TIME LOSS AT STARTING FOR A SPRINTER

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Much to the dismay of every track coach in this country, there seems to be some lag at the start of every race. For the shorter distances, up to 100 yards, any lag is of extreme importance because a reduction of 1/10 of a second in the runner's time is an achievement.

That there is such a lag, and the extent of this time loss, is shown quite clearly by the graph obtained in the following manner. If the world record times for the dashes of various lengths are plotted against the distance run, the resulting chart will be a straight line up to the point corresponding to 100 yards (Fig. 1). After this distance, the runner ceases to run uniformly, and the line begins to curve toward the time axis. The points corresponding to the 40, 50, 55, 90, and 100 yards all fall upon the same line. The records for the 60 and 70 yard runs are poor, but, the 60 yard record was made in rubber soled shoes on a cinder track, and the 70 yard dash was made on grass.[1] Because the points fall upon a straight line, the slope, and therefore the velocity, ds/dt, is a constant. This means that for short distances, a runner making a record holds a maximum speed, and this instantaneous velocity, ds/dt, is the fastest speed obtainable in the light of the records which are available. The value of this velocity calculated from the graph, is approximately 37.5 feet per second.

If the line graph is extended from the point corresponding to 35 yards to that representing zero distance, the line does not pass through the origin, but crosses the time axis at a point equal to 1.2 seconds. This may be interpreted as meaning that the runner who is heading for a world's record, would breast the tape at exactly the same instant as a "perfect" runner who would stand at the starting line for 1.2 seconds, and then instantaneously would begin to run at the maximum velocity.

In order to determine the curve with which the runner accelerates, some method must be devised to record both time and distance intervals. It is this curve which will tend to bend the line on the graph down to the origin. The necessary data for the experiment were obtained at the outdoor track at the college in the following manner. Seven pairs of stakes were driven in the ground, seven on each side of the track. The first pair marked the starting line, and the others marked two yard intervals, all the way out to twelve yards. To one of the stakes at the starting line was attached a device whereby the expanding gases of the starting gun would cause an electrical contact. On the other six stakes upon the same side of the field were attached small switches which would be closed by a pull upon the thread with which they were attached to the other side of the track. With this arrangement of strings and switches, a runner would start

[1] These records were obtained from Cromwells-Championship Field and Track.

running, and close electrical contacts every six feet along the track. All six switches and the starting arrangement were connected in parallel in such a way that the closing of any one of the switches would cause a mark upon a moving tape in a Gaertner tape recorder nearby. A small synchronous motor was also attached to the recorder in a manner so as to transmit impulses to the traveling ribbon every 1/5 of a second. As a runner starts and speeds down the track, for the first twelve yards, small marks are recorded on the tape at the time the gun goes off, and every time a string is broken. Parallel with this series of marks, but removed a few millimeters are recorded the 1/5 second impulses of the synchronous motor. The ribbon may then be removed, and the distances measured and cálculated. When the average velocity between two stakes is plotted against the time required, there results a curve which starts out quite steeply, climbs steadily, and then tapers off to a line parallel with the x-axis corresponding to zero slope and constant veloc-

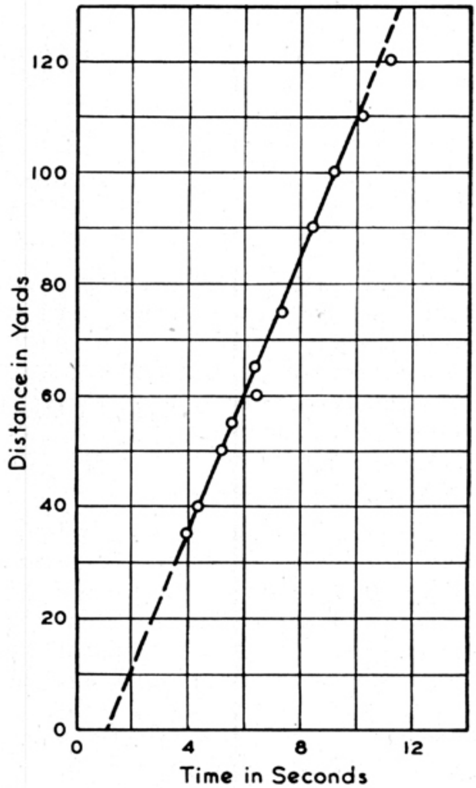

FIG. 1.—World record times for various races plotted against corresponding distances.

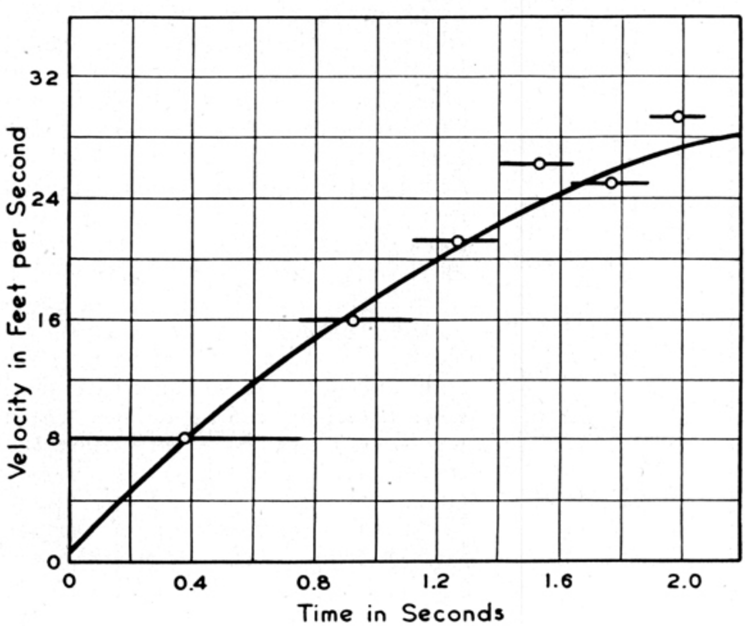

FIG. 2.—Velocity time curve from the average velocities during corresponding time intervals.

ity (Fig. 2). This straight line may correspond to any velocity and probably will depend upon the man who is running. The constant velocity line will, however, never be equivalent to or be more than 37.5 feet per second, unless the runner ties or beats the world records up to 100 yards. If he could keep up the rate, he would smash every record over that distance. After 100 yards, however, other factors enter in and the runner must slow down. Some work has been done by others on the track records for distances of 200 yards and more.[2] In this case a whole new set of laws come into use. No longer does the start have the importance that it does for the short distances, and also the body, at the end of a long race is almost completely exhausted, while this is not true for dash and sprint races.

It is fascinating indeed to apply the laws of physics to a man who is straining every muscle to better himself in the field of sports. Whole books could be written on the subject; the force exerted by the legs, the horizontal and vertical component of this force, the difference in time caused by different running surfaces, and the limitations due to inertia might well be used as chapter headings in such a volume. In conclusion, acknowledgement is made to Dr. Martin for his help and suggestions. Also to members of the Physical Education Department who helped so freely, many thanks are given.