Lecture T3 –The G-Track Start Switch (US 8,043,139 B2) 12/28/15

INTRODUCTION

Millions of Pinewood Derby races have been run since the inception of the race in 1953, mostly by Cub Scouts and their parents. But the currently available race tracks have a problem in the way electrical car start timers are turned on. Refer to the prior art **Figure 1** which points out a typical start mechanism, a version of which is shared by all prior art tracks. The typical location of a start gate is at the top of an initial elevated track portion called a ramp. A spring force may be supplied by strong rubber bands or a spring arrangement such as shown in **Figure 1**. When trigger action allows the start posts to rotate, thus releasing the cars, the lever of a common micro switch is released by the start post support bar. The movement of the micro switch lever applies or releases pressure that activates an internal snap-action contact closure inside the micro switch. This final action then triggers an electronic race timer. So first there is a release of the start post support bar 23, such motion in turn moving the micro switch lever 28, and then this lever causing in turn compression or release of its internal snap-action switch. This sequence of events leads to inaccurate start times. In such a conventional start switch arrangement, there is substantial variability in the time elapsed from the instant the start posts allow gravity forces to begin to move the cars until the micro switch contacts send a start signal to the race timer. Race winners can be decided by timer differences on the order of a tenth of a millisecond, and the prior art spread in race starting times may typically be tens of milliseconds. This variability can lead to an undesirable spread in race times for repeat runs of a car down the track. Thus, the true performance time capability of a car may not be recorded. Also, simulation models of gravity cars are constantly improving, and these require precise initial conditions that G-force begins when time begins. Thus, the measured start time to test the models could also benefit from improvement.

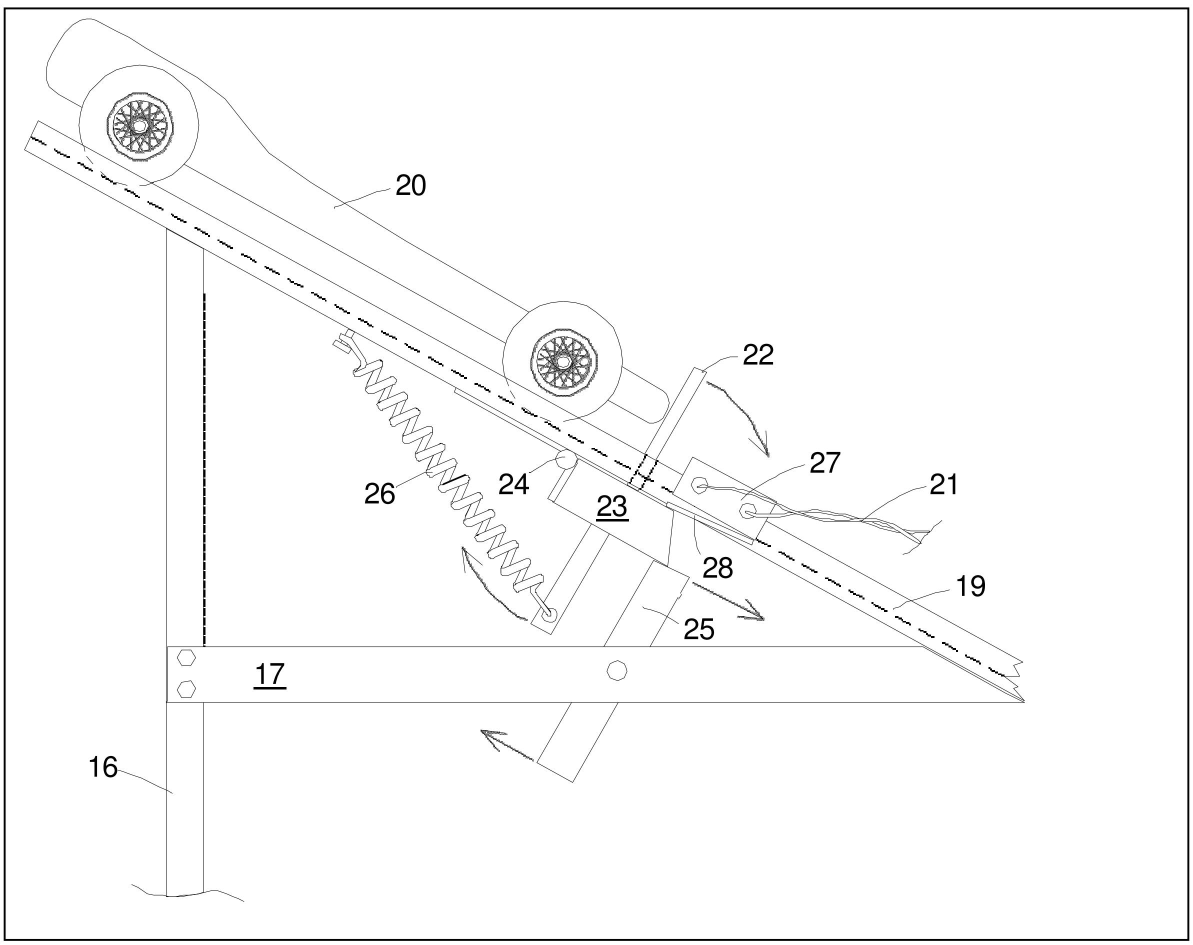

Figure 1 – Prior art view of a typical start gate

THE G- START SWITCH

This start switch, named the G-Start Switch, is shown in side view in **Figure 2**. It is covered by a patent licensed by Hobby Distribution Inc. of Tonawonda, NY. For more detailed physics and drawings, please refer to the patent **US8043139**.

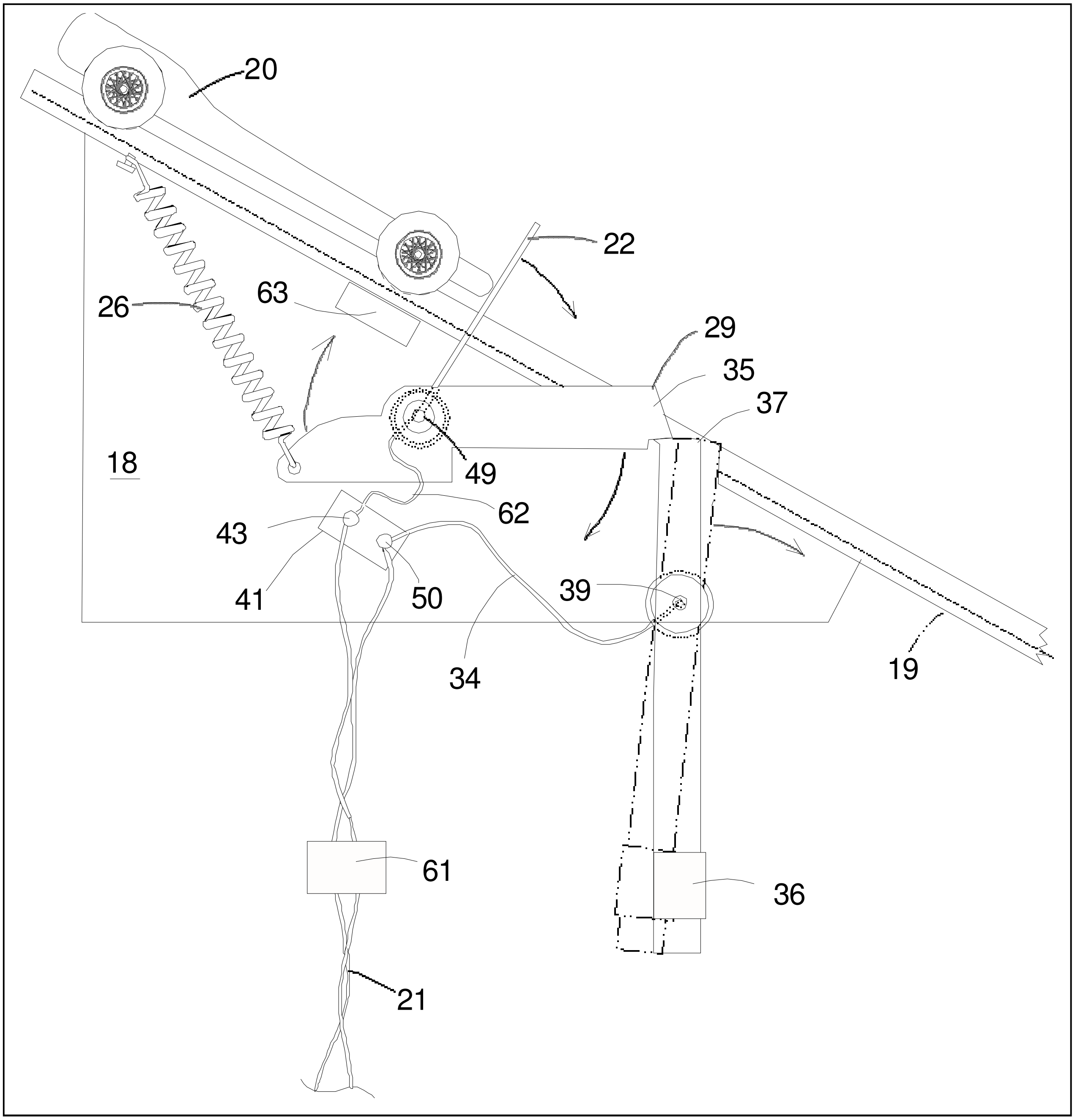

Figure 2 – The G-Start Switch

The ideas for solving the start problem were, in order:

1) In **Lecture 3**, with a micro switch, the standard deviation of the Friction Test Rig times averaged 0.070 s.

2) In **Lecture 11**, the SD of the Friction Test Rig times was only about 0.003 s when the micro switch used in 1) was replaced by a light shutter that rotated with the start posts and interrupted a light beam illuminating the same type NC phototransistor. This showed that the major part of time uncertainty was in the micro switch.

3) Although the SD improved considerably with the light occlusion switch of 2) there seemed no easy way to ensure that that timer start signal was turned on precisely at the same time the G force was initially applied by the very beginning of start post lowering action. Other systems are on the market that let the front of the leading car interrupt a laser beam, but here the G force has already been applied in order to allow the car front to roll into the laser beam. So this can cause an offset or bias of several milliseconds between timer start and G force application. Also the fastest car is the one that starts timing for the slower cars which have not yet reached the distance traveled by the fastest car before it started the timer. They therefore have to travel a longer distance between their time start and the finish line, a definite disadvantage.

4) Referring back to **Lecture T2**, the Pendulum-Based start gate, when this start assembly was being assembled the answer to the above problem 3) showed itself in a sudden mental light bulb moment. The normally closed (NC) G force turn on switch, wherein trigger lever 37 is mechanically forced to separate from the horizontal start post support drop member 35, could also be an electrical time start NC switch if the separating members were conductive and properly insulated. Thus **Figure 2** shows the basis where the start post release, still spring driven, serves also as the NC timer start switch. This serves as the basis of a patentable invention separate from the Pendulum-Based start gate invention of Lecture T2, but we can ***combine the two inventions to get an essentially perfect start gate*.**

Thus, **Figure 3** shows the **G-Start** gate, a combination of:

US 8016639 The Pendulum-Based Start Gate
US 8043139 The G-Start Switch

Note in **Figure 3A** we show the G-Start gate is the same as the Pendulum-Based Start Gate of Lecture 2 but the spring action is replaced by the gentle, smooth pendulum action. This combination will be trademarked as the G-Start with the "gate" understood. In **Figure 3B**, there is shown an end view of the start assembly. Also in **Figure 3A** the conducting wire 52 contact with the trigger lever 37 is by a small brass screw # 4-40, the other end of the wire with its spade lug to terminal assembly 42. Item 49 is an insulated shoulder washer for the pivot bolt of the trigger lever. **Figure 2** and **Figure 3** are from the two different patents above so the part numbering is not identical. Journal bearing 39 is insulated similar to bearing 40 below.

Figure 3B also shows an inset enlargement **Figure 3C** with details of the journal bearing assembly 40. The start post support shaft 32 protrudes through a nylon journal bushing 46 with appropriate clearance for ease of rotation. The journal bushing 46 fits into a cylindrical metal insert 47 suitable for insertion into a hole placed in the mounting plate 18. Another insulating plastic washer 48 is just inside the end view of the drop member 35. Axial play is adjusted by a collar 45 which is fixed to the start post support shaft 32 by a set screw. In the patent Figure 2 a conductive path was using a wiper against a solid rod 32, A preferred embodiment here has a cylindrical "telescoping" brass tube 32 as the post support shaft being a 3/8" telescoping brass tubing with a 1" length of the next size smaller inserted firmly as a plug in. The item 64 1" piece has the red wire 43 connecting to terminal 42. As shown in this **video**, this arrangement allows pendulum free swinging.

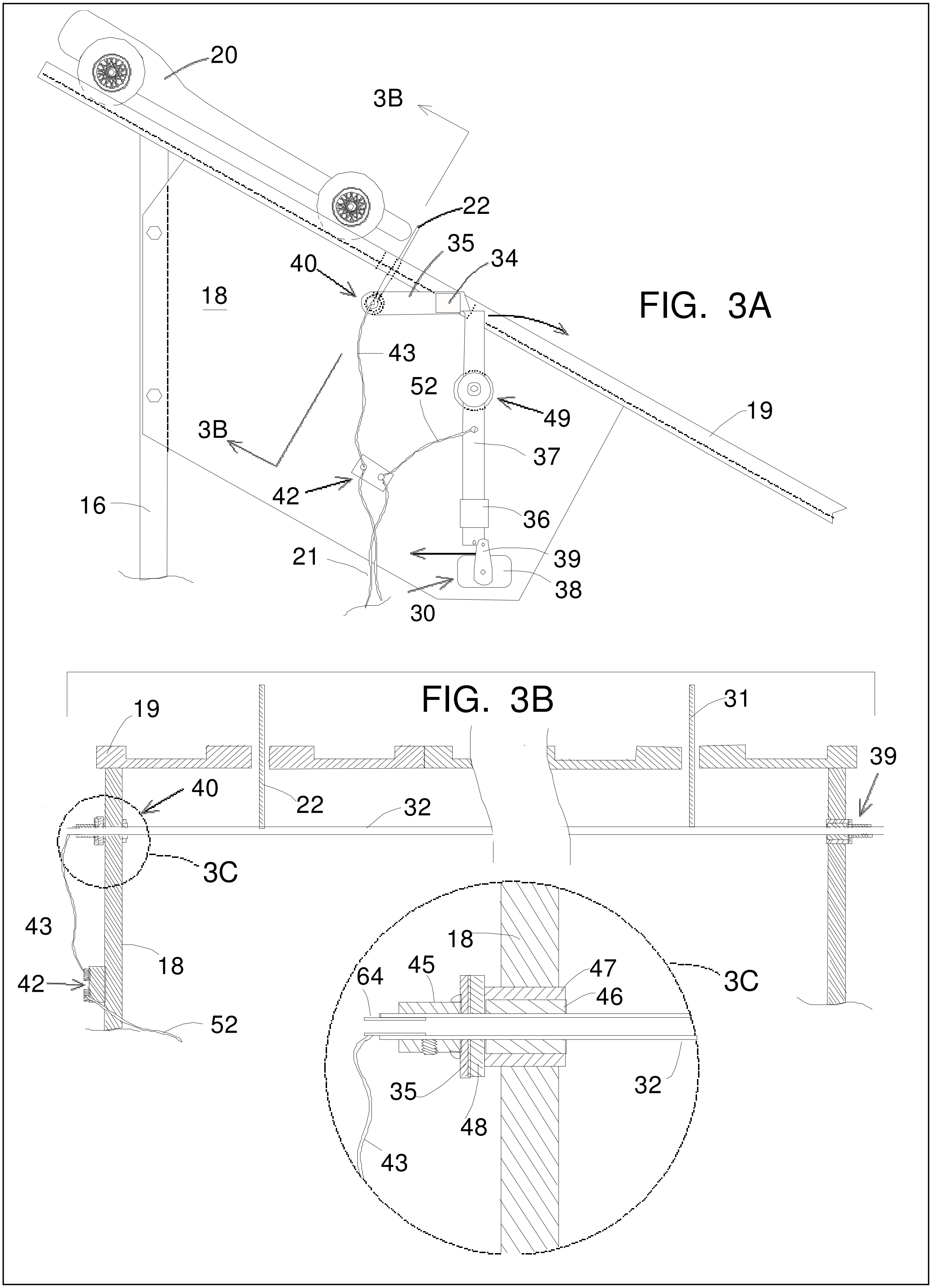

Figure 3 – The G-Start Gate

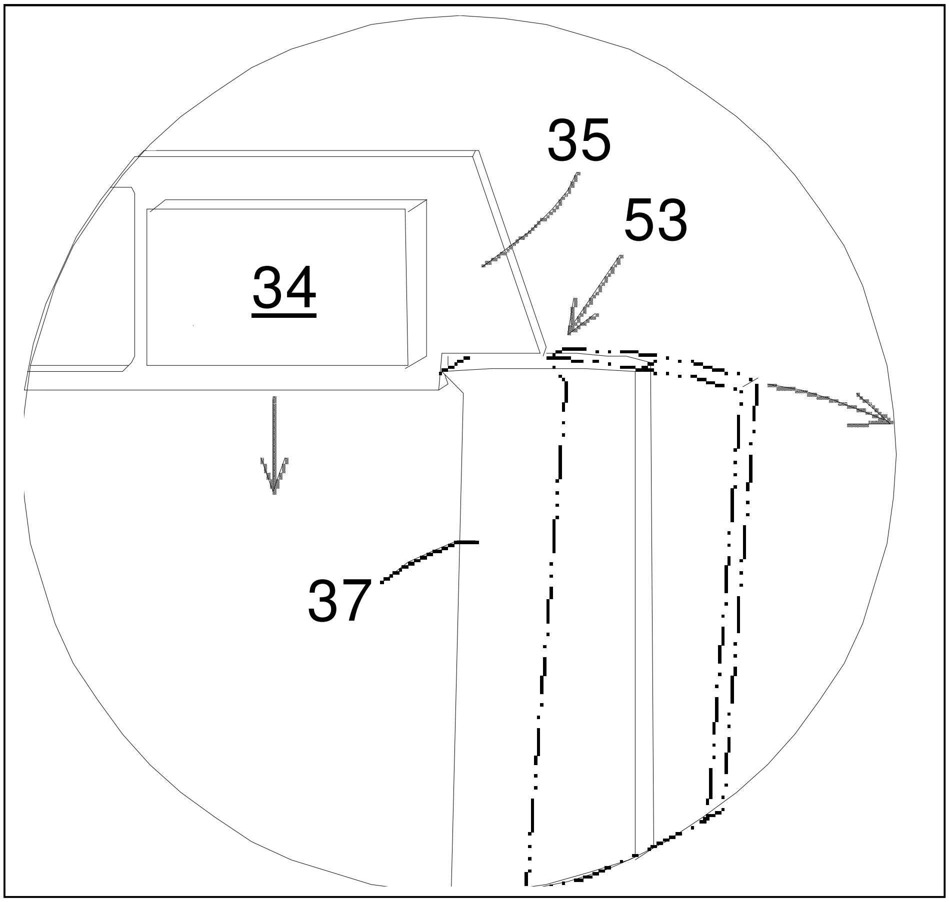

Figure 4 – The G-Start Switch

As just described, a normally closed switch is thus formed from the trigger lever and drop member contact along with appropriate wiring and select placement of insulation. The enlarged view in **Figure 4** allows one to appreciate what happens during operation. Notice the contact area 53 where the tip of the drop member 35 touches the trigger lever 37 top. The drop member bottom is thin and sharp compared to the relatively broad top of the trigger lever to ensure reliable contact (thin rigid plastic pieces could be glued to each side of 37 extending upward slightly so item 35 cannot slip sideways off 37) Imagine, in slow motion, that when trigger lever 37 top is moved to the right, there is a point when only a few metal atoms of lever 37 are supporting a few metal atoms of member 35. This overlap distance for the contact area 53 is then on the order of a few billionths of a centimeter, yet a small amount of electrical bias current can still flow. When the two metal pieces separate as the drop member drops downwards, there is then essentially zero time between the 1 G acceleration motion obtained by member 35's tip and the cessation of current flow. Thus the contact opening signal sent to the timer, at the electron in wire velocity being 2/3 the speed of light, is effectively simultaneous with the start of drop member motion under gravity. The top of member 37 is curved with radius to the fixed pivot of 37 so slight movement of 37 will not be transmitted to the start posts 22.

So again, in slow motion, consider the initial twisting torque applied to the pendulum assembly because of its inertia and the force of weight 34 acting over a lever arm distance of about 5 cm to its pivot point. The twisting motion will be propagated first to the left down the drop member to the start post support shaft 32, then to the base of start post 22 and then up the post 2 cm to the point where the start post touches the car nose. The twist motion could have components of both transverse and longitudinal acoustic wave propagation, which in common metals like steel or brass are both approximately 500,000 cm per second. The point where the car nose touches the start post is a distance of about 10 cm through connecting metal to the right tip of drop member 35. Therefore, the car nose is released to gravitational acceleration approximately 20 millionths of a second after the timer is started, assuming instant electrical communication. A car travels 16 ft/s when dropped from 4 ft, so in 20×10^{-6} s this time allows a distance of travel at the finish line amounting to one hundredth of a cm or about 4 thousandths of an inch. An identical car released say 20 cm away from the drop member would then be about 4 thousandths of an inch slower than the closer car.