the trough eastward caused a drop of about 7° or 8° in temperature in the interior of California, while the Arizona temperature remained as high as ever.

Chart D shows the conditions the next day, July 12, and here we have more rain in the North Pacific States and British Columbia, most of which is attended by thunderstorms. The high-pressure area off the Pacific coast has apparently lost energy, and the secondary over southern Idaho has reappeared. There is also evidence of a storm developing over the Bering Sea which may complicate matters should it move southeastward.

On the 13th the conditions are shown on Chart E (fig. 2) and here is seen a development of the high-pressure area which was faintly indicated on Chart C. The low-pressure area over Bering Sea is less pronounced and the consolidation of the southern Idaho low-pressure area with the original low-pressure area over Arizona has taken place. The rain has diminished and most of it fell locally along the North Pacific coast.

The next day, July 14, is represented on Chart F, which is somewhat like Chart A; but with this difference, the barometer is lower in the north and rainfall, which was lacking on Chart A, is quite abundant along the North Pacific coast. Thunderstorms have occurred at Yakima, Spokane, and Kalispell. Temperatures in the interior of California have risen about 8° in consequence of the rearrangement of pressure.

The conditions on the 15th are shown on Chart G, and here is seen a secondary over Idaho, with relatively low pressure over the Canadian Northwest. The high-pressure area has moved east, and the high-pressure area over the ocean is about the same as it was for the last few days. So few reports from the ocean are available that this high-pressure area can not always be definitely located. The rains are light and sporadic. Thunderstorms occurred in the southern portion of California and also at Winnemucca and at Seattle.

The final chart, marked H, shows a general unsettled condition over the Pacific States. Rain has fallen quite generally in Nevada, northern Washington, and western Montana. The eastern high-pressure area is disintegrating, and the relatively low pressure of the day before over the Canadian Northwest has recovered somewhat. This low-pressure area two days later reached the upper Mississippi Valley, and still later passed down the St. Lawrence Valley. In doing so it caused showery conditions in the Lake region and in the North Atlantic States.

Nothing would be accomplished by showing more charts, for they are continually repeating themselves with slight variations all summer long. They give an excellent idea of the difficulties encountered in predicting rain during the summer months in the Pacific States. During the period from July 11 to 16, inclusive, rain fell in nearly all portions of the San Francisco forecast district, and it was evident that it would do so. However, to place this rain geographically for 12-hour intervals was an entirely different matter, and the only thing possible was to make an indefinite forecast for places where it was thought the rain was mostly likely to occur.

Reports from Mexico and a greater number of upper-air observations would undoubtedly be of help in obtaining more definite information regarding the mechanism of the offshoots from what I believe should be called the semipermanent Arizona low. The California part, which first attracted my attention, now seems to be an auxiliary that probably has something to do with directing the movement of the stream lines, or eddies, northward. By taking the northward course they receive additional heat as well as a greater supply of moisture than would be the case if they moved to the northeast or to the east.

DISCUSSION.

By E. H. BOWIE.

With regard to the quotation from Griffith Taylor in the opening of Mr. Beals's article, I would remark that my understanding of this matter is that it has been presented to us quite fully by the late Professor Ferrel in his discussion of the formation of cyclones; in the minds of some, however, convection does not account for the formation of cyclones but has to do with the origin of showers and thunderstorms as observed in the Tropics and other parts of the world.

Doubtless many meteorologists will take exception to the view that in overheated, arid areas there is built up a column, or dome, of warm, ascending, turbulent air as suggested by Taylor. The English idea, if I may so call it, is to the effect that air rises in threadlike streams, not *en masse*, and that between these threadlike streams there will be areas over which air is descending. Hence the sporadic character of thundershowers in regions of strong convection, such as the southeastern part of the United States.

Certainly if heat alone would produce cyclones there should be a considerable number over the far Southwest during the summer, but such is not the case as may be easily seen by reference to MONTHLY WEATHER REVIEW SUPPLEMENT No. 1, Types of Storms of the United States, by Bowie and Weightman. This report shows that for the months of June to September, inclusive, in 21 years but 30 cyclones moved out of the area under discussion, or a little more than 2 per year.

DISCUSSION.

By W. J. HUMPHREYS.

The description of the development of cyclonic storms in the region of southwestern Arizona is both interesting and useful.

It may be remarked with reference to the trough of low pressure which appears to be largely induced by the high temperature of the Arizona and California valleys, that such trough, as indeed all troughs, is unstable and likely to break up into isolated lows or secondaries. This is especially true when the trough is well developed or flanked by a high to the west and another to the east with oppositely directed winds on its two sides.[1]

If there is no precipitation, such a low (secondary) probably will soon be dissipated. With precipitation it may persist for some time and over long distances.

DISCUSSION.

By A. J. HENRY.

Before entering upon a discussion of Mr. Beals's paper it would be helpful to state briefly the several aspects of the paper upon which there is general accord.

Although the author does not specifically state the number of cyclones of the type described he has considered, I think we can accept the count given in Supervising Forecaster Bowie's statement, viz, about 2 per year (in summer).

[1] While this situation may and does arise in the cold season it would fail in the warm months, since high-pressure areas at that time of year seldom, if ever, extend as far south as the lower margin of the Great Basin in Nevada.—EDITOR.