New apparatus for “Monkey and Hunter” demonstration

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Abstract

We present an apparatus for “Monkey and Hunter” demonstration in the student lab. We can easily construct it at a low cost and the blow gun has a high hit rate.

Keywords: Monkey and Hunter, Photogate.

Resumen

Se presenta un aparato para el "Mono y Cazador" haciendo demostraciones en el laboratorio de estudiantes. Se puede construir esto fácilmente a bajo costo y la pistola de aire comprimido tiene una tasa de éxito alta.

Palabras clave: Mono y Cazador, Fotocompuerta.

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I. INTRODUCTION

The “Monkey and Hunter” demonstration illustrating the behavior of falling bodies and projectile motion is a student favorite. Many texts [1, 2, 3] contain this demonstration.

Apparatus of this kind is available but the longer the shooting range, the poorer is the hit rate. We can suppose three reasons for this: first, it is difficult to aim at the small target; second, when the bullet leaves the muzzle and it breaks an electric circuit, it is deflected a little; third, if the conventional electric circuit is broken, when the beam of light is interrupted, an upward force is applied to the falling target again after the bullet leaves the barrel. This can delay the fall of the target. We will improve these deficiencies in technique, and present here a new apparatus which has a high hit rate.

II. THEORY

A hunter aims his gun and fires a bullet directly at a monkey as shown in Fig.1.

At the instant the bullet leaves the barrel of the gun the monkey drops. The two should collide in mid - air regardless of the speed of the bullet. If gravity could be eliminated, the bullet would travel the straight line path G_0 M_0, and the monkey would remain at M_0. With gravity acting, however, the bullet travels the path $G_0G_1G_2G_3$, and the monkey drops from M_0 to G_3.

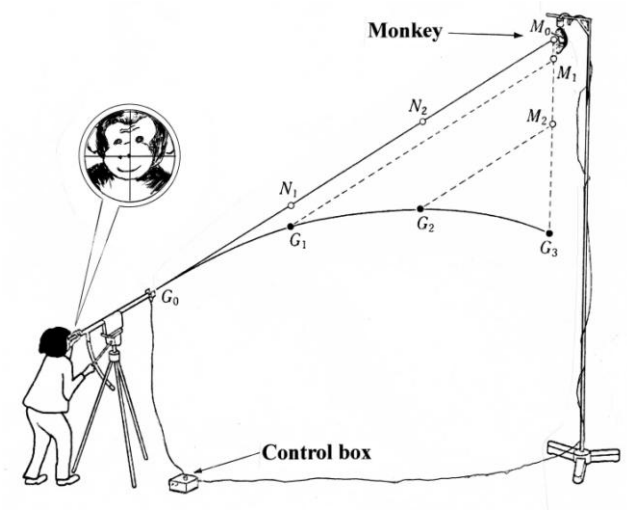

FIGURE 1. Diagram illustrating the “Monkey and Hunter” experiment.

During each fraction of a second both fall the same distance from their gravity - free positions and collide at G_3. For example, both drop 44.1m during third second. The greater the speed of the projectile the shorter will be the time and the distance M_0 G_3.

III. APPARATUS

A blow gun is a plastic tube that has a photogate at the muzzle end (Fig.2).

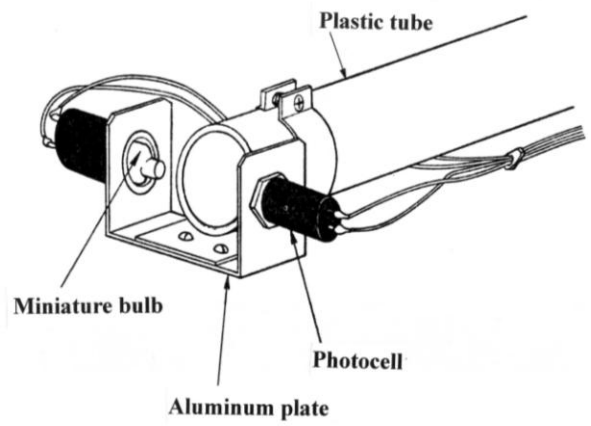

FIGURE 2. Photogate set near the muzzle.

The gun is settled on a tripod. We can sight at an elevated target directory through a telescope attached to the end of the barrel of the blow gun, as shown in Figs. 1 and 3.

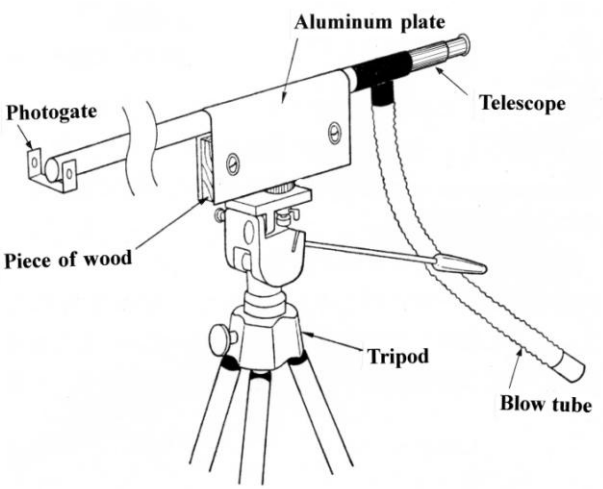

FIGURE 3. Blow gun is settled on a tripod, and telescope is attached to the end of the barrel of the blow gun.

The target is a stuffed monkey with an iron washer attached to its head, and it is 6.0cm in height. An electromagnet operated by a 6.0V dry battery holds the monkey. The electromagnet is mounted on a stand which is 6.0[m] horizontally away from the gun. Figure 4 is the side view of the blow gun. The gun is charged with a bullet, a 2.0[cm] diameter wooden ball. There is a stopper in a place away from the muzzle by 53cm. The ball touches the stopper, and rests as shown in Fig.4.

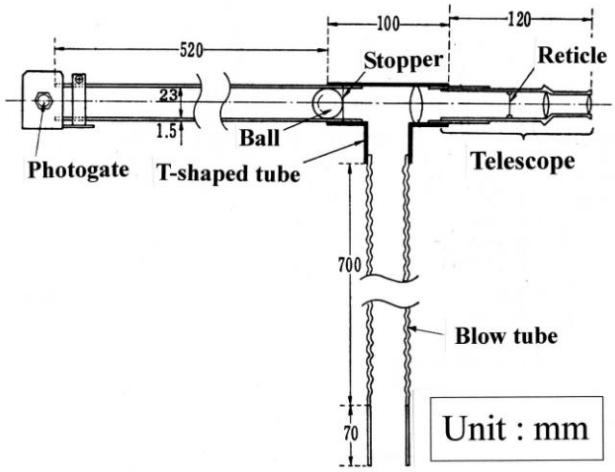

FIGURE 4. Side view of the blow gun. Stopper is 53 [cm] away from the muzzle. Blow tube is connected to a T - shaped plastic tube.

The stopper is made of a needle. The needle heated enough by fire is inserted into the plastic tube, and both ends of the needle out of the plastic tube are cut off as shown in Fig. 5.

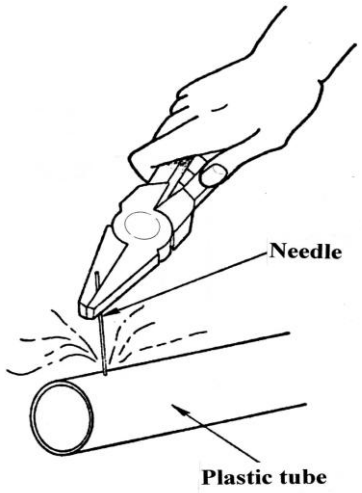

FIGURE 5. How to insert the needle into the plastic tube.

A blow tube made of a washing machine waste pipe is connected to a T - shaped plastic tube (Fig. 4). The ball is pushed out by a prepared piston, and the half of the ball just goes out of the muzzle as shown in Fig. 6.

In this situation of the ball, the position of the photogate is adjusted so as to break the electric circuit. Fig. 7 shows an electric circuit configurations for the photogate and the electromagnet.

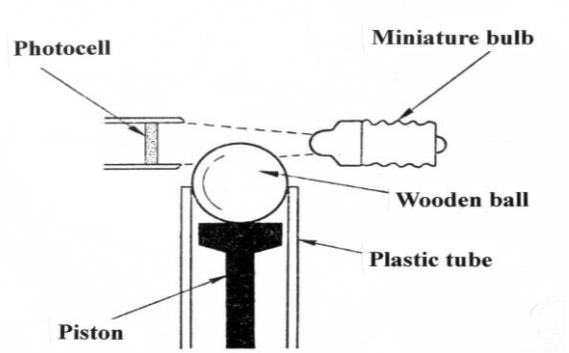

FIGURE 6. How to make a fine adjustment to the position of the photogate.

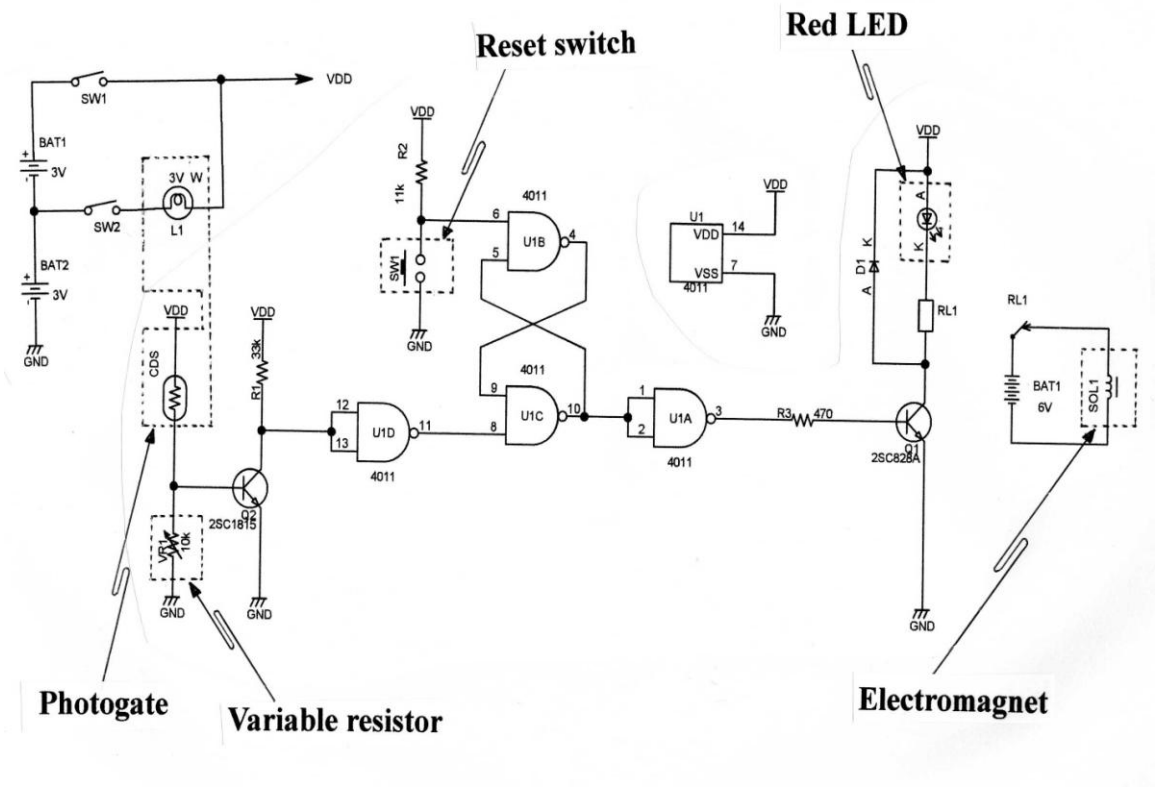

FIGURE 7. Electric circuit configurations for the photogate and the electromagnet.

The resistance "VR1" shown in Fig. 7 is a variable resistor which allows adjustment such that the sensitivity of the photogate is maximum. When the ball is put into the barrel of the gun, the ball passes through the photogate, breaking the circuit and causing the monkey to fall. Then, we have to push the "reset" button to allow current through the electromagnet, and attach the monkey to the electromagnet again (a red LED will light). At the instant the ball leaves the muzzle and passes through the photogate, the electric circuit is broken, and the monkey is released by the electromagnet. The monkey and the ball will meet in mid air on the way down.

IV. CONCLUSION

The blow gun described above has a long range and a high hit rate. However, we have a plan to improve on this apparatus. In the future, there will be no wire between the gun and the target in order to set up the apparatus more easily. When the beam of light incident on the photocell is interrupted by the bullet, a radio transmitter will send the signal of an electric wave, with frequency of 27MHz, to a receiver set near the target over 5m away. Then, the electric circuit will be broken and the target will be released by the electromagnet.

ACKNOWLEDGMENTS

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REFERENCES

[1] Gambhir, D., *Introductory Physics*, Vol. 1 (Mc Graw-Hill, USA, 1976), p. 17.
[2] Dull, C. E. and Williams, J. E., *Modern Physics*, (Holt, Rinehart and Winston Inc., USA, 1963), p. 85.
[3] White, H. E., *Modern College Physics*, 3rd Ed. (Van NostRand, USA, 1956), p. 111.