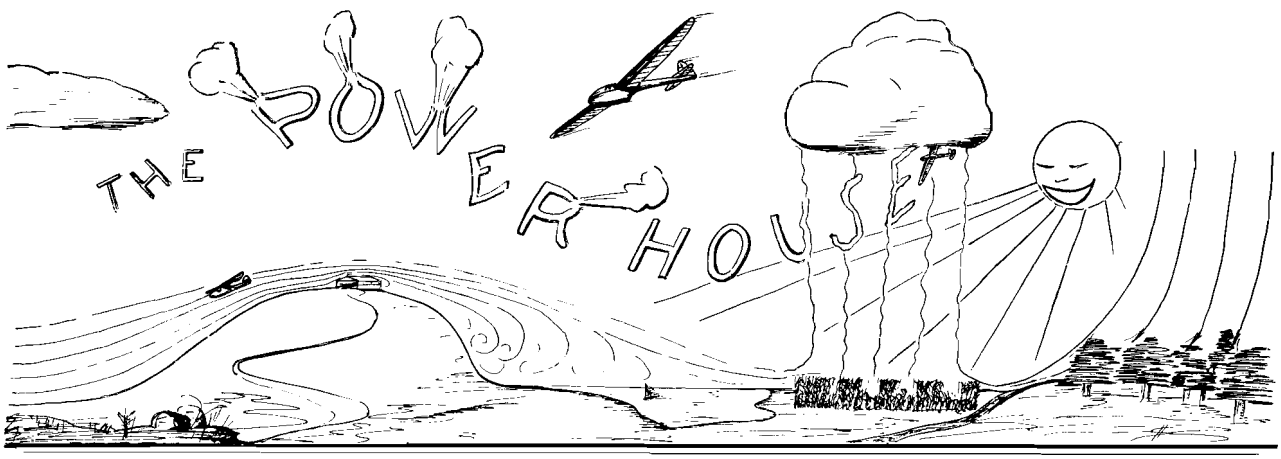

Conducted by Barney Wiggin of the U. S. Weather Bureau

Turbulence Associated With Miscellaneous Types of Clouds

by L. P. Harrison of the U. S. Weather Bureau

(E) *Turbulence Determined by Precipitation.*

WHEN a cloud forms at a level where freezing conditions prevail (temperature 32° F., or lower), and ice crystals come into existence, the falling of myriads of the crystals into a lower portion of the cloud or another cloud constituted of supercooled liquid water droplets will lead to turbulence. The processes involved are similar to those described in the September-October, 1942, issue of SOARING.

Collision of an ice crystal or ice pellet with a water droplet whose temperature is below 32° F. causes water to freeze in solid union with the particle. This liberates latent heat of fusion which amounts to about 80 calories per gram of water frozen. Thermal energy from this source goes to heat the combination to 32° F., and to heat the surroundings by a slight amount. Consequently, the air where the freezing occurs is warmed relative to the higher levels in the cloud where the same process is not going on. A steepening of the lapse rate results.

If the layer is not unstable for saturated air immediately prior to this, it may become so as a consequence of the process, and if it was already unstable for saturated air, then it becomes more unstable. Either of these contingencies leads to augmentation of turbulence.

Another phenomenon may operate to the same end, namely, liberation of latent heat of vaporization plus latent heat of fusion when water vapor condenses into frost around an ice pellet falling through a cloud of supercooled water droplets. The pellet usually falls from higher levels where lower temperatures prevail. As a result of this, the falling pellet is cooler than the surrounding cloud air which is generally saturated with water vapor due to the presence of the supercooled water droplets. Hence the vapor pressure of the cloud space is appreciably greater than the vapor pressure at the surface of the ice pellet. Diffusion of water vapor to the pellet generally proceeds at a faster and faster rate as it falls to lower levels where greater and greater differences between these vapor pressures in question exist. Due to this increasing drift of vapor from the space to the surface of the pellet growth of the latter is hastened. Involved in this outcome is the intensified rate of condensation (from vapor to frost) and of accretion of ice by collision with supercooled water droplets during accelerated fall of the particle.

The latent heat of vaporization of water at 32° F. is about 596 calories per gram, hence the total, about 676 calories is liberated for every gram of water vapor converted to frost. Owing to the increase of condensation (sublimation) and ice accretion as the pellet falls through the cloud of supercooled droplets, a greater liberation of heat may be expected at lower levels than at upper levels, especially since the larger droplets tend to drift down and collect more plentifully below, leaving the finer droplets suspended above.

Consequently, a further steepening of the lapse rate and marked reinforcement of turbulence is likely to result from the precipitation of ice crystals or snow into a supercooled water cloud.

After the frozen particles fall to lower levels where