Locating Big Guns by Their Sound

By MAY TEVIS

ONE of the most interesting men in France is the veteran master of the science of Experimental Phonetics, the distinguished Catholic priest, l'Abbé Jean Rousselot. There has just been created at the College de France a special chair of Experimental Phonetics, the funds for whose support are included in the Budget of the Bureau of Public Instruction. This is a fitting reward for the labors both in peace and in war of this illustrious scientist, who has been studying the phenomena of sound nearly all his life, and who, beginning with a poorly-equipped laboratory of only four rooms at the College de France in 1897, made so many improvements in the simple phonetic apparatus which was all he then possest, that in the course of a few years his laboratory was taken as a model for no less than 18 others in various countries, the chief of these being at Hamburg.

The Abbé, who is now in his 75th year, was apprenticed to a nail-maker in his boyhood, but he soon attracted attention from his teachers by his keen mind and especially by his eager interest in language. It was not long before this interest extended from the dry text before him to the living speech that written language represents. Year by year his devotion to this study continued to grow until it embraced not only the sounds of the voice, but the mechanism by which they are produced, i.e., the mouth and lips, the nostrils, the larynx, the tongue and the teeth, and the organs of respiration. It was but a step further to undertake the study of the complementary organ of speech—that is, the ear which receives the impressions of speech and transmits them to the brain.

Not content with even this wide field of research, his enthusiasm led him to undertake researches in the entire field of sound and, finally, in the realm of sound in ballistics. It has been happily said of him that he has taught deaf mutes to speak and big guns to hold their tongues. It was through his study of voice production and his analysis of the motions and changes of form of the lips, mouth, larynx, nostrils, etc., that he was able to so analyze speech into its elements, that he could teach children and adults whose deafness had prevented their learning to speak thru imitation, as normal children do,—to produce vowels, consonants, and finally words and complete sentences. It was his study of sounds of all sorts and his decomposition of them into

The Work Done in Experimental Phonetics by the Abbé Rousselot

their elements by means of various delicate instruments, some of which are shown in the accompanying illustrations, that gave the good Abbé the power during the bitter days of the war to render an invaluable patriotic service to bleeding France by locating the gun batteries of the enemy.

As early as the summer of 1915 he was stationed at Fontainebleau taking records on revolving drums of all the wild confusion of sounds which reigned there—and then, from the study of these tracings, each representing a given sound, calculating the intensity, the pitch, and the timbre of the latter. Possest of these data he was able to determine, by means of carefully worked out tables, not only the exact position *but the calibre of every gun in the German batteries.*

There seems something almost miraculous, indeed, in the precision with which he was able to distinguish such various sounds coming from various distances, as that of the explosion of the charge or the sound wave coming from the mouth of the gun, the whine of the projectile in the air, and the noise of the shell's explosion—and this amidst the myriad of other noises made by the wind or by echo, by the explosion of mines or by men's voices. For days on end he camped in the forest of Fontainebleau devoting his time, his strength and his skill to "La Belle France" in this manner, while from October, 1917, to November, 1918, he was occupied in making experiments on French submarines and in teaching their crews to detect their hidden German foes.

Some of the earliest work done by Rousselot which laid the foundation for the important labors just described, was a study of the penetrative power of various sounds, ranging from whispers to deafening noises. Thus he found that with an ordinary voice, no sound of which was clearly perceptible at a distance of 9.6 meters, the hearer could understand the vowels a, e, i, o, u, when the distance was decreased to 9 meters, while the consonants all required a lesser distance, but one of varying degree, in order to be comprehended.

THE MECHANICS OF SOUND PRODUCTION

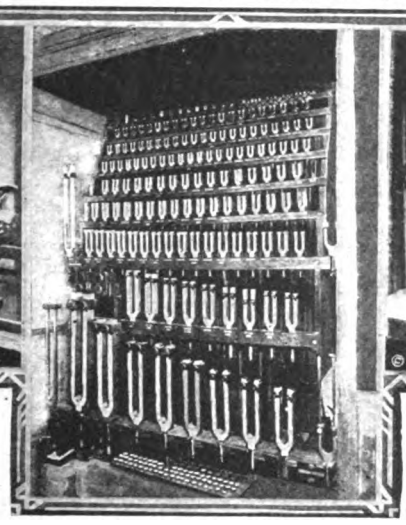
While Rousselot has invented a number of devices for studying or recording sound, such, for example, as his *nasal olives*, which are small rubber bulbs pierced by an aperture to be placed in the nostrils for registering variation in the force of breath employed, his chief mechanical work has been in the line of developing and perfecting instruments devised by earlier workers in the field.

Thus it has long been known that tuning forks vibrate in harmony with sounds uttered near them when these are of the same pitch. It is evident, therefore, that by having a sufficiently large battery of tuning forks any composite sound can be analyzed into its elements, since each fork will pick out and record the tone with which it is in harmony. Such a battery of tuning forks is shown in one of our pictures, ranging from the great fork at the bottom which sounds with the dull and sullen tone produced by 32 vibrations per second, to the tiny one at the top whose legs oscillate at the enormous rate of 40,000 vibrations per second, and which utters a correspondingly high and faint "squeak."

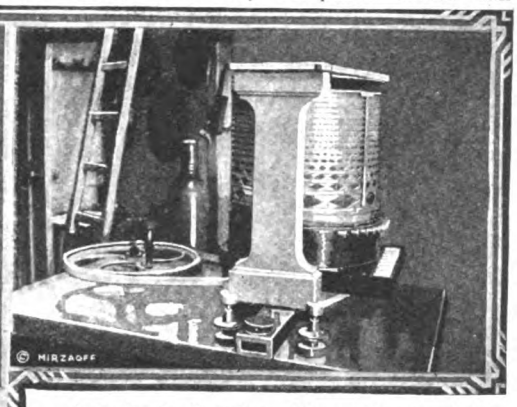
A recording drum or *tambour* is also a well-known device for recording the tracings produced by the vibration set up by sounds. In another picture we see such a recording drum connected with a mouth-piece over which a speaker bends.

Again, the siren is a very old apparatus for producing and counting the vibrations of sound waves. In its simplest form the siren consists of a disc of metal, pierced with a circle of holes at regular intervals and made to revolve in front of a jet of air. As it revolves the air flows thru each hole in turn; at first while the disc is revolving slowly mere puffs of air are perceived, but when it revolves so fast that these puffs are no longer to be distinguished separately, a musical tone is produced, which increases in pitch as the velocity of rotation of the disk is increased. The huge siren shown in our illustration is based on this same principle, but is far more complex and elaborate, as is apparent at a glance.

The Abbé Rousselot in His Laboratory; Various Pieces of Apparatus are Shown, Including Two Specially Constructed Toothed Disks for Studying the Tones and Overtones of Sounds.



A Most Interesting Battery of Tuning Forks as Mounted Under the Direction of the Famous Abbé, Ranging from Thirty-Two Vibrations per Second up to Forty Thousand, Covering Practically the Range of Audition of the Human Ear.



Apparatus for Registering Human Speech and Also the Air Pressure or Current Coincident with it; the Koenig Siren as Perfected in His Laboratory by the Abbé Rousselot.