it is desired to represent the Russian " soft sign," the apostrophe may be used. To take Dr. Brauner's examples, the Permanent Committee for Geographical Names would write Chicherin, Jemchujni, Mendeleev, Kon', Tatyana, Pushkin, Dyadya, Mechnikov.

Complete tables, not only of transcription from Russian but of the English values of other European and Near-Eastern alphabets, may be found in " Alphabets of Foreign Countries transcribed into English according to the R.G.S. II. System," recently published by and now obtainable at the Royal Geographical Society.

EDWARD GLEICHEN,
Chairman, Permanent Committee
on Geographical Names.
Royal Geographical Society, Kensington Gore,
London, S.W.7, May 7.

The Helmholtz Theory of Hearing.

DR. E. W. SCRIPTURE, in his letter on the above subject in NATURE of April 22, p. 518, has dealt with the case in which the note is continuously *changing*, and shows that when this is so every resonance organ of the ear must act at every instant for every vibration of the voice. Now suppose a pure fundamental note (*i.e.* one without harmonics) to be started and continued. At the start it would, on the principle of the apparatus designed by Dr. Hartridge, cause *all* the resonance organs of the ear to act, and we should hear a certain quantity of sound. Then gradually all, except one, of the resonance organs would cease to act, and we should hear only by means of the one which was synchronous with the pure note, and if this were so, presumably the quantity of sound would then appear to us much less than at the start. Has such an effect ever been recorded? If not, there would appear to be something wrong with the hypothesis.

A. S. E. ACKERMANN.
17 Victoria Street, Westminster,
London, S.W.1, April 27.

PROF. SCRIPTURE has advanced in his letter in NATURE of April 22, p. 518, an argument which, if it were sound, would indeed necessitate the abandonment of the resonance theory. He must, therefore, excuse me if I point out what I consider to be the weak links in his chain of reasoning.

The first statement in his letter with which I find myself at variance is that according to the resonance theory only one resonator should respond to one tone. This is not only in disagreement with what Helmholtz wrote, but is also in disagreement with experiment. The resonance model referred to by Prof. Scripture, of which a photograph is reproduced in Fig. 1, showed that beside the intune resonator marked C being in vibration, there is also obvious movement in the one to the right-hand side as well. If there had been other pendulums of intermediate length mounted on either side of " C," there is no doubt that a number of these would also have been set into vibration, the actual number varying with the degree of damping applied to each. Helmholtz worked out the case of the ear resonators by means of calculations which appear to apply equally to all types of oscillating systems. He estimated that for tones about the middle of the musical scale, resonators having natural periods different from the incoming vibration by one semitone would be performing forced vibrations, the amplitudes of which would be approximately one-tenth that of the strictly intune resonator.

Now I have already stated (*Brit. Journ. Psych.*, April 1922, p. 370) the reasoning on which is based the estimate that some 600 resonators correspond to each octave in the musical scale. One semitone on either side of the intune resonator would, therefore, include about 100 resonators, and all these must be vibrating with one-tenth the amplitude (or more) of that of the intune one.

We see then how completely this estimate is at variance with Prof. Scripture's suggestion that according to the resonance theory only one resonator should be in vibration.

The second statement with which I cannot agree is that every vibration in a glide (since each vibration is different from the one which preceded) or every

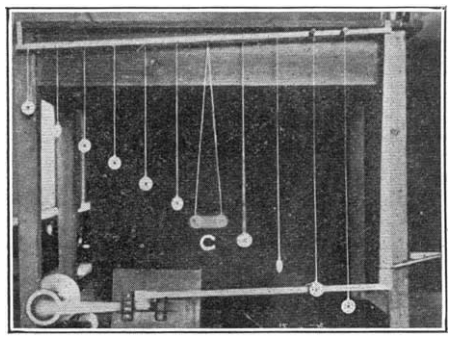

FIG. 1.

spoken word (since the voice tone is continually changing) must therefore set every resonator into motion from the highest to the lowest, and I have never observed any behaviour on the part of my resonance model which would give any basis for such a supposition. I have attempted to calculate what would happen to a series of resonators which are set into vibration, not by a fixed tone, but by a tone changing in pitch. I find that, as in the case of a fixed tone, a group of resonators is set swinging, but that this group is larger than that set swinging by a pure tone, and I infer that the centre of this group moves up the scale with the same rate per second as does the incoming sound, but with a small time lag. For example, if the pitch of the tone is changing by as much as one octave per second the group of resonators appears to be only two or three times as large as that set swinging by a pure tone. Presumably then the tone will be quite recognisable, although it will not have the purity that a fixed tone possesses. This latter effect may possibly be correlated with the unpleasant character of a rapidly changing tone, *e.g.* the commencement of a steam syren blast. Whereas there does not appear to be any evidence at present by which the above estimate can be checked, yet I think that it must be at variance with the facts to state, as Professor Scripture has done, that when the pitch of the incoming vibrations vary, all resonators irrespective of length must be set equally into vibration.

I regret that it was my model which raised these doubts in Prof. Scripture's mind concerning the resonance theory. I should have made it quite clear to him that there was roughly a semitone difference of pitch between each pendulum and its neighbour. The model was not designed to demonstrate the better-known phenomena of resonance, but to elucidate the effect of interrupting temporarily a musical tone; for this purpose a few rather widely spaced pendulums sufficed. If the number of pendulums in the model had approximated more closely to the number apparently to be found in the ear, then Prof. Scripture would, I feel sure, never have criticised the resonance theory as he has done.

H. HARTRIDGE.
King's College, Cambridge, April 26.