building, Philadelphia, the total thickness through the floor was seventeen inches less with the mushroom system than with the beam and girder system. Mr. Turner claims that for a given clear story height it effects an economy of about 10 per cent. of the material in the vertical walls.

In the matter of speed and ease of erection the flat slab is much superior to any other type. The centering is simple and easy, there being no beams to build around. There is no bother with stirrups, and is it claimed that it is easier to make a good bond between old work and new because the concrete is not so deep and the inert material known as laitance does not accumulate to so great an extent.

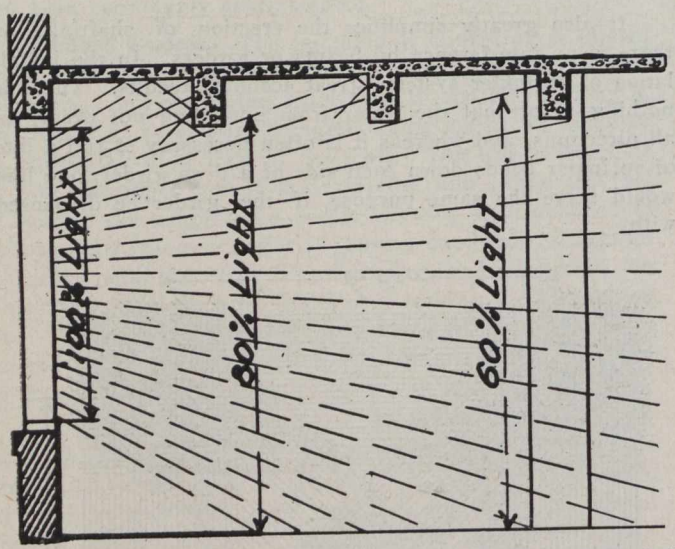

Fig. 2.—Beam and Girder System. Light Rays Reflected by Ceiling are Pocketed by Beams.

Maximum efficiency in reinforcement is attained as the stresses go direct to the columns, not having to be carried round a corner, so to speak. The greatest quantity of metal is over the column head where moment and shear are both a maximum. The concrete is being worked in several directions by the multiple way reinforcement, the distortion in one direction tending to offset and counterbalance that in the other. The metal runs so many ways over the support that the whole structure is tied together, and no failure can occur without adequate warning being first given. The fact that the concrete is concentrated in the slab and that the stresses due to any concentrated load are carried in so many different directions tend to produce rigidity, and to reduce the heavy vibration caused by the working of printing presses and like machinery.

The cost of forms is reduced owing to their simplicity and the fact that they can be so designed that they can be used over and over again without material alteration. In a warehouse built for the Terminal Wharf and Warehouse Company, of Boston, the forms were designed in the draughting room and shipped complete to the site. Since then they have been used in another building. Each panel was erected and removed fifteen times and some twenty, and at the end of that time were still serviceable.

In another instance, assuming the material delivered at the site on cars, and that form lumber could be used twice, the following results were obtained for the cost of forms:—

Floors with beams, girders and slabs..	10 cents per sq. ft.
Slab floor without beams	7 cents per sq. ft.

As to economy, it is claimed that the amount of material required to build a slab or panel that will carry a given test load is less than with any other type. This economy increases rapidly as the load to be carried increases, since the strength of the slab increases approximately with the square of the depth, and hence the relative increase in cost for a given increase in the capacity of the construction is small. In this connection it is well to remember that these floors are considered by many engineers to be lighter, and hence cheaper, than is good practice. However, a reputation has been built for them on their ability to successfully withstand very heavy test loads.

In a paper entitled "The Economical Design of a Reinforced Concrete Floor Panel," Mr. J. Norman Jensen gives cost data for a typical floor panel twenty feet square designed in fourteen different ways. He concludes that of all the designs the flat slab appears to be the most economical. His slab was heavier than Mr. Turner's, being designed by a method requiring considerably more steel. His figures for four of these systems, as illustrated in Fig. 4, accompanying the diagrams, and show a decided economy in the use of the flat slab system, it being 15 per cent. cheaper than its nearest competitor.

In common with everything else, however, the flat slab system has certain disadvantages. The greatest of these is undoubtedly the fact that no adequate theoretical analysis of the stresses in such a floor has ever been put forward, and in consequence there is great uncertainty as to the exact stress distribution within the slab. While this is true it must be admitted that, even at this early stage in its development, it is perfectly feasible to design a flat slab floor and guarantee its safety under the design load, and still maintain a good margin of economy over the earlier types.

Again, the fireproof qualities of the construction have been questioned as the main steel reinforcement in the panel is only protected in most cases by from ¾ inch to 1 inch of concrete on the bottom, a thickness quite inadequate to properly protect the steel in a severe conflagration. Also in a shallow slab of this sort an error in placing the reinforcement is liable to produce more serious results than in a comparatively deep beam or girder. On account of its greater deflection and the flaring column head the flat slab type of

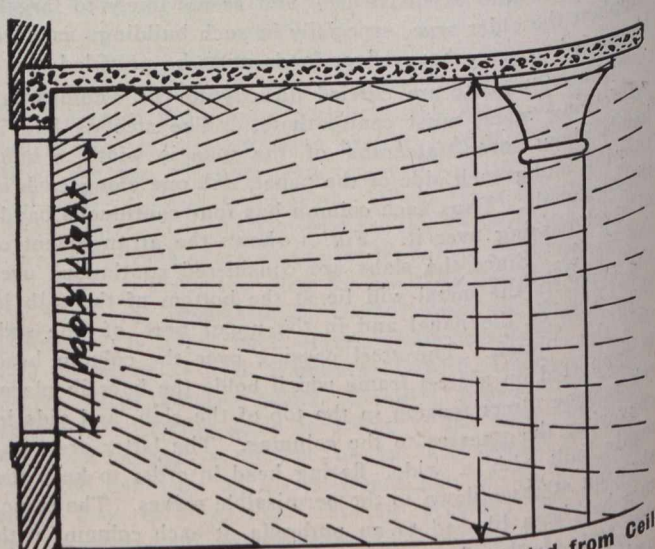

Fig. 3.—Flat Slab System. Light Rays Reflected from Ceiling Give an Even Distribution.

floor is more apt to set up excessive bending stresses in the columns than is the ordinary floor designed in the beam and girder system. Care in the design and in the placing of the steel will minimize these disadvantages.

The Behavior of a Flat Slab Under Load.—It is interesting to consider the manner in which the slab in such a sys-