8. Winders, unless they are of the type shown at G and L, Fig. 29, or are arranged as dancing steps (see J', Fig. 29), may be a source of danger, especially to young children, and they should therefore be avoided. This is not always possible when the going is greatly restricted, and winders may then have to be utilized either at the top or, preferably, at the bottom of a flight; in cramped positions there may be no alternative to the provision of winders at both the head and foot of a flight.

When used, it is usual to divide what would otherwise be a quarter-space landing into three winders, as shown in Fig. 38. If four are used, as shown by broken lines at H', Fig. 29, the average width of each tread is inadequate; if two only are provided, as shown at B', Fig. 29, the average width of the treads is excessive, they are difficult to carpet, and the corner between the riser, lower tread and wall string is not easy to clean.

9. The height of a raking handrail (i.e., parallel to the pitch) should be 2-ft. 7½-in. measured vertically from the line of nosings to the top of the handrail (or 2-ft. measured normally from the line of nosings), and that of a horizontal handrail should be 3-ft. (see C, Figs. 30 and 32, and C and D, Fig. 36).

10. A stair should be in such a position that it can be conveniently approached from the lower rooms and afford a ready access to the upper rooms. Doors should be situated at least 1-ft. from the head and foot of a stair. A door which opens immediately off a top step is least desirable as it creates a potential danger, especially to visitors; and there is, of course, less risk of a collision occurring between a person hurriedly descending a stair and one leaving a room through a door which is not directly adjacent to a bottom step.

STEP PROPORTIONS.—A well-designed stair, even when the floor space is limited, should entail the minimum expenditure of energy in its ascent, and it must therefore be neither steep nor inadequately pitched (see 2, p. 80). The step of the average person measures approximately 23-in. and it has been computed that about twice the effort is required in climbing to walking horizontally. The following two rules, based apparently upon the foregoing, have been proved by experience to give a satisfactory ratio between the rise and going of a step:

1. Going plus twice rise equals 23 to 24-in.

2. With a 12-in. going and a 5½-in. rise as a basic ratio, for every inch deducted from the going half an inch is added to the rise, i.e., 12-in. going and 5½-in. rise, 11-in. going and 6 in. rise, 10-in. going and 6½-in. rise, 9-in. going and 7-in. rise, etc.

Rule 2 therefore agrees with rule 1 in so far as the going plus twice rise equals 23-in. in each case. Rule 1 has been complied with in all of the stairs illustrated in Figs. 29-39 inclusive.

Another common rule is: Going multiplied by rise equals 66-in. It will be seen that this does not agree with rule 2 when the going is less than 11-in.

Whilst a stair conforming to either rule will give satisfactory results, and it is therefore desirable to be guided by them when designing a stair, it will be realized that occasionally in practice a very restricted going of a flight is unavoidable and strict compliance is not then possible.

The nosing is, of course, additional to the going, and the projection of the tread beyond the face of the riser should preferably not exceed the thickness of the tread, as an excessive projection may cause a person to trip when ascending.

A stair with very narrow treads cannot be descended comfortably, as more than the usual care has to be taken to clear the nosing with the heel to obtain adequate foothold on the tread below. For this reason the preferred minimum going is 9-in. A satisfactory proportion for house stairs is a 10-in. going [1] and a 6½ to 7-in. rise. In public buildings, where the stairs are a prominent feature and ample space is usually available, it is common to employ a 12-in. going and a 5½ to 6-in. rise.

STAIR DESIGN.—The essential requirements specified on pp. 80 and 82 should be kept in mind when designing a stair. The type of stair decided upon depends a good deal upon the size and shape of the stairway.

The number of steps to be decided upon is governed to a large extent by the total going available. If the height from floor to floor is fixed, as it usually is, and the going is unrestricted, the number of steps is determined in the following manner: Assuming that the proposed rise is to be between 6½ and 7-in., say 6¾-in. (which, as stated above, is satisfactory for a house stair), the number of risers equals the height divided by 6¾. Thus, if the floor to floor height is 9-ft. 3-in. (111-in.), the number of steps equals $\frac{111}{6\frac{3}{4}} = 16$ or 17. Adopting the latter figure, the exact rise is $\frac{111\text{-in.}}{17} = 6\frac{9}{17}\text{-in.}$ The going will then $= 23\text{-in.} - (2 \times 6\frac{9}{17}\text{-in.}) = 23\text{-in.} - 13\frac{1}{17}\text{-in.} = 9\frac{16}{17}\text{-in.}$, say 10-in. It should be noted that the number of treads is one less than that of the risers, as the surface of the upper floor forms the tread for the top step.

If the going of the flight is so restricted that the minimum going of 9-in. (see above) can only be adopted, then the number of steps equals $111\text{-in.} \div \frac{23\text{-in.} - 9\text{-in.}}{2} = 15$ or 16. Adopting 15 as the number, the rise of each step $= \frac{111\text{-in.}}{15} = 7\frac{6}{15}\text{-in.}$ This will be satisfactory, as it conforms to rule 1, i.e., $9\text{-in.} + (2 \times 7\frac{6}{15}\text{-in.}) = 9\text{-in.} + 14\frac{4}{5}\text{-in.} = 23\frac{4}{5}\text{-in.}$

This matter is again referred to on pp. 83 and 93.

The construction of straight flight, dog-leg and open well stairs will now be considered in detail.

STRAIGHT FLIGHT STAIR

This is detailed in Fig. 30.

The ground floor and first floor plans of a small house are shown at A and B,