GILBERT

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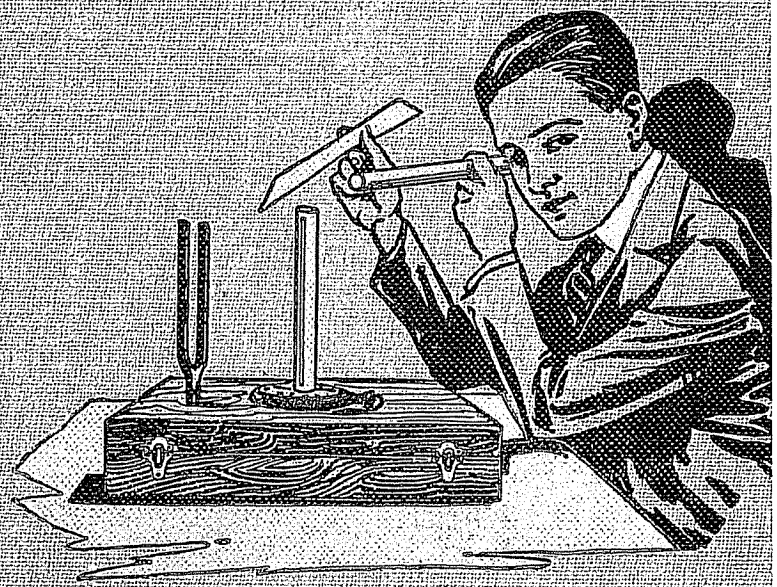
SOUND EXPERIMENTS



John Wade Gayley, Jr.
from
Aunt Mary and Uncle Orvie
Christmas 1923

GILBERT SOUND EXPERIMENTS

A New and Fascinating Play
FOR BOYS

BY
ALFRED C. GILBERT
Yale University, 1909

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INTRODUCTION

My sole aim in writing this book is to bring the Science of Sound down to your understanding so that you can have a whole lot of genuine fun—the kind of fun I liked when I was a boy—in doing these intensely interesting and scientific experiments which I am about to explain.

This book will not make you the smartest boy in your class at school, but it will teach you a lot of things that perhaps the smartest boy in school does not know, and you will stand for leadership among boys because you will know some things that most boys and even grown up people know very little about.

We are living in the age of the world's greatest discoveries and inventions, and you should realize the importance of the fact that the world's biggest scientific and engineering problems are yet in front of us. Just think we do not even know what electricity is as yet, and not one of the recent great discoveries or inventions such as wireless telegraphy or the telephone are anywhere near perfected. The problems of food production, soil fertilization, automatic machines of every description and kind, are problems in their mere infancy and they hold in store abundant possibilities for the scientist who will perfect and work out the things that are of so much importance to the whole civilized world. This book is an honest endeavor to kindle that scientific enthusiasm which every boy has, in the hope that I may start many of you on the way to the goal of achievement to furnish the world with new discoveries and new inventions; to unravel many unknown scientific and mechanical wonders of our earth and life.

In my book on Weather I said that we lived in an Ocean of Air and without this Ocean of Air the earth would be a world of desolation.

Now sound is conveyed to the ear through air. If either the ear or the air were destroyed we would be buried in the deepest silence.

When I tell you that there is really no sound or noise, does it not arouse your curiosity? Do you know that hearing is just feeling with the ear? That, in reality, the thing which we call sound, which we think of as noise or as a musical tone, is just an impression on the brain.

The tree does not hear anything. It may feel the pressure of the wind but, to the tree, the world is a world of silence. The only reason that we interpret sound as meaning anything is because our ears record such sounds as noise or music.

What do we mean when we say we hear sound? What is the difference between noise and music? Why does a piano play? Why do sounds go through the wall? What makes the wind whistle? What makes an echo? Why does a sea shell make a noise like the waves of the ocean? Let us see if we can find the answer to these questions and at the same time have a lot of fun doing other interesting experiments in Natural Magic or the Science of Sound.

A. C. Gilbert

GILBERT SOUND EXPERIMENTS

Chapter I

MOTION, "TO AND FRO"

Before I can lead you into the interesting experiments of sound, you will have to have patience enough to carry out the few simple experiments outlined in this chapter, as these are so necessary to enable you to understand the "whys and wherefores" of the experiments that are to follow.

Just one interesting little story I must tell you here; first, because it is interesting and second because it describes how a boy scientist, by careful observation and reasoning many hundred years ago, led up to some of our important laws of physics.

This great scientist, known as Galileo, born in Pisa, Italy, in the year of 1564, was destined to be one of the greatest philosophers and inventors that the world has ever known.

As a boy he was bent upon a scientific career. He took up his study at the University of Pisa. On a certain afternoon when he was still a young boy he had occasion to visit the great Cathedral of Pisa. While he was there, he saw the watchman lighting a lamp that hung from the ceiling of the cathedral. In order to light the lamp it was necessary for him to draw it down toward him and when finished lighting it, he let go of the lamp and it swung back and forth. This attracted the attention of Galileo and, having a scientific trend of mind, he

became interested in the movements of the lamp. At first the lamp swung in a long arc back and forth and then, as you all know, its motion grew less and less. But what you probably do not know, and the thing that struck him as intensely interesting, was that these "to and fro" movements or oscillations, whether the lamp was swinging wide or short, were always made in exactly the same time.

He then went home and reasoned it out. He made a piece of apparatus that was similar to the lamp—that is, with a thread and weight attached to it he made what is now called a pendulum. He was thereby able to duplicate the swinging motion of the lamp and measure it accurately. In this way, he discovered the laws of "to and fro" motion—that is, of the pendulum and its vibration.

Now do a little observing for yourself and see if you can compare this "to and fro" motion of the pendulum with things in Nature. Go out of doors and observe things that are taking place all about us.

What is the effect of the wind upon the trees? Do we not find that they are swaying backward and forward? The telegraph wires that hang on the poles are swinging to and fro, likewise the waves of the sea. In fact, you are going to find as we go along with our experiments that all of these motions that we see about us, and the sounds that come to our ears and the waves that carry the telephone messages and the telegraph and wireless messages, are all results of this "to and fro" motion.

THE PENDULUM

Make a pendulum apparatus of your own by means of a plumb bob attached to a thread. The length of the thread from where it is supported above to the center of the plumb bob is the length of the pendulum.

Experiment No. 1. Swing the plumb bob backward and forward. The movement from one side of the arc to the other and back again is known as a complete vibration—that is, from 1 to 3 and back to 1 again. (See Figure 1.) The movement of the plumb bob from one side of the arc to the other is known as a simple vibration—that is, from 1 to 3; the movement of the plumb bob from the center or point of rest to one side—that is, from 2 to 3 is the amplitude of vibration. The period of vibration is the time required to make a simple vibration.

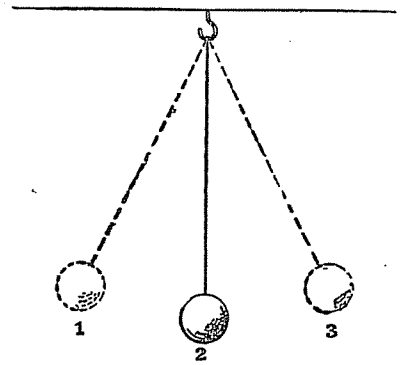

FIG. 1

THINGS TO KNOW AND NOTICE ABOUT THE MOVEMENTS OF THE PENDULUM

1st. That the motion of the plumb bob is most rapid at the center—that is, at position No. 2.

2nd. That the pendulum or plumb bob comes to a point of rest at the center (like the old cat dies) and oscillation or vibration ceases.

Cause. Why does the pendulum not keep swinging? The truth of the matter is that it could not stop itself. It is the force of gravity and friction of the air which, little by little, stops the pendulum and finally brings it to a point of rest. That is, the plumb bob comes to rest at a point as near to the center of the earth as it can; because gravity draws it in that direction into a vertical position or point No. 2.

Hold the pendulum in your hand and cause it to swing first high, then low. Ask some of your friends whether the period of the pendulum is greater when swinging high or low. Ninety-nine out of a hundred will tell you that it is greater when swinging low than when you give it a long swing. The reason they give you this answer is because they are not scientific. They do not know what you are going to know after you make the next experiment; that is what Galileo discovered hundreds of years ago.

Experiment No. 2. Take a watch and count the number of oscillations that the pendulum makes in ten seconds. Start the pendulum swinging from different positions, giving it first a long swing then a short swing. Determine the time of the vibrations when it is swinging high and swinging low and you will be surprised to find that the pendulum will always vibrate in the same period of time, no matter how long the swing or how short it is. This is the most wonderful and important law of the pendulum.

Experiment No. 3. Try plumb bobs of different weights—one of wood, one of lead; that is, one light and one heavy but of the same size. Count the motions as in the above experiment and determine the time of vibration, and you will find that you have worked out the second great law of the pendulum—that is, it makes no difference whether the weight is light or heavy; as long as the pendulums are of the same length both will vibrate in the same time.

Special Note. We told you that the friction of the air had an influence on the stopping of the pendulum. Consequently, if the plumb bob is large, there would be more friction and naturally it would come to rest quicker. But if you could carry this experiment on in a vacuum (where there is no air), it would not make any difference whether the weight was large or small—the vibration would be in the same time.

Experiment No. 4. The third great law of the pendulum is arrived at by taking several weights of the same size and weight and swinging them on different lengths of thread. (See Figure 2.) You may then determine the number of vibrations per second for each one and prove the third law of the pendulum, which is that the shorter the pendulum the more rapidly it vibrates or oscillates.

These principles that we have just illustrated with the pendulum are intensely interesting to us because, first, they are going to help us in understanding and appreciating the science of sound and, second, they are of great importance in the movements of the clock.

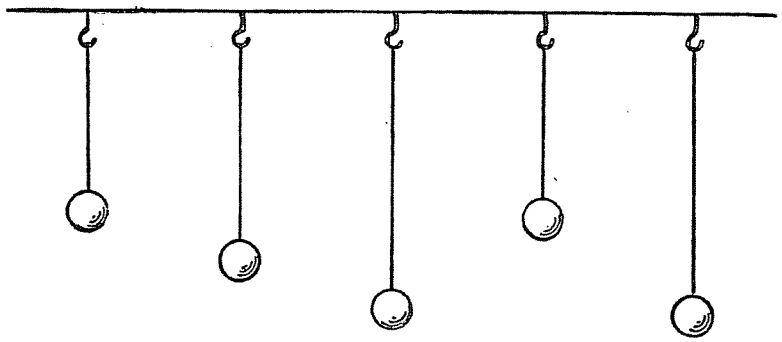

FIG. 2

Speaking as a scientist, the movements of the pendulum after all have a great deal to do with our every-day life, for we set our time for going to bed and arising in the morning by its actions; it is the guardian angel of the trains that run by time, etc.

In another book on scientific experiments with motion, we will take you into some interesting fun and study on the pendulum

action of the clock and we will give you the apparatus for actually duplicating the clock and putting it together yourself and understanding the principles that make this instrument work.

In addition to the three great laws of the pendulum you should notice one more thing about its manner of swinging. Have you ever pushed a swing in the park or in your back yard? When the swing is at rest, you give it a shove and it starts swinging, but not very high. As it starts forward the second time, you give it another shove and it swings higher. By exerting a moderate amount of energy, you can soon get the swing going so high you can hardly reach it, provided you push it just as it is starting forward each time. You would not think of pushing the swing when it is coming toward you. If you did, you would never get it going to any great extent.

With this in mind, you will now be able to understand a very mystifying trick which I will explain to you.

CONCENTRATION OF THOUGHT TO PRODUCE SOUND

Get a series of different size bottles. Through the center of the cork of each bottle make a hole, through which you pass a thread and to the end of the thread attach a little lead weight. Now each of these pendulums, formed by the thread and weight, swings at different lengths. If you have carefully read the first part of this chapter, you will note that the shorter pendulum will vibrate faster than the longer one; and if you bear in mind the action of a swing that we have just been talking about, you will understand the working of this very mysterious and magical feat.

See Figure 3 as to how to arrange these bottles on the table. You now ask your friends about the table to select any one of the bottles and concentrate their minds on that one bottle, and

watch it intently. Then each one is to place his hands upon the table, and by force of their thought (?) you will cause the little bottle to produce a sound.

Now what you do is to set the table in vibration by very slight

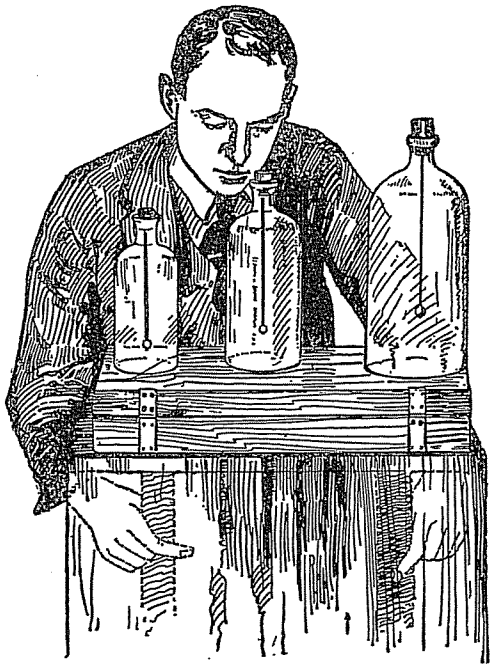

FIG. 3

movements of your hands which should be made unnoticed by your audience. Keeping your eye on the pendulum in the bottle that has been selected, make these movements so they are at the same rate as those of the pendulum; gradually, by keeping these motions of the table going, which by practice can be accom-