EVOLUTION OF EXERCISE MACHINES

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Summary

The process of creation of new exercise machines and modification of existing devices requires presence of two initial components: scientific-and-technological advance, creating new engineering opportunities and directions and deepening of theoretical knowledge in the area of physiology of exercises. In this chapter the path of development and modification of devices, used by people for training of different motor qualities, is traced. Design features of different exercise machines and functional characteristics of different power drives, used for application of specific loads, are considered.

1. Introduction

Sometimes it is much easier to trace the evolutionary path of this or that phenomenon, than its history. In the case of training devices, this path allows us to see a particular trend of their development in the future. The study of the historical path for the given area of human activity is less interesting. Actually, dates of appearance of this or that exercise machine or details of foundation, merging and liquidation of companies, manufacturing training devices, are not important for the theory and practice of sport, for medicine and scientific researches. It is much more interesting to trace the evolution of inventive ideas, novelties of scientific-and-technological advance and also theoretical knowledge from sports physiology, sports or clinical practice, penetrating the area of development of exercise machines. So, for example, it is absolutely not important and principally impossible to determine the moment of appearance of the first exercise machine, intended for special training of a certain motor quality of a specific group of
muscles. At the same time, from the evolutionary point of view, it is evident, that common weights or dumbbells are the simplest training tools. Such start points lead to an assumption, that the use of a common cast dumbbell for some exercises, in particular, for one-articulate hand movements, is uncomfortable, since in this case rotation motion actually should be executed about an axis of a tool. Otherwise, holding of a dumbbell in such movement requires an additional compressive stress of the hand muscles for elimination of its rubbing in a hand, since such friction leads to appearance of cutaneous corns or even to traumas. Thus, an idea to supply a dumbbell with rotating handle comes to an inquiring mind. In this case a dumbbell does not rub the hand, but rotates relative to its handle (supported with bearings), held by the sportsman. Such “small invention” significantly improves the efficiency of the training process. First of all, load on supplementary muscles, which in many cases limit training with high weight, is decreased. Secondly, such construction allows performing exercises rapidly - time for stoppage and inverse rotation of dumbbell is not wasted. The following step - appearance of a dismountable dumbbell. It is obvious, that prompt load increase/decrease capability allows selection of training weight more precisely, optimizing, thus, the training process on the whole. Usage of a large set of cast dumbbells of different weights is not efficient both from economic and ergonomic point of view. The following step - elongation of the handle of the dumbbell to hold it by both hands. Thus, we come to a classical barbell. And a sports physiologist, a trainer or a doctor does not care when and why this modification of sports equipment has appeared.

2. Free Weight

So, the first evolutionary step of development of training devices is a free weight. Distinctive feature of a free weight is an opportunity to perform training exercises with all possible degrees of freedom, and a minus point is that a great number of additional muscles, executing the role of stabilizers, is activated. Meanwhile, for a long time it is evident for sportsmen and trainers, that selective training of separate groups of muscles, participating in the whole movement, is more important for increase of efficiency of a target/competitive movement. It is connected, first of all, with unavoidable presence of lagging groups of muscles. The physiological mechanisms, underlying management of muscles in the execution of a complex multiarticulate motion (intermuscular coordination), work according to the principle of compensation and minimization of power inputs. In other words, for provision of adequate motions stronger groups of muscles take upon themselves a lion's share of the total load, unloading, thus, lagging groups of muscles. Therefore, this circle closes up, and the only way out is purposeful training of muscles-outsiders. Such conclusion, apparently, leads to an idea of limiting the number of degrees of freedom.

3. Modification of Constructive Solutions

From a design point of view all types of exercise machines can be subdivided into three big groups: units with a linear movement; units with an angular movement; load-block units.

In exercise machines of the first type the free weight can move only lineally. For this purpose special rails or linear bearings are used. A classical example of an exercise
machine with a linear movement is a well-known Smith-machine, consisting of a frame with vertical guides for sliding of a barbell with discs. It gives great advantages in performing such exercises, as squatting and bench press (standing, sitting, lying and with different angles to a horizontal line). In the execution of these movements with a usual barbell additional groups of muscles (at squatting - muscles of back, for presses - deltoid or pectoral muscles), which do not allow one to perform exercises with full concentration on basic groups of muscles, are engaged.

Exercise machines with angular movement (lever exercise machines) - hammer-machines are intended for selective execution of one-articulate movements: bending-unbending in shoulder, elbow, hip, knee and ankle joints.

An intermediate position between free displacement of weight and strictly limited movement is occupied by load-block exercise machines. On the one hand, movement in these units is free enough due to flexibility of a used cable, on the other hand – it is restricted, since the contact of the cable and the block, sliding on it, is rigidly fixed at a certain point of space. Load-block exercise machines are used for improvement of tractive force (at upper and lower traction) of flexor muscles. The main advantage of these exercise machines is automatic (at a level of a motor command) selection of an optimum trajectory of movement at considerably reduced role of stabilization muscles.

Rigging of a load-block exercise machine with a rigid element of a lever exercise machine with varying shoulder of force application (“Nautilus”-type machines) has revolutionized the training world. It has happened due to the use of a special rotating eccentric with a special profile and a rigidly attached working lever. Efficiency of training with the use of such exercise machines is explained by the following physiological basis. In connection with change of a number of simultaneously closed actomyosin bridges at change of length of a muscle, the force, demonstrated by the muscle, varies between significant limits, depending on the angle in a joint. The free weight, as we know, is capable to provide only fixed loading. Therefore, in different amplitude phases muscles are underloaded or overloaded. Usage of a special profile of load change, corresponding to special features of a particular group of muscles, due to change of an arm of an applied force, sharply raises efficiency of training, allowing one to execute a motion with the maximum force during the whole amplitude. In due time usage of machines of “Nautilus” type was so eager, that special eccentrics were made for each fan of this exercise machine, since each person preferred his own individual profile of force distribution.

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Biographical Sketches

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