

PHYSICS

# Why Is a Crooner? Science Seeks Answer

## Tests Show That Good Voices Are Likely to Be Loud Voices, Too; Overtones Important to Quality

USING instruments that turn sounds of the singing voice into electrical impulses and make possible voice "photographs," science is at last trying to find out what makes the mystic "good singing" voice. And what acoustical difference there is between the voice of an operatic star and a radio crooner.

At the Peabody Conservatory of Music in Baltimore, Wilmer T. Bartholomew is collecting data which may soon take some of the dogmatic tradition, cut-and-try methods and mysticism out of voice teaching. He wanted to find out if the usual system of mental imagery, in which the voice student is told to sing by "getting it up," "forward," "against the teeth" or "all through the head," really helps. The results are reported in the *Journal of the Acoustical Society*.

The musical research indicates that while the attempt to sing "all through the head" improves the singing tone it has little effect on the production of good quality. The mental imagery is good psychology and physiology but not physics. It is good pedagogy, but a trial-and-error and not a scientific pedagogy.

All the attempts to make the pupil sing from particular spots in his head or throat help singing by relaxing the tongue and jaws and the enlargement of the pharynx. In general, music teach-

ers find, a "yawning sensation" tends to help voice quality while the "swallowing sensation"—a much more frequent physical act—tends to harm voice quality.

From an acoustical standpoint a "good" voice must possess vibrato, that is, it must wobble but do its wobbling evenly about six or seven times a second. And the vibrato should include a regular variation in pitch, intensity and timbre. In a good voice this unconscious varying of tone is more marked the louder one sings.

Popular opinion to the contrary, it appears that the person who has good quality of voice can sing louder than an individual with poor quality. A large

throat which usually produces a good singing tone is also able to go to higher intensity of sound by allowing freer vibration of the vocal cords.

A good voice, too, should have what music teachers call a low formant; the low frequencies of sound should be strong in proportion to the higher ones. Any note sung consists of a fundamental frequency plus overtones or "partials." A good voice can produce the fundamental and plenty of the second partial. Thus for middle C, 262 cycles per second, a good voice has plenty of the second partial at double the frequency, 523 cycles per second. Poorer voices sing the fundamental but mix in with it the third, fourth and fifth partials, the pleasing second partial being weak.

Finally a good singing voice has also a high formant consisting of frequencies between 2,800 and 2,900 cycles. Most of the energy in the good voice, in fact, appears to be expended in creating these higher pitched sounds even when the singer is producing low notes. In a baritone singing a low note the high formant sounds may be equivalent to the 25th partial.

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MILITARY SCIENCE

# Machine, Not Horse, Will Make Kings of Tomorrow

WILL warriors of tomorrow ride into kingships on the backs of machines, as the warriors of past ages rode into their kingships on the backs of horses?

Latin "rex" and Sanskrit "rajah" both derive from a common original word meaning "horseman," indicating that it was the borrowed power of the horse that raised these rulers to their thrones. Will our present-day Duces and Fuehrers, who live by the borrowed power of machines, eventually evolve into "mechanarchs," or something like that? Is the mid-Twentieth Century to get, if not gods out of the machine, then at least kings?

One is tempted to speculate. Most great kingdoms of the past have been built on the skill in the art and science of war possessed by relatively small groups of men loyal to a single magnetic leader: Alexander's terrible cavalry and that impregnable fortress on foot, the spear-bristling Macedonian

phalanx; the ruthlessly triumphant legions of Rome; the mailed knights of the Middle Ages. All these, and their parallels elsewhere in history, pitted small numbers of skilled, disciplined men, whose life profession was arms, against masses of half-trained, indifferently-armed citizen soldiers, volunteer or conscript. They plowed through them, mowed them down, made them subjects or slaves. The skilled soldiers of the little armies became aristocrats, their leaders kings.

Gunpowder, that great equalitarian force, for a time made skill in the old handicraft of war of less avail. The democratic armies of Gustavus Adolphus had two kinds of front-rank soldiers, musketeers and pikemen. A nameless clever armorer in Bayonne showed how the pike-point could be fastened onto the musket, and thence-forward for some three centuries all foot-soldiers were equals, armed with a gun to shoot, and a bayonet for pike-

## ▼ R CAN YOU LIVE WITHOUT WATER?

an address by

## A Abel Wolman

Chief Engineer, State of  
Maryland Health Department

Wednesday, Aug. 22, at 3:30  
p. m., Eastern Standard  
Time, over Stations of the  
Columbia Broadcasting System. Each week a prominent  
scientist speaks over the  
Columbia System under the  
auspices of Science Service.

stabbing at close quarters.

The World War rapidly re-introduced much of the old complications of front-line armament, again putting a premium on professional skill in killing. Up to the front, with rifle and bayonet, went grenades of half-a-dozen kinds, trench mortars, small-caliber cannon, automatic rifles, machine-guns, gas weapons of all degrees, flame-throwers, flares, rockets—a veritable orchestra of death. To the front also came tanks, and strafing planes flying low.

Probably no modern soldier is proficient in all modern front-line weapons; but with equal probability the long-enlistment soldier, such as the man of the German Reichswehr, has adequate command of several of them, just as a good orchestra musician can play half-a-dozen instruments acceptably.

Like the Pretorian Guard of Imperial Rome, a small, technically skilled force may make emperors—or break dictators.

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#### MATHEMATICS

## Relativity Yields Formula Good for Many Machines

**O**F WHAT USE is relativity? This is a question frequently asked by the impatient layman. Theoretical enlightenment, the unification of diverse phenomena, etc., have been the kind of answer he has so far received. But now a more practical answer is given by Dr. Gabriel Kron of the Engineering Department of the General Electric Company at Schenectady. He finds that the mathematical methods of relativity, the famous "tensor theory" can be applied to dynamo electric machinery, in fact to all kinds of rotating electrical machinery.

And there is great advantage in so doing. Up to now, Dr. Kron points out, every different type of machine has a different mathematical theory, and the method that applies to one does not apply to another. Worse still, the same machine has many different theories according to the different engineers that have handled it, so that, as Dr. Kron says, we have as many separate theories as there are different types of machines and different types of engineers.

### Months to Learn Theory

It takes several months, he says further, to learn the theory of one machine. Consequently each engineer knows thoroughly only his own machine. To know another he must start over again at the beginning.

Dr. Kron, instead, establishes a "set of tensors" for the "generalized machine" and shows how by a routine "transformation of coordinates" the formulae can be applied to any type of machine whatsoever. It takes no longer, or even so long, he maintains, to learn this general method than it

does to learn the theory of a single machine, and when the engineer has done so, he has the enormous advantage of having mastered every type of machine instead of only one.

In short, the tensor theory is like a universal language. It may be a little troublesome to learn, but once acquired you can get along without other languages.

Dr. Kron's method is presented in a formidable paper, ninety-one pages in length, in the *Journal of Mathematics and Physics* published by the Massachusetts Institute of Technology Press.

### The Useful Tensor

The tensor theory was devised many years ago as a means of handling complicated sets of equations involving many unknowns and many dimensions of space. The tensor is a symbol that stands for a whole set of equations of a particular form. These symbols can be handled by themselves, thus saving the immense labor and possible confusion of writing down all the separate equations. The method has so far been applied only to the gravitational theory of relativity. Attempts to develop a universal unified field theory which should include both gravitational and electro-magnetic phenomena have so far failed. Dr. Kron's generalized theory of electrical machinery is, however, a kind of special unified field theory. It includes the electrical phenomena and the weight and inertia of the moving parts as well. He makes use of curved space and many spatial dimensions, even using when necessary an infinite number of dimensions.

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#### ETHNOLOGY

## White "Witch Doctors" Scorned as Illogical

**T**HE ENGLISH are the most illogical people living. This is the verdict of the African natives who associate with them.

And Dr. J. S. B. Leakey, British searcher for ancient human bones in Africa, who brought this news to the International Congress of Anthropological and Ethnological Sciences meeting in London, says:

"They are not unreasonable in thinking so."

The Africans are puzzled because the whites, so it seems to the blacks:

1. Practise witchcraft in many forms.
2. Attack witchcraft practised by the blacks.

3. Consider it wrong for Africans to punish members of their community practising black magic.

4. Refuse to punish people accused of killing by witchcraft on the ground that witchcraft is impossible.

5. Although attacking blackman's witchcraft, try to prevent Africans from using whiteman's "witchcraft."

### Science as Witchcraft

The Africans are convinced that white men practise witchcraft, Dr. Leakey explained. And to support their contention they point to such modern marvels of science as chloroform, use of fingerprints in identifying criminals, making of photographs, which the natives consider is the catching of a man's shadow in a box, predicting eclipses, thermometers, blood tests, phonographs, radio, etc.

"We deny yet we fear witchcraft," Dr. Leakey observed. "We can not expect African natives not to believe in witches. It must be remembered that just 200 years ago the English condemned witches to death."

Dr. Leakey also contended that Europeans should go slow in attempting to change African marriage customs because the European models are seldom suitable for use among the natives.

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An entomologist reports that the coffee bean weevil has a curious head structure, the mandibles with which it grinds up its coffee-bean diet being entirely separate from the rest of its mouth—very much as if a human being had its teeth and jaws near his nose and the rest of his mouth where it is.