9. Coefficient of skin friction.—*a.* In the case of a flat plate at right angles to the air stream the resistance is almost entirely due to the pressure difference in front of and behind the plate. This is not however the case with most solids. In general, resistance may be divided into two parts:

(1) Pressure difference.

(2) Skin friction.

b. When a solid passes through the air it carries along with it a very thin layer of air, the exterior surface of which forms a plane of air cleavage. The resistance of the air particles to shear on this plane is called skin friction.

c. The value of the skin friction on an airship hull, as determined empirically by Zahm and others, is given by the formula:

$$R_f = 0.0035 \rho S^{0.93} v^{1.86}$$

where S is the total surface area. A somewhat more convenient formula is—

$$R_f = 0.00309 \rho S v^{1.85}$$

10. Resistance of streamlined body.—*a.* As mentioned before, the total resistance is composed of resistance—

(1) Caused by pressure difference.

(2) Due to skin friction.

The pressure-difference resistance is least for a very long and slender form. In fact, the greater the fineness ratio, the less will be the pressure-difference resistance. An increase in fineness ratio, however, leads to an increase in surface area and so to an increase in skin friction. It is necessary therefore to compromise on a moderate fineness ratio, as a very long and slender form would have so high a skin friction as to more than counterbalance the gain by reduction of the pressure-difference resistance. A fineness ratio of 4 to 1 is very good for a small nonrigid, but for large rigids it has been found advisable to increase this ratio to 6 or 7 to 1. Recently an airship had been designed whose hull has a much smaller fineness ratio than the conventional designs. This airship has a capacity of 200,000 cubic feet and a fineness ratio of 2.82, noticeably shorter than any ships recently constructed. A model of this ship was tested in the wind tunnel of the Washington Navy Yard and was found to have the lowest resistance coefficient of any model ever tested there.

b. Since the volume varies as the cube of a linear dimension, while the cross-sectional area and surface area both vary only as the square,