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PATENT SPECIFICATION

Application Date: Jan. 20, 1936. No. 10637/37. **470,907**

(Patent of Addition to No. 455,466 : Jan. 18, 1935.)

Complete Specification Accepted: Aug. 20, 1937.

(Divided out of Application No. 1820/36 (No.455,466) under which a Specification was laid open to inspection under the provisions of Section 91 (4) (a) of the Patents and Designs Acts, 1907 to 1932, on July 20, 1936.)

COMPLETE SPECIFICATION

Improvements relating to the Construction of Ships

I, RUDOLF ENGELMANN, a German Citizen, of 96, Heimat, Berlin-Zehlendorf, Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to an improvement in or modification of the ship described and claimed in the parent Specification No. 455,466. The ship according to the parent specification is based on the problem of producing a ship of such form that total resistance is reduced to a minimum, so that a very high speed can be attained with relatively low output, even in a heavy sea.

In the case of the ship according to Specification No. 455,466, however, it has been found that the initial point of the above-water superstructure, particularly with a rough sea, easily gives rise to a bow-wave which increases the resistance. Here also, at high speed, the disadvantage is experienced that the front part of the above-water superstructure is covered with a thin layer of water which results in an increase in frictional resistance. A further disadvantage of the ship according to Specification No. 455,466 consists in that the ship, as it has only a slight reserve displacement, tends to undercut when ploughing through large waves.

The object of the present invention is to improve the ship according to the parent specification by giving the hull of the ship a suitable shape. The invention consists in arranging in the under-water hull in front of the initial point of the superstructure, a trough-shaped recess having its lowest part just in front of the superstructure, and extending laterally and rearwardly to behind the initial point of the superstructure, and forwardly while forming an upwardly curved shallow hump, merges gradually into the otherwise unchanged under-water ship. Instead of such a trough-shaped recess in the under-water hull, there may also be provided in front of the superstructure a gently, upwardly curved bulge projecting over the water line and which, towards the bow and towards the stern, merges gradually into the otherwise unchanged underwater hull. The result obtained by these measures is that behind the initial point of the superstructure a wave trough is formed, so that the front part of the superstructure is free from water even in a heavy sea and slack-water resistance cannot occur here. At the same time the result is obtained that the superstructure is not covered with a film of water at high speed, and causes only slight surface friction. Moreover, over the rear part of the hull there is formed a wave-crest which assists the cavitation-free operation of the propeller.

Furthermore, the invention consists in that at the sides of the front part of the underwater hull there are provided longitudinal fins running fore-and-aft and having a downwardly directed inclination. These longitudinal fins ensure the longitudinal stability of the ship, i.e. prevent the ship from undercutting, in that it prevents the water from flowing off sideways from the front part of the hull, and together with the obliquely upwardly inclined ship's bottom located between them, compel the water to exert a dynamic counter-force from below which prevents the stem of the ship from sinking. Numerous experiments have proved that by means of these longitudinal fins a considerably better support of the front part of the ship can be obtained during the progress of the ship, than can be obtained by means of a pair of front deep-rudders, while at the same time the longitudinal fins offer very much less resistance than a pair of deep-rudders.

Finally, the invention consists in that the above-water superstructure is provided at its front part with a laterally projecting surface which—seen in side view—extends obliquely downwards towards the stern. These surfaces can be made adjustable and preferably, in side view,

[*Price* 1/-]

Price 4s 6d

extend in undulatory manner. The surfaces which project laterally from the above-water superstructure are preferably formed from the superstructure itself, in that the lower part of the superstructure merges with an outwardly directed curve into a broader upper part of the superstructure.

This form of construction of the above-water superstructure likewise contributes to preventing the front part of the superstructure from being covered with a thin layer of water when the sea is calm. This form of construction also prevents the superstructure from being completely flooded when the ship is ploughing through big waves, and, in consequence of the dynamic lifting forces, tends to lift the ship when it is ploughing through big waves, without pitching movements being transmitted to the ship in a heavy sea. Furthermore, this form of construction of the above-water hull gives the latter a greater reserve displacement, which is very desirable with a ship of this type, as otherwise the reserve displacement is only small.

Several forms of construction of the invention are illustrated in Figs. 6—10 of the annexed drawings. Figs. 1—5 represent features disclosed in the parent specification, but for the sake of clarity it have been thought desirable to reproduce them here.

In these drawings:—

Fig. 1 is a side view of a ship.

Fig. 2 is a horizontal longitudinal section on the level of the line K W L in Fig. 1.

Fig. 3 is a horizontal longitudinal section along the line 12—12 of Fig. 1.

Fig. 4 is a horizontal longitudinal section along the line 4—4 of Fig. 1.

Fig. 5 is a vertical cross-section along the line 0—10 in Fig. 1, the cross-section being shown in two halves, namely a cross-section along the line 0—7 in the left part of Fig. 5 and a cross-section from 7—10 in the right-hand part of Fig. 5.

Fig. 6 shows the part lying in front of and behind the points of attachment of the above-water superstructure, in three different forms of construction and on an enlarged scale.

Fig. 7 shows vertical cross-sections along the line $6\frac{3}{4}$, 7, *a*, $7\frac{1}{2}$ and *b* for illustrating the recess of the under-water hull shown in Fig. 6 by the line *e*, *h* and *g* and also the line *i*.

Fig. 8 shows vertical cross-sections along the line *a*, $7\frac{1}{2}$ and *b* in Fig. 6 for illustrating the bulge in the under-water hull shown in Fig. 6 by the line *e*, *k*, *g*.

Fig. 9 shows vertical sections through another form of construction of the above-water superstructure.

Fig. 10 is a view of the ship according to Fig. 1 with an above-water superstructure according to Fig. 9 indicating the undulatory course of the stabilising surfaces of the superstructure.

The ship according to the parent specification, as may be seen from Figs. 1—5, is so designed that the upper edge of the under-water hull 1, when the ship is in the normal trim position at full speed, is in exact alignment with the surface of the water, and the upper edge of the hull, being shown in side view, is designed as a straight line and the maximum cross-section of the underwater hull is located in front of the middle of the ship. The underwater hull is substantially fusiform, the longitudinal axis passing through the stern end 4 of circular cross-section, is arranged lower than the corresponding axis of the bow end 3. The apex of the bow end 3 is slightly rounded; the limiting edges 5, 6 of the bow end merge with slight curvature into the keel line 9 and the upper edge 10 of the underwater hull.

The apex of the stern 4 is connected by a slightly curved portion 7 with the end point of the above-water superstructure 2 and by a slightly curved portion 8, with the substantially straight keel line 9.

The above-water superstructure 2 does not extend, towards the bow, beyond the part of the normal cross-section (at 7); the middle of the upper edge of the superstructure is straight and towards the bow and the stern curves uniformly towards the underwater hull. When the ship is in normal trim at full speed, no part of the superstructure protrudes under the surface of the water (Fig. 1).

The plan of the superstructure can be seen in Fig. 2. In the middle part the plan is bounded laterally by a straight line, whereas, towards the bow, it ends in a slender point, and towards the stern in a blunter point.

The sections shown in Figs. 3 and 4 along the line 12—12 and line 4—4 of Fig. 1 clearly show the form of the longitudinal section of the underwater hull, and needs no further explanation.

The cross-sectional form of the hull is shown in Fig. 5. In the vicinity of the point of the bow the underwater hull is of circular cross-section, as shown in the cross-sections along the lines $9\frac{3}{4}$, $9\frac{1}{2}$ and $9\frac{1}{4}$; at the same time the circumference of the hull increases. In the case of sectional line 9, the cross-sectional form is no longer exactly circular, but approximates to a vertical ellipse whose lower cross-sectional half is greater than the upper cross-sectional half. In the sectional lines $8\frac{1}{2}$ and 8 the elliptical or oval is still more strongly pronounced; in this case the lateral lines of the cross-section approximate to straight lines, whereas the bottom has a clear flattening. In the cross-sections $7\frac{1}{2}$ and 7 the straight course of the lateral edges and the flattening of the bottom is still more clearly pronounced (Fig. 5 right half). At the top the cross-section is no longer strongly rounded.

At the line 7 the position of maximum cross-section is reached, and then alters first of all mainly in that the underwater hull is provided at the top with a flat surface corresponding to the plan surface of the superstructure, which surface first of all broadens laterally, then remains constant, and then decreases laterally. Accordingly, the cross-sectional form widens at the top from line 7 to line 4. From cross-section 6 substantial tapering of the upper cross-sectional halves takes place, so that here the cross-section assumes a pear shape. The tapering of the upper halves continues as far as the end of the stern, and from about cross-section $2\frac{1}{2}$ onwards there is a strong diminution of the cross-sectional height. At cross-section $\frac{3}{4}$ for instance, the form is again elliptical, and at the cross-section $\frac{1}{2}$ and $\frac{1}{4}$ as far as the end of the stern the cross-section is again circular.

Fig. 6 shows, on an enlarged scale and in a construction according to the invention, the part of the underwater hull located in the vicinity of the initial point of the superstructure. The full line *e, f, g* corresponds to the shape of the ship according to Fig. 1. With this form of construction it is possible that, at a high speed, accumulation of water will occur at the point of attachment of the superstructure which has the effect of increasing resistance. In order that this may be avoided a recess or an inwardly curved portion may be provided in front of the point of attachment of the superstructure in the underwater hull, as indicated by the broken line *h*, and its limit in the transverse direction is shown by the line *i*. The recess has its deepest point slightly in front of the superstructure, and extends towards the stern to behind the point of attachment of the superstructure, and runs towards the bow while forming a slight upwardly curved hump in the front part of the underwater hull as shown in Fig. 5.

Instead of the recess it is also possible to supply the underwater hull, in front of the point of attachment of the superstructure, with a bulge, as indicated by the line *e, k, g*. This outwardly curved portion is gently curved at the top and protrudes above the water line. Towards the stern it ends in the point of attachment of the superstructure, and towards the bow merges, while still curved, into the front part of the underwater hull otherwise constructed in accordance with Figs. 1 and 5.

Both forms of construction have the advantageous effect that the superstructure is more free of water, which leads to a considerable increase in efficiency.

Fig. 7 shows the form of the recess, the left half being a section along the lines $6\frac{3}{4}$ and 7, and the right-hand half cross-section along the lines *a*, $7\frac{1}{2}$, *b*.

In Figs. 7 and 8, by way of comparison, the cross-sections of the form of the ship according to Figs. 1 and 5 are entered in broken lines.

Fig. 9 shows the sloping position and the longitudinal extension of downwardly directed fins arranged on each side of the base surface of the front part of the underwater hull, and running fore-and-aft, which fins, in conjunction with the base surface of the front part of the hull, produce, during travel, a lifting effect on the front part of the hull, whereby longitudinal stability is considerably improved. The longitudinal extensions of the fins extend from about line $9\frac{1}{2}$ to about line 8 in Fig. 1.

The cross-sections through the superstructure according to Fig. 9 are located in the plane of the frames 3—$6\frac{1}{2}$ indicated in Fig. 10; at the left part of Fig. 9 the cross-sections are shown through the superstructure in the plane of the frames 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, whereas the right-hand part of Fig. 9 shows cross-sections through the front part of the superstructure in the plane of the frames 5, $5\frac{1}{2}$, 6 and $6\frac{1}{2}$.

Altogether, the cross-sectional lines 0 (point of stern) to 10 (point of bow) are indicated in Fig. 10. In this figure, 1 denotes the underwater hull, 2 the superstructure, 3 the bow of the hull and 4 the stern part of the hull.

The cross-section at frames $6\frac{1}{2}$ shows that the front part of the superstructure first of all has the same shape as shown in Fig. 1. From frame 6 onwards towards the stern the cross-sectional form of the superstructure is that shown in the sections in the plane of frame 6, $5\frac{1}{2}$ and 5. In the section in the plane of frames 6 and $5\frac{1}{2}$, the cross-sectional form of the superstructure according to Fig. 1 is indicated in broken lines, so that it can be seen that the superstructure, as compared with the form of construction according to Fig. 1, has undergone a considerable increase in volume. The stabilising rudder surfaces are denoted by 15 in Fig. 9; they end outwards in an edge 14 which is shown in side view in Fig. 10, and shows the undulatory course of the surface from the front part of the superstructure to its middle. Fig. 10 shows that in side view the stabilising surfaces in the front part of the superstructure, begins at the top with a forwardly and downwardly directed curve, and that the surface curves progressively downwards towards the middle part of the superstructure, corresponding approximately to the course of a wave. As may be seen from the cross-section in Fig. 9, the surface 15 is at first, i.e. at frame 6, only gently curved outwards, whereas the curvature increases progressively towards the middle part of the superstructure, until at frame 5 the surface 15 has a substantially horizontal course. From the frame 5 onwards the width of upper part of the superstructure gradually decreases, as may be seen from the section at frame 4½, until at frame 4 the form of the superstructure has again reached that shown in Fig. 1.

The form of the edge 14, its level and also its extension to the middle of the superstructure and its beginning at the front part of the superstructure depend upon the speed of the ship and the height of the waves; for a ship with a definite maximum speed or cruising speed the height and the course of the edge 14, i.e. the stabilising surfaces and their extension fore and aft must be determined by experiment in order to obtain the best value.

The stabilising rudder surfaces need not be formed by the shape of the side walls of the superstructure, but the same effect can also be obtained by fitting on the superstructure according to Fig. 1, stabilising rudders such as are known, for example, in connection with submarines; in this case the surfaces may be designed to be adjustable.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A ship as claimed in Specification No. 455,466, characterised in that in front of the foremost point of the superstructure there is provided a recess in the underwater hull having its deepest part slightly in front of the superstructure, and extending laterally and rearwardly to behind the initial point of the superstructure, and forwardly, while forming an upwardly curved shallow hump, merges gradually into the otherwise unchanged under-water hull.

2. A ship as claimed in Specification No. 455,466, characterised in that the underwater hull has in front of the foremost point of the superstructure a gently upwardly curving bulge protruding above the water line, and which towards the bow and towards the stern merges gradually into the otherwise unchanged underwater hull.

3. A ship as claimed in Specification No. 455,466, characterised in that at each side of the base surface of the front part of the underwater hull there is fitted a longitudinal fin extending from a point near the bow towards the stern and having a downwardly directed inclination.

4. A ship according to any one of the preceding claims, characterised in that in order to obtain a stabilising rudder effect during a heavy sea, and an additional increase in buoyancy so as to prevent bow waves covering the front part of the superstructure, the latter is provided at each side of its front part with a laterally projecting surface which, seen in side view, extends obliquely downwards towards the stern.

5. A ship according to Claim 4, characterised in that the surfaces projecting laterally from the superstructure are adjustable.

6. A ship according to Claims 4 or 5, characterised in that, seen from the side, the course of the surfaces projecting laterally from the superstructure is undulatory.

7. A ship according to Claims 4 or 6, characterised in that the lower part of the superstructure merges in an outwardly directed curve into the broader upper front part of the superstructure.

Dated this 14th day of April, 1937.

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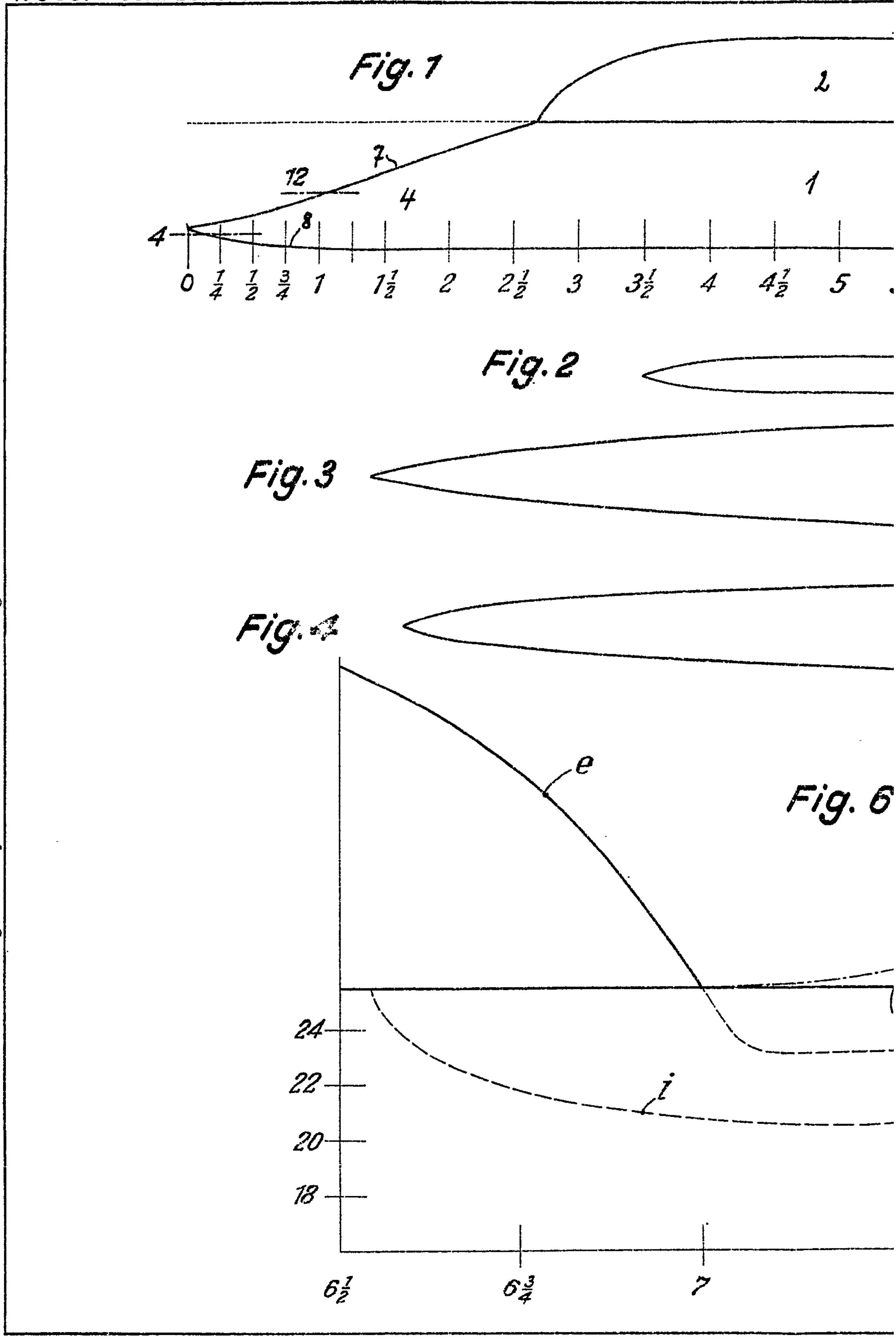
Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 6
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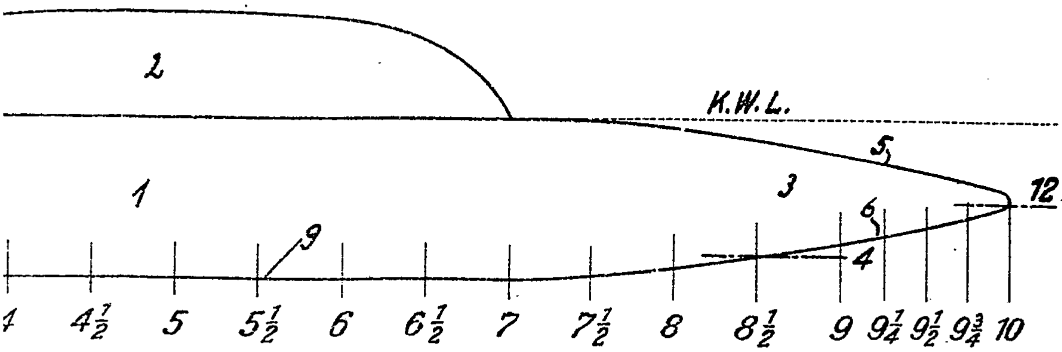
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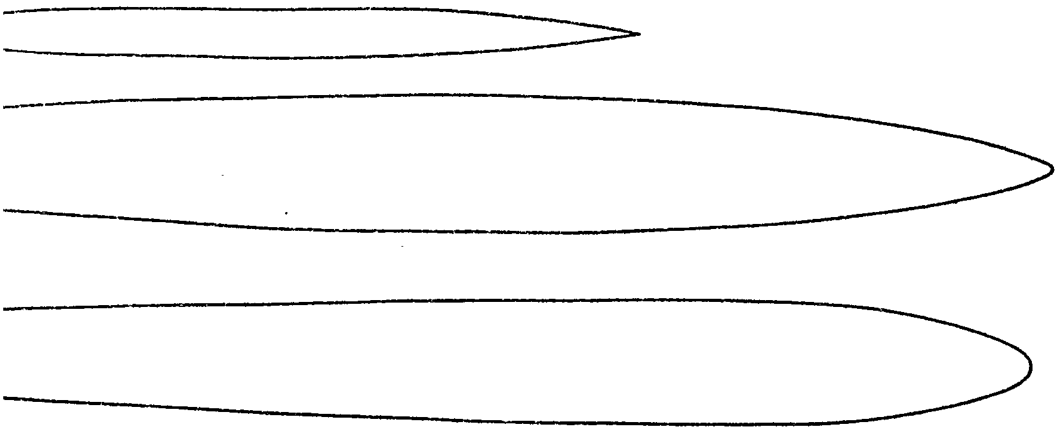

Fig. 6

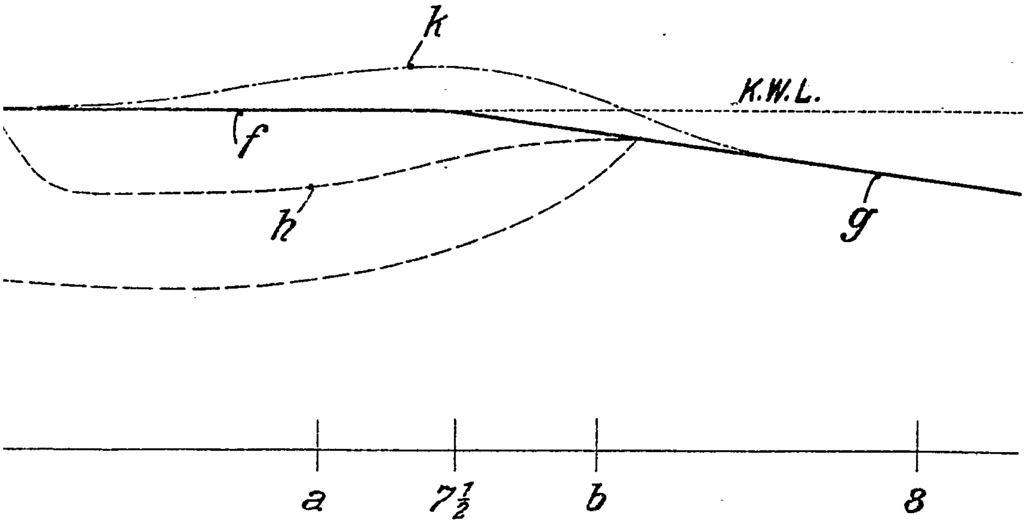
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Fig. 1

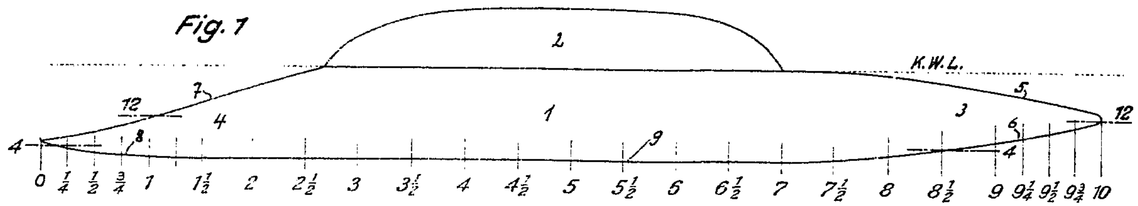


Fig. 2

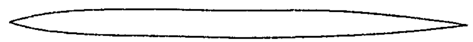


Fig. 3

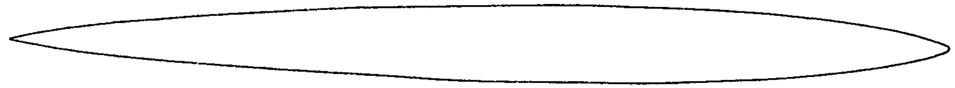


Fig. 4

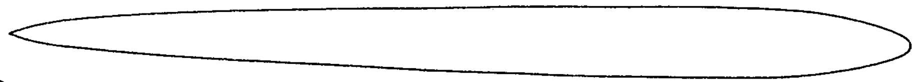
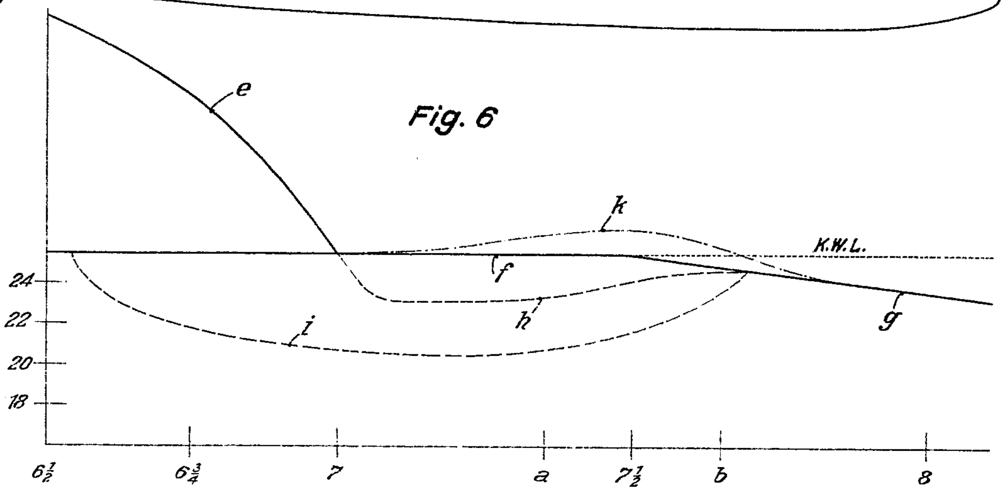


Fig. 6



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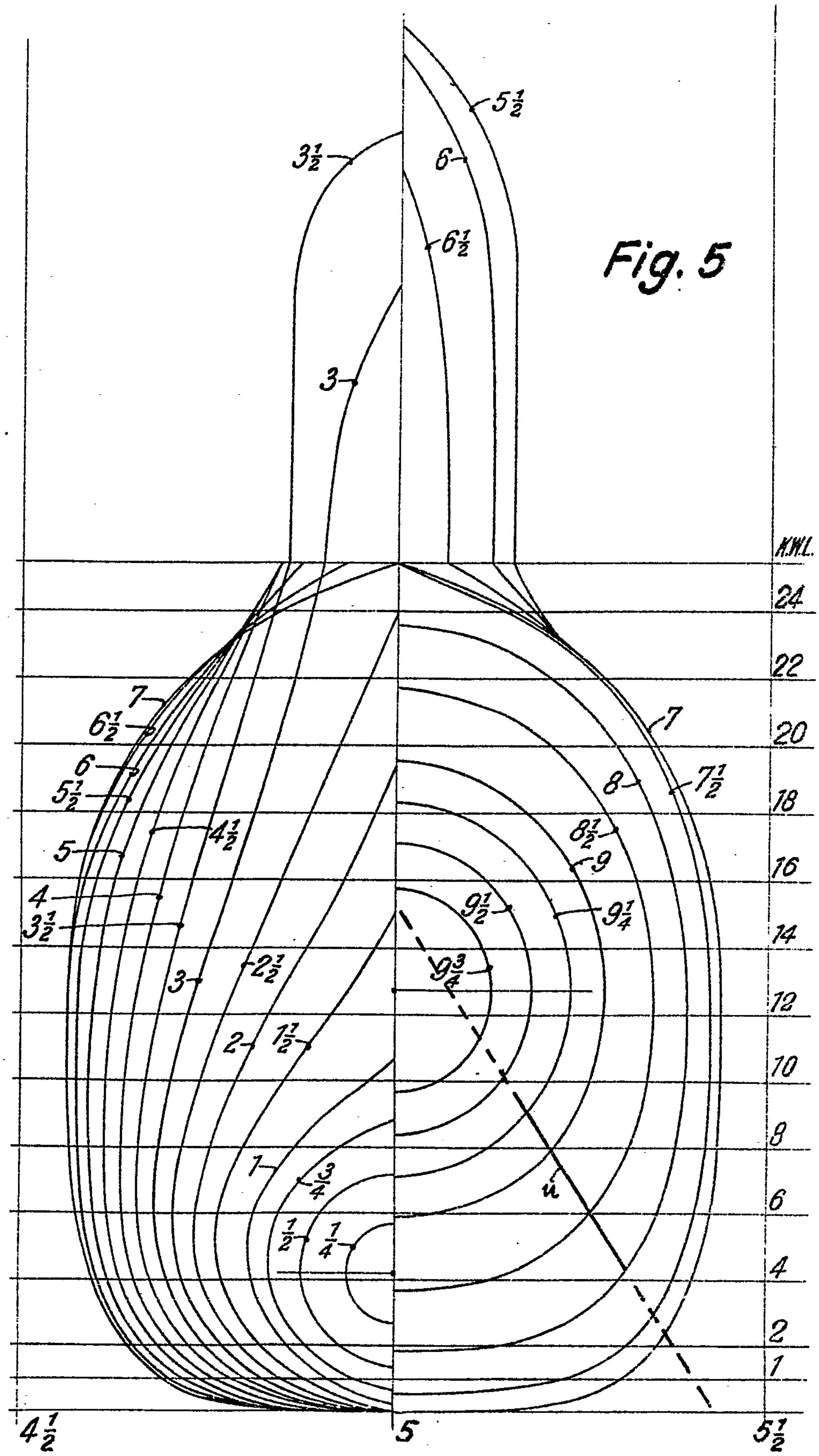
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Fig. 5

SHEET 2

4 SHEETS

SHEET 4

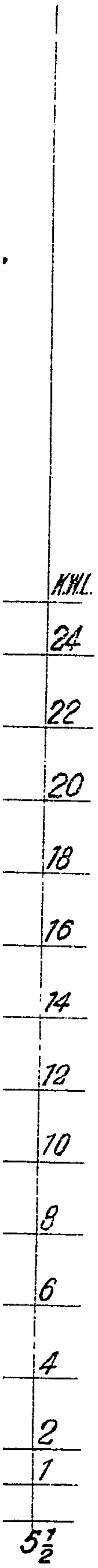
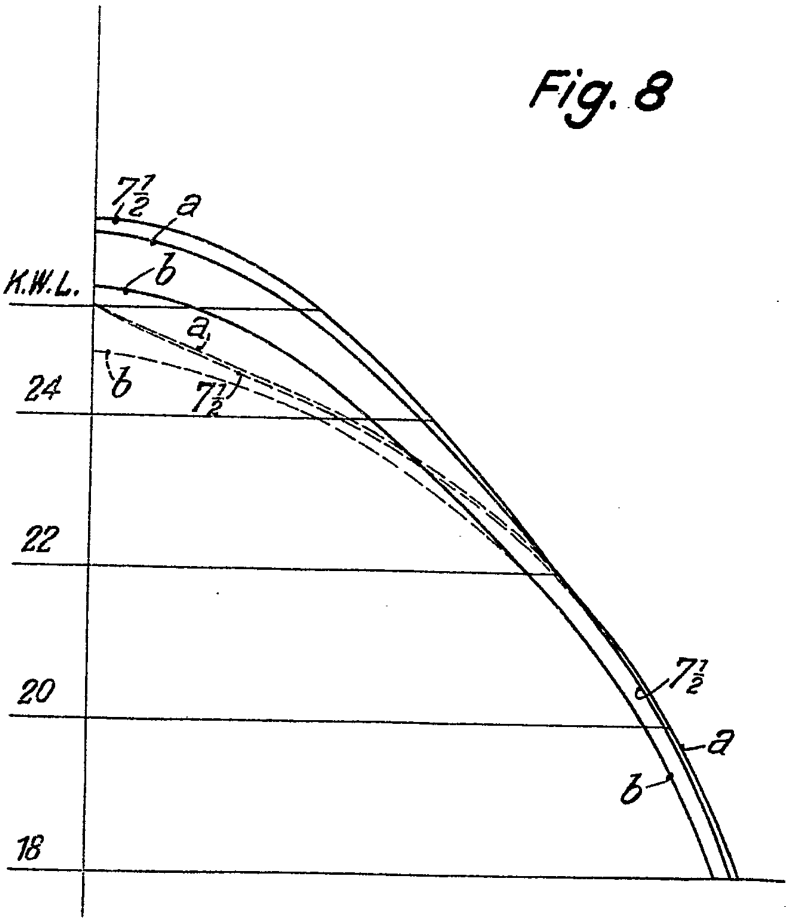


Fig. 8



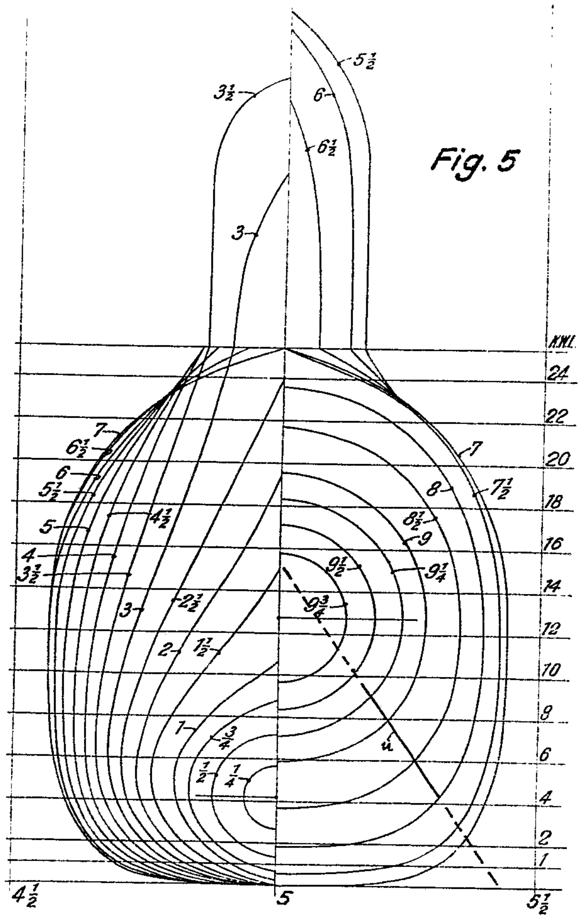


Fig. 5

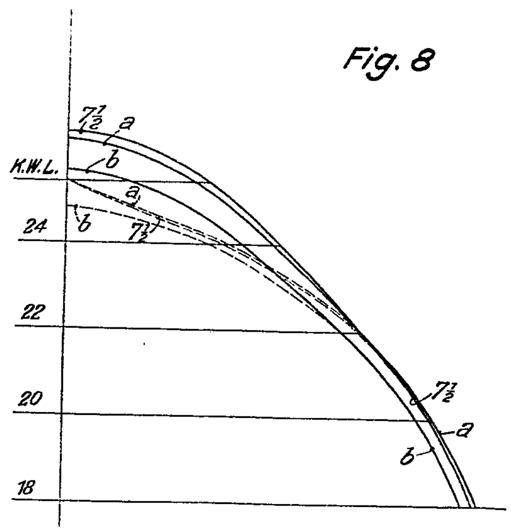


Fig. 8

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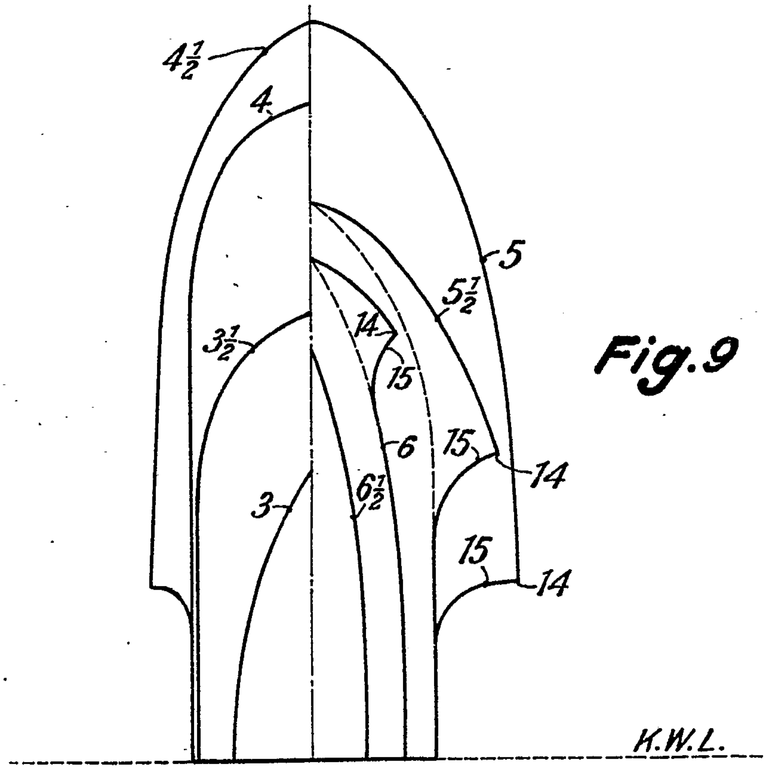

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K.W.L.

Fig.9

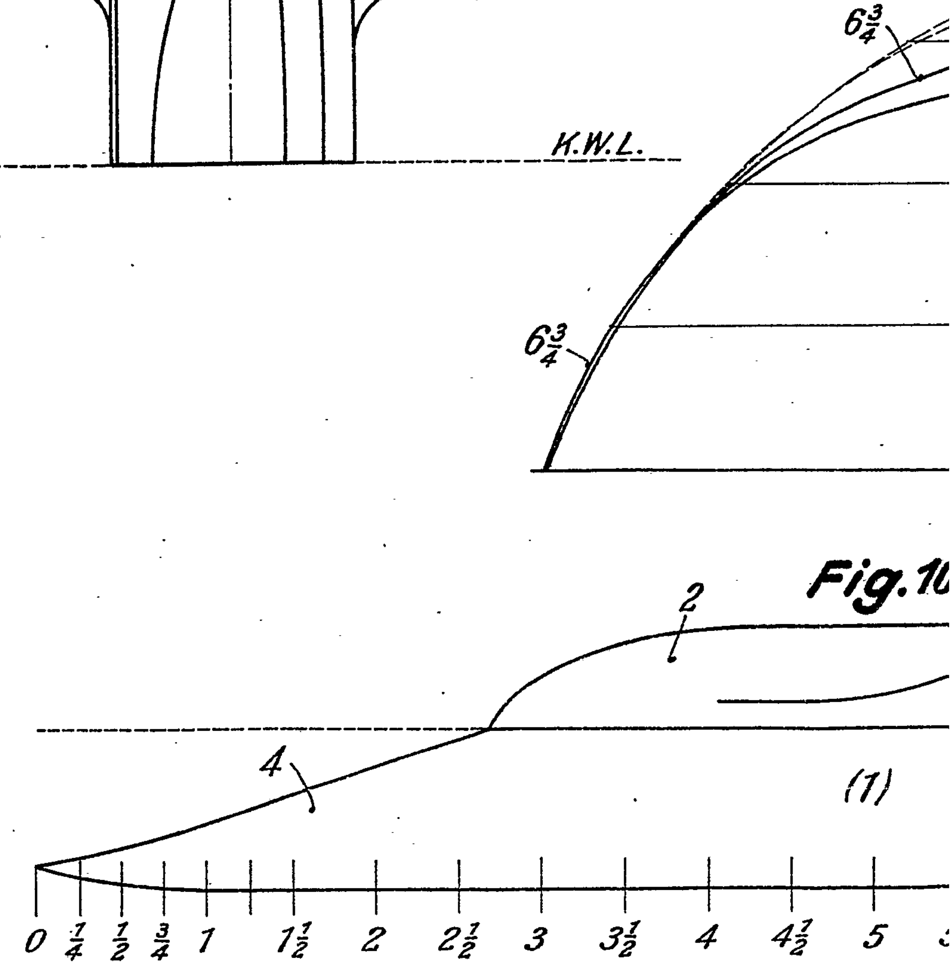

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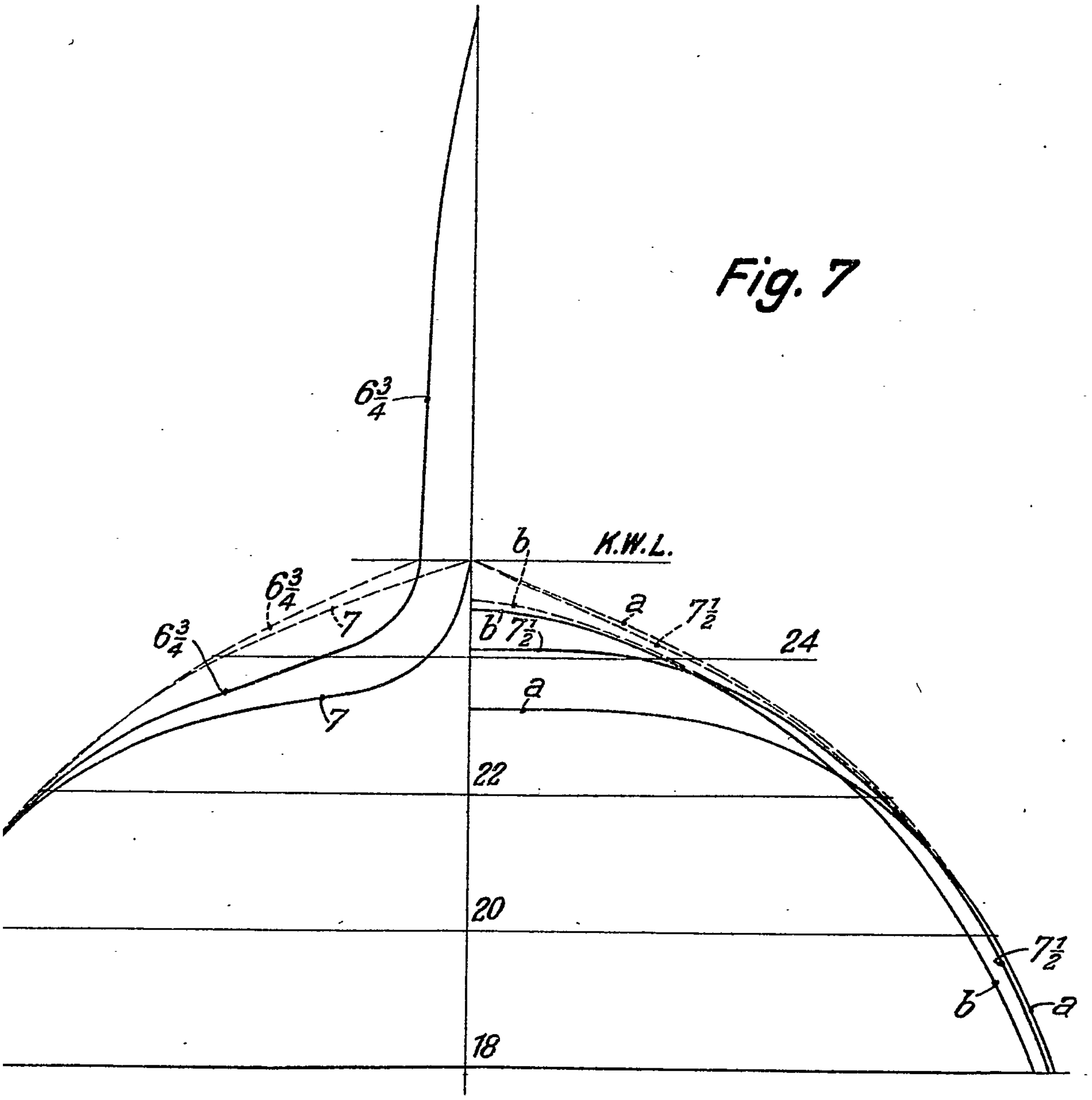
Fig.10

Fig. 7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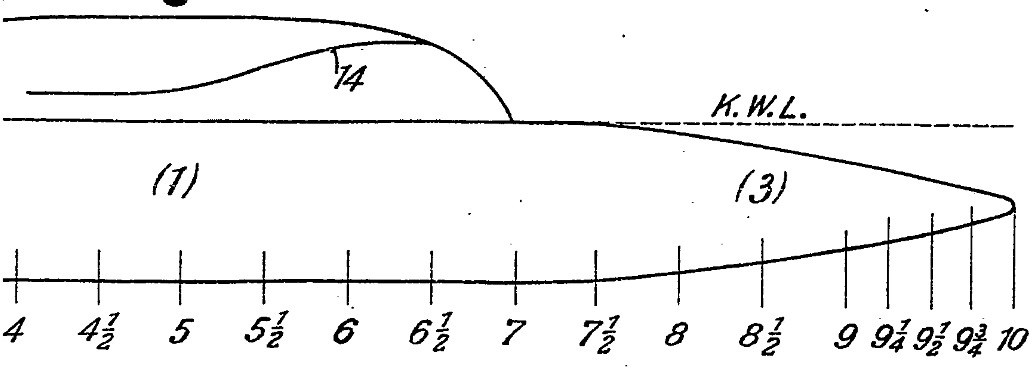
a
18

Fig. 10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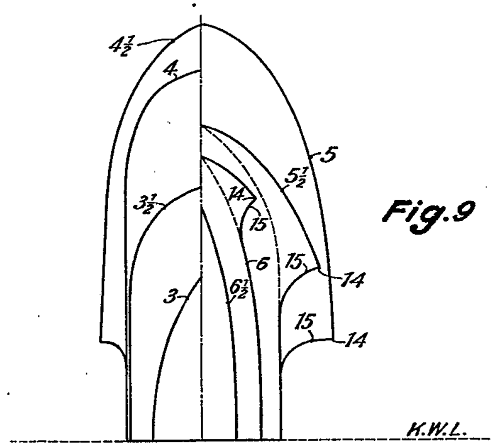

Fig. 9

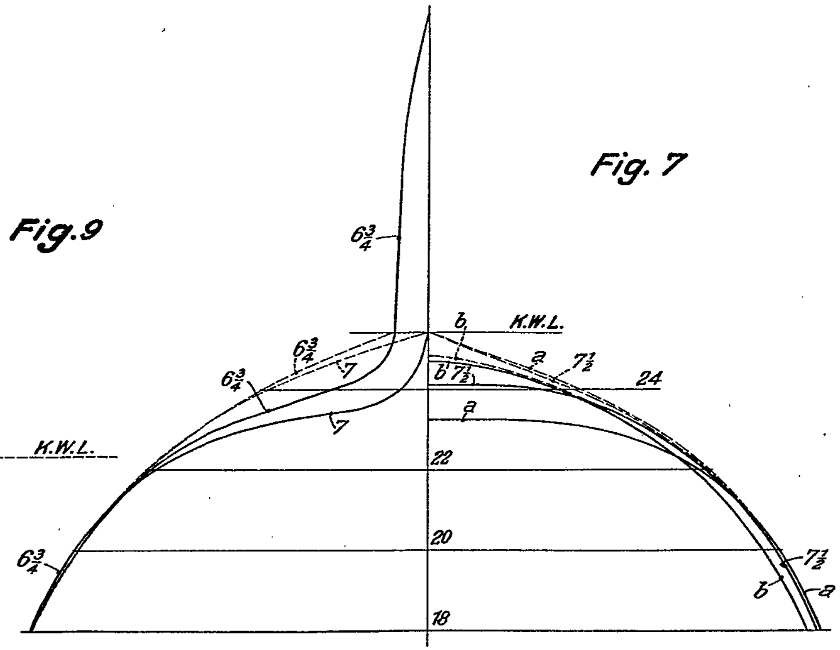

Fig. 7

Fig. 10