pressure light or moderate, a metal having a fairly high percentage of lead may be used. In the same manner, with intermediate conditions between pressure and speed, correspondingly intermediate compositions can be selected.

The surroundings of a bearing should also be taken into consideration if they are at all unusual. If a bearing is placed in a position where it is subjected to a gritty dust, a higher grade or a harder metal should be used than what would be required for the same service conditions where dust is not encountered. This is owing to the fact that a soft metal is liable to have imbedded upon its wearing surface the grit surrounding it, a difficulty which with a harder Babbitt is not so likely to occur.

Where a bearing is subjected to outside heat a better quality of metal should be chosen than would be necessary for the same bearing under cooler conditions. This is self-evident, in that all bearings, no matter how well fitted or perfectly adjusted and lubricated they may be, are, under full service conditions, warmer than the surrounding air, and the total work of friction, whether great or small, appears in the bearing in the form of heat. The heat given off by a bearing is a direct measure of the amount of the total working friction in that bearing.

The question of care and attention that a bearing receives should also be taken into consideration. A bearing that is lubricated at long intervals or with a poor grade of lubricant requires a higher grade of metal than that which would be required under more favorable conditions.

There is nothing very difficult in making Babbitt suitable to any kind of service. It is only necessary that the work be done by an experienced metallurgist. *Right here* is where we see the importance and value of dealing with a maker whose experience and reputation are above question, and who produces alloys of high quality and sells them honestly at fair prices.

NEW COLLIERS AND TUGS FOR U. S. NAVY.

On June 20 last bids were opened at the Navy Department, Washington, for four naval colliers and two tugs. In the number of colliers were included the two for which bids were received in November last, but which could not then be considered, owing to either an excess over the limit in the appropriation or to irregularities in the submission of the bids. The law governing the construction of these two colliers must conform with the provisions of an act entitled "An act relating to the limitation of the hours of daily service of laborers and mechanics employed upon the public works of the United States and of the District of Columbia," approved Aug. 1. 1892, which means in defined words an eight-hour workday.

The two colliers authorized by act of Congress, approved March 4, 1911, as well as the tugs above mentioned, are not subject to the act above cited, its provisions having been eliminated. The Maryland Steel Company, of Sparrows Point, Md., submitted the lowest bid for the construction of the colliers Nos. 11 and 12 (not subject to the eight-hour workday), their bid being $961,000 (£197,000) for each.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., submitted bids for the construction of all four of the colliers, Nos. 9 and 10 (subject to the eight-hour law) at $975,000 (£200,000) each, and Nos. 11 and 12 at $995,-000 (£204,000) each. The ships being practically alike, the difference between the two bids would approximately represent the difference in cost of construction to this company under the eight-hour law as compared with standard practice.

The New York Shipbuilding Company, Camden, N. J., submitted the lowest bid for the construction of the two seagoing tugs at $194,000 (£40,000).

COLLIERS NOS. 11 AND 12.

Their chief characteristics are contained in the following: They are single-deck vessels, about 530 feet long, 65 feet beam and 27 feet 6 inches mean draft. Speed, 14 knots at load draft. All the ship's scantlings and arrangements of bulkheads, etc., will meet the general requirements of the American Bureau of Shipping.

In full-load condition the vessels must have a continuous sea speed of 14 knots when carrying 12,500 tons of coal, inclusive of bunker, with an additional 250 tons covering other items.

They have a double bottom extending under the cargo-carrying spaces, as well as under the engine and boiler rooms, while the forward and after-peak compartments will be arranged as trimming tanks. Arrangements for carrying fuel oil in bulk will also be provided for.

The vessels will be fitted with complete coal-cargo handling appliances, consisting of necessary masts, derricks, elevated rails, reversible winches, etc., arranged in such a manner as to deliver coal at rate of about 100 tons per hour from each main cargo hatch, making a total delivery of about 1,200 tons per hour. All necessary pumps, piping and connections will also be provided for handling oil cargo.

Each vessel will have an electric plant, electrically-driven ventilation fans, all suitable appliances for interior communications, such as engine and steering telegraphs, voice tubes and telephones.

An efficient pumping and drainage system will be installed for filling and emptying ballast and trimming tanks, together with a fresh and salt-water system for use in galleys and quarters. A steam heating system will be installed. Accommodations, with staterooms, will be provided for commander, executive and navigating officer, senior engineer officer, three watch officers, doctor, paymaster, two warrant machinists, besides crew's accommodations.

The propulsive machinery will consist of twin-screw. triple-expansion engines of the merchant marine type, and of adequate size for the speed stipulated. The boilers will be of the cylindrical type, with separate combustion chamber for each furnace. A donkey boiler will be fitted for use in port. All necessary auxiliaries will be installed, including evaporators, feed heaters, refrigerating plant, steam reversing engine, steam turning engines and ash hoists.

SEAGOING TUGS.

The general features for each of the tugs are:

Length between perpendiculars.....	175 feet.
Length over all....................	183 feet.
Breadth, molded	34 feet.
Breadth, extreme over guards......	35 feet 6 inches.
Draft, trial condition, aft..........	14 feet.
Draft, trial condition, forward.....	15 feet.
Displacement	1,100 tons.
Total bunker capacity about........	435 tons.
Continuous sea speed..............	14 knots.

The vessels will be built to have the highest rating provided for by the rules and inspection of one of the registration societies. The ships to be fitted with all modern appliances, such as steam capstan and windlass, a reversible steam winch for each of the two cargo booms, steam steering engine, refrigerator and evaporator plant, electric plant and wireless telegraph apparatus, etc.

The propelling machinery for each will consist of a merchant marine triple-expansion engine and two cylindrical boilers. with all necessary auxiliaries.

THE POWERING OF MERCHANT SHIPS AND DESIGN OF THEIR FORMS.

BY PETER DOIG.

To those who are familiar with the assembling graphically of progressive trial results in Admiralty constant form, the task of rendering the curves obtained amenable to law must seem one with much inherent difficulty. The Admiralty constant, or displacement coefficient, as it may be better termed, is familiar to all, being the value

$$K = \frac{D^{2/3}\,V^3}{H}$$

where D is displacement in tons, V speed in knots and H indicated horsepower. As is well known, this coefficient is not a constant, properly speaking; and it may be well at the outset to remind ourselves of the assumptions underlying it. These are: (*a*) That the resistance varies as the square (and consequently the work done as the cube) of the speed; (*b*) that the proportion between "useful" work, or work not wasted in overcoming machinery and propeller frictions, etc., and gross work of the engines, is always a constant fraction; (*c*) that resistance at any particular speed is proportional to wetted surface, or two-thirds power of the displacement, to which wetted surface is itself approximately proportional. If these were absolute laws then a certain unvarying displacement coefficient would be got at any speed of a given ship, and values varying only as the (displacement)$^{2/3}$ of different vessels would be the rule. The skin or frictional part of resistance varying as the 1.83 power of the speed, the foregoing would very nearly hold if all resistance were frictional between ships of no great difference in length; but the introduction of the wave-making phenomena alters this index considerably. Its value gets higher with speed until at very high velocities, where it again decreases. This gives the curve of displacement coefficients a typical form as plotted on a base of speed-length ratio $\left(\frac{V}{\sqrt{L}}\right)$ When the effect of greater relative waste of work at low speeds, due to lower engine efficiency, is allowed for, a curve is obtained starting high in value and decreasing until very high relative speeds are reached, where, in tropedo craft, for example (at $\frac{V}{\sqrt{L}}$ about 1.6), the line has an approximately level trend.

To clear the way towards some reconcilation of the greatly varying values found, it will be of help to consider the factors affecting it in ships of the same displacement. These may be taken: (1) Speed; (2) fullness or block coefficient; (3) proportions; (4) propulsive efficiency; (5) to some degree, owing to the lesser frictional resistance per unit of surface with increased dimension, length, and (6) form, by which is meant the nature of the horizontal and transverse sections.

Though needing careful treatment in view of all these influencing factors, this coefficient method has maintained its position as a handy and flexible means of estimating power in all shipbuilding countries except France, where a similar but less satisfactory coefficient, involving the area of the fullest transverse section instead of the two-thirds power of the displacement, has been long in use. The writer is convinced that the displacement coefficient can be used in a more general way than is current, although it is no doubt being superseded by the more scientific methods of the model basin. As the naval architects and engineers enjoying the use of such an establishment form a very small number in the profession, the present paper, it is hoped, may be of help to the great majority debarred from such a luxury.

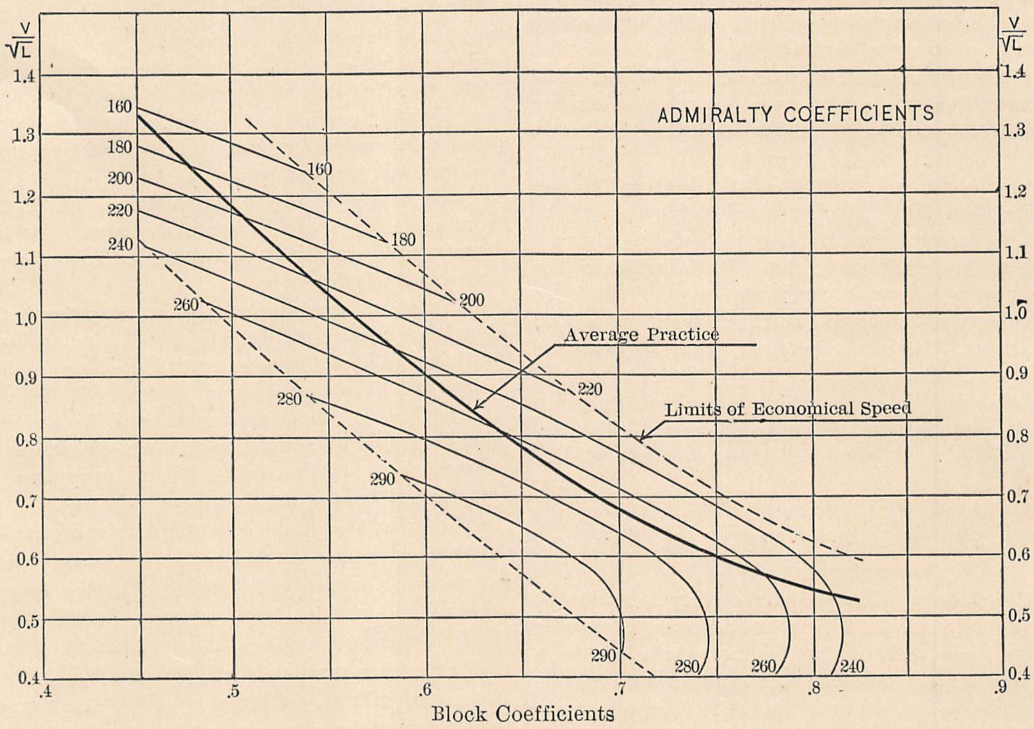


DIAGRAM SHOWING THE EFFECTS OF FULLNESS OR BLOCK COEFFICIENT AND SPEED ON DISPLACEMENT COEFFICIENTS.

An attempt has been made by the analysis of the coefficients obtained in the trials of a large number of merchant vessels to eliminate the effects of the factors enumerated above. As the ships considered are of different builders' designs, the forms should cover most of the practical variations from the normal; so that the effect of number (6) is, so to speak, automatically averaged in the process adopted. A computation of the effect of (5) assuming a standard length of 400 feet, and taking an average proportionate frictional resistance to total resistance (on which the effect directly depends), gives the following corrections: