



FIG. 1. Greatly simplified diagram of the central region of the muscle spindle. Following Boyd (42) the motor innervation of the two kinds of intrafusal muscle fiber has been shown as separate ( $\gamma_1$  and  $\gamma_2$  fibers), but whether this is actually so has not yet been firmly established and is questioned by Barker (12).

with a very large afferent fiber, consists of spirals round the central parts of both the bag and the chain fibers. The secondary ending, with a smaller afferent fiber, lies mainly on the chain fibers and often spirals round these fibers as well as having sprays on them; in addition, the secondary ending may have a few sprays on the nuclear-bag fibers but these never lie on the nuclear bags (though they may be on the myotube region) and they do not spiral round the bag fibers. The secondary endings are thus clearly differentiated from the primary endings on morphological grounds.

Boyd (1962) illustrates a representative muscle spindle based on the findings from many spindles in the soleus and tenuissimus muscles of the cat, and a description of this may give some idea of the morphological complexity of the muscle spindle. This spindle contains 2 nuclear-bag fibers, each  $26 \mu$  in diameter and 7.5 mm in length, and 4 nuclear-chain fibers, each  $12 \mu$  in diameter and 4 mm in length. The ends of the nuclear-chain fibers are attached to the nuclear-bag fibers. There is a single primary ending with a large nerve fiber of  $12 \mu$  diameter which terminates in spirals on the central  $300 \mu$  of all 6 intrafusal fibers. There is 1 secondary ending with an afferent fiber of diameter of  $6 \mu$  which lies mainly on the chain fibers but sends a few sprays to the bag fibers. The ending is about  $400 \mu$  long and lies immediately next to the primary ending. There are 5  $\gamma_1$  motor fibers of about  $3 \mu$  diameter close to their point of entry to the spindle and 7  $\gamma_2$  motor fibers of about  $1 \mu$  diameter at the same point. The  $\gamma_1$  fibers end in 8 discrete end plates on the polar portions at each end of the nuclear-bag fibers; 4 plates lie on each nuclear-bag fiber. The 7  $\gamma_2$  fibers terminate in about 24 somewhat diffuse separate endings, about 6 endings lying on each nuclear-chain fiber and none on the nuclear-bag fibers. These  $\gamma_2$  endings cover the central half of each nuclear-chain fiber, except