(Where d(R) for the scalars equals the real dimension of the scalar representation R). There is, therefore, no problem in retaining aymptotic freedom for g, as long as the number of scalars is not too big.

In addition we are now required to study the renormalization group equations for the scalar couplings. There are, in general, many such couplings. We are, of course, only interested in the quartic couplings. One such coupling exists for any representation of the gauge group, namely the square of the inner product (the quadratic Casimir operator). If the representation in question is real the vertex is given in Figure 9, and if it is complex the vertex is given in Figure 10.

A general representation of the gauge group will, in general, possess many additional quartic invariants. For each such invariant there will be perforce a dimensionless coupling constant. (Some examples will be given below). Therefore, in general, the renormalization group equations will be a set of coupled linear differential equations. It is useful to consider first a simple example in which there is only one quartic self coupling. This is the vector representation (real dimension = 2N) of SU(N). If ϕ denotes the (complex) scalar field transforming according to this representation, the scalar interaction is given by:

$$L = |(\partial\mu - igB_\mu)\phi|^2 - \frac{\lambda}{2}(\phi^*\phi)^2 \tag{6.3}$$