No. 654,655. Patented July 31, 1900.

# E. LINDEMANN.

## MEANS FOR REDUCING SKIN FRICTION OF SHIPS.

(Application filed Sept. 5, 1899.)

(No Model.)

Fig. 1.

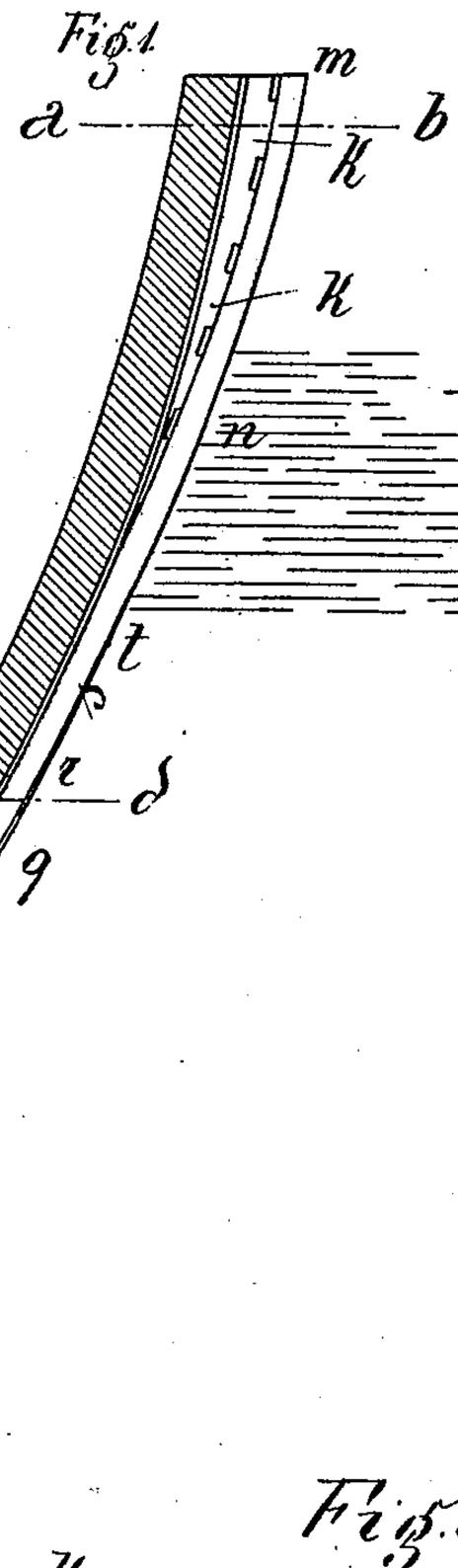


Fig. 2.

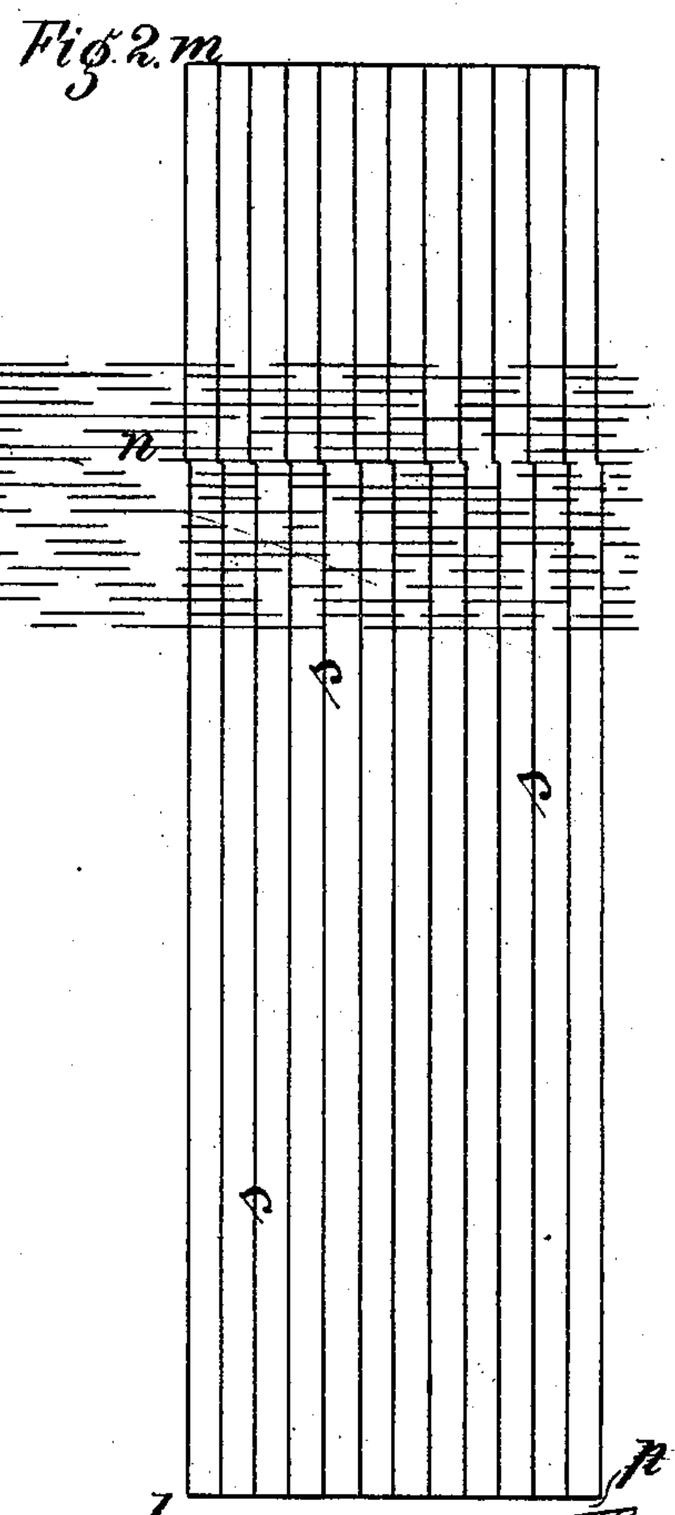


Fig. 3.

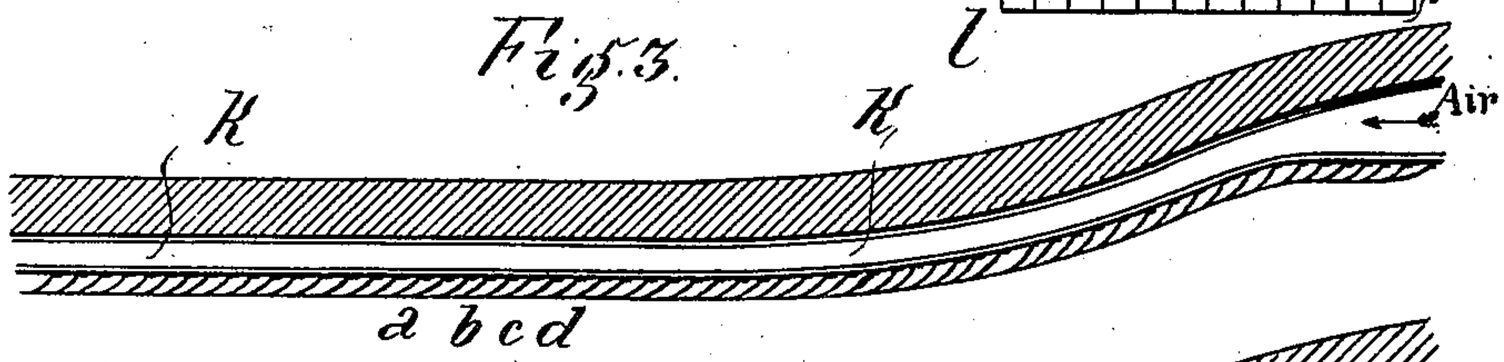


Fig. 4.

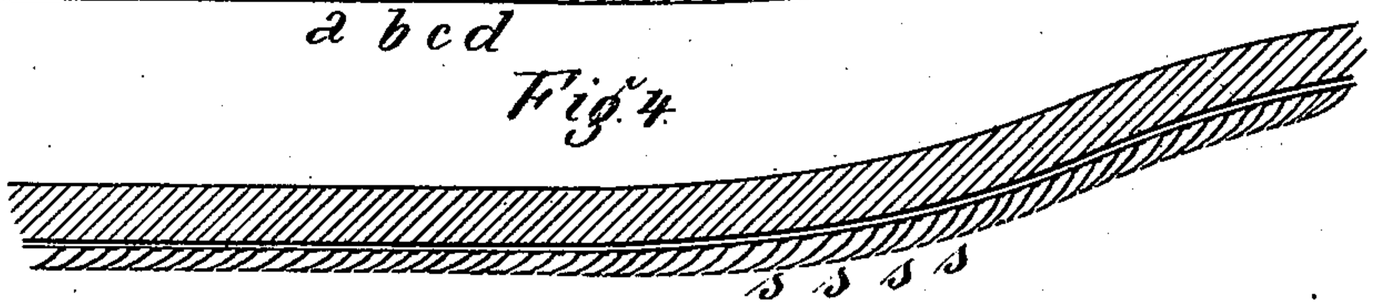


Fig. 5.

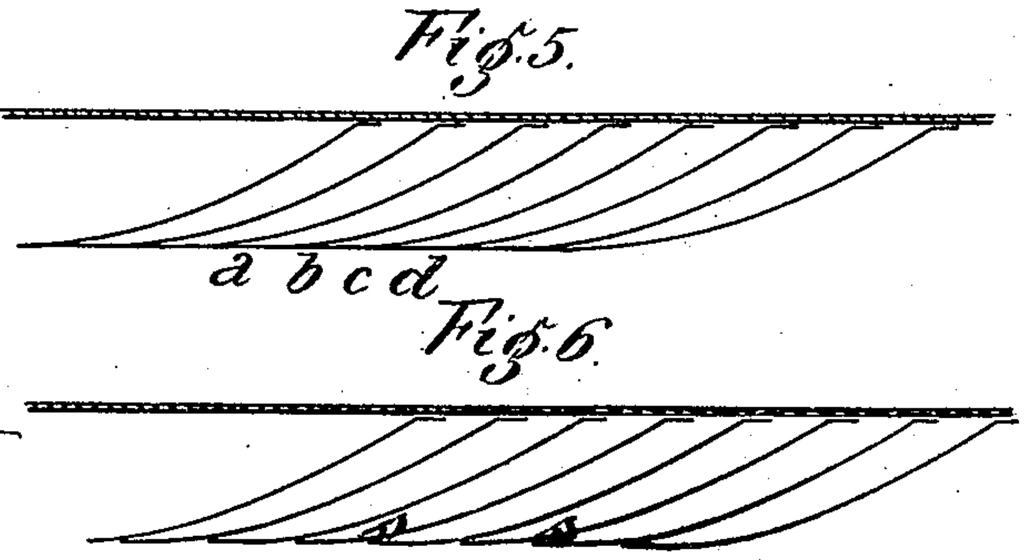


Fig. 6.

Witnesses:
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# UNITED STATES PATENT OFFICE.

EDUARD LINDEMANN, OF MUNICH, GERMANY.

## MEANS FOR REDUCING SKIN-FRICTION OF SHIPS.

SPECIFICATION forming part of Letters Patent No. 654,655, dated July 31, 1900.

Application filed September 5, 1899. Serial No. 729,526. (No model.)

*To all whom it may concern:*

Be it known that I, EDUARD LINDEMANN, engineer, a citizen of Germany, residing at Munich, Bavaria, Germany, (post-office address, Schellingstrasse 41$^{I}$,) have invented a certain new and useful Improvement in Reducing Friction of Ships' Sides; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

By the movement of ships through the water an essential resistance is caused by the friction, which hinders the fast movement of the same, and the result is a diminution of speed caused by the friction of the ship's bow with the water. The greater the speed the greater will be the resistance. By the diminution of the friction-surface between the exterior of the ship and the water the friction and resistance would be lessened. The following method and the hereinafter-described arrangement are such that the amount of friction is lessened by providing between the outside of the vessel and the water a thin layer of air. As the skin of fishes is provided with scales, the slippery nature of the slime of the same lessens the friction between the fish and the water. In a like manner if the ship's bow were covered with metal plates having spaces between the friction between the ship's bow and the water would be lessened by air escaping therefrom. For this purpose so much of the surface of the ship as lies under water is surrounded with a thin air layer in a similar manner as the skin of fishes is covered with slime. This air layer is automatically formed by the speed of movement of the ship without mechanical means or compressed air. The scale-like metal plates lying one upon the other form pockets over which by the movement of the ship the water glides, so as to draw air out of the pockets. This produces an exterior air layer acting against the friction, lessening the effect of the friction and increasing the speed. The greater the speed in a like manner will the air-space be increased, proportionally reducing the resistance.

In the annexed drawings, Figure 1 is a cross-section of a ship. Fig. 2 is a side view of the same. Fig. 3 is a longitudinal section after the line *a b*. Fig. 4 is a longitudinal section after the line *c d*. Figs. 5 and 6 show sectional views of the plates.

In the exterior of the vessel narrow vertical overlapping plates *a b c d*, Figs. 3, 4, and 5, are arranged, which extend from the edge to the keel of the vessel, Figs. 1 and 2. Each plate overlaps the next rear one in a similar manner to the scales of a fish, Fig. 5. Between each of these plates a pocket, as shown in Figs. 5 and 6, is formed, which from its upper part *m*, Figs. 1 and 2, to the part *n* is closed and of which the part below *n* coming underneath the water-line is open. At the keel-line *l p*, Fig. 2, the pockets are closed. The plates are arranged so that between each of them is a narrow opening or slit *s*, Figs. 1, 2, and 3, under the water-line. The lower part *n l*, Fig. 1, of these pockets conforms to the outline of the ship and fits closely thereto; but the upper part *m n* is separated from the same, so that an air-chamber *k*, Figs. 1 and 3, is formed. This air-chamber *k*, Fig. 3, is open at the bow of the ship and closed at the stern, so that by the forward movement of the ship air is drawn into the air-chamber and passes into all the pockets. The air-chamber *k*, Fig. 1, is connected at its lower part to the pockets, so that the air by reason of the pressure will pass into the pockets, rushing out of the same through their narrow openings. When the ship is stationary, the pockets below the water are filled with water. The water will not remain in the pockets so long as the speed of the ship is greater in proportion to the flow of the water which is governed by the water-pressure and the draft of the ship. Thus by the action of the moving water air is drawn out through the openings of the pockets. The suction of the air by the water is assisted by the entrance of the air into the air-chambers open at the bow of the ship. It results, therefore, that by the forward movement of the ship the water in the pockets is forced out through the narrow openings or slits of the same by the air-pressure in the air-chamber *k*, Fig. 3. The slit openings *s* of the pockets are connected together at suitable points *t r q x y z*, Fig. 1, blocks being interposed.

As the whole surface of the ship is covered with the overlapping plates, the whole

surface when moving is incased, as it were, with a layer of air on account of the air passing out of the pockets, such outflow of air being caused by the movement of the ship through the water. The greater the speed of the ship the greater the air-layer. The air layer thus reduces the amount of the frictional surface, and the speed is increased. The action is automatic. In order to further increase the speed, steam can be introduced into the air-chamber, Fig. 3, so that both air and steam can pass into and out of the pockets.

Having now described my invention, I claim the following:

1. The combination with a side of a ship, of a series of plates secured transversely thereto, each plate extending rearwardly and contacting at its free edge with the adjacent rear plate, said contacting edges having apertures below the water-line, and means for supplying air to the spaces between the plates, substantially as described.

2. The combination with the side of a ship, of a series of plates secured transversely thereto, each plate extending rearwardly and contacting at its free edge with the adjacent rear plate, said contacting edges having apertures below the water-line, and means for supplying air from the bow of the ship to the spaces between the plates, substantially as described.

3. The combination with the side of a ship, of a series of plates secured transversely thereto, each plate extending rearwardly in a curve convex side upwardly, said plates contacting at their free edges with the adjacent rear plates and having apertures in proximity to said contacting edges and below the water-line, and means for supplying air to the spaces between the said plates, substantially as described.

4. The combination with the side of a ship, of a longitudinal partition extending from the side at a short distance below the water-line upwardly, a series of plates secured transversely to said partition and also to the side of the ship below said partition, each plate extending rearwardly and contacting at its free edge with the adjacent rear plate, said contacting edges having apertures below the water-line, said partition having apertures communicating with the spaces between said plates, and means for supplying air to the space between the partition and the side of the ship, substantially as described.

5. The combination with the side of a ship, of a longitudinal partition extending from the side at a short distance below the water-line upwardly, a series of plates secured transversely to said partition and also to the side of the ship below said partition, each plate extending rearwardly and contacting at its free edge with the adjacent rear plate, said contacting edges having apertures below the water-line, said partition having apertures communicating with the spaces between said plates and also having communication with the atmosphere at the bow of the ship, substantially as described.

6. The combination with the side of a ship, of a longitudinal partition diverging from the side of the ship on a line below the water-line upwardly, a series of plates secured transversely to said partition and also to the side of the ship below said partition, each plate extending rearwardly and contacting at its free edge with the adjacent rear plate, said contacting edges having apertures below the water-line, said partition having apertures communicating with the spaces between said plates, and means for supplying air to the space between the partition and the side of the ship, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

EDUARD LINDEMANN.

Witnesses:
EMIL HENZEL,
ANTON REISS.