4266 Krape, R. D., Penn. State College.
 4267 Locke, D. J., Worcester Poly Inst.
 4268 Dreiss, F., Texas A. & M. College.
 4269 Waxman, J. H., Carnegie Tech. Schs.
 4270 Coward, H. F., Union College.
 4271 Hoyt, W. S., Union College.

Total, 87.

The Panama Canal*

The first attempt of the French engineers to construct a canal across Panama was without careful survey and no thought of sanitation. A story illustrating the unsanitary conditions existing at that time is as follows: An engineer was sent by his chief to investigate certain work and was to report the next morning. He did not report at the appointed time, and on inquiry it was found that he had already been buried two hours. The second attempt of the French was made in 1894. Careful surveys were made and work started, but dishonesty, combined with the deadly work of the mosquitoes, seems to have been the cause of failure. The engineers of the United States Government carefully surveyed 13 different routes before the present route was chosen, the choice being greatly affected by the position of the Chagres River and the Panama Railroad. The Chagres River has very large floods at times, and these would interfere with the operation of the canal. By means of the Gatun dams, the river is made to form a large lake, this lake will be part of the canal water course, thus saving considerable excavating. The maximum flow of the Chagres River for 36 hours would only raise the level of the lake one foot. The canal is 40 miles from shore to shore, with the Atlantic end west of the Pacific end. At the widest part it is about 1,000 feet in width, and about 300 at the narrowest. The level of the canal is 85 feet above the sea, with three locks at each end to raise the ships entering and to lower those leaving. The entire work

at present is under Col. Goethals. He has divided it into three parts, two of which at the Atlantic end are in charge of army officers, and one at the Pacific end, in charge of civilians. Very little electrical apparatus is being used at present, the work being started with too much haste to allow time for its installation. But later, the operation of all valves and gates, each of which weighs 750 tons, will be by means of electric motors. The amount of work in the Culebra cut is prodigious. At this point the canal will be 534 feet deep. Steam shovels taking two cubic yards of earth at each bite, and from 15 to 20 bites a minute, keep a continuous stream of loaded cars moving out of the cut. The most important department is the Sanitary Commission. The first work of the commission was to clear, pave, and furnish with pure water, the cities in which the workmen must live. When this was done, the mosquitoes had to be eliminated. Men are kept busy squirting oil on the marshes and water holes to prevent the breeding of this pest, as a precautionary measure against yellow fever.

Visual Sensation in the Alternating Magnetic Field

BY J. B. WHITEHEAD

In a recent note published in the Proceedings of the Royal Society (B. 82, 557) Professor S. P. Thompson describes a simple experiment by which an influence of the magnetic field on visual perception has been detected. The subject's head was placed inside a coil which carried an alternating current and the result described is the perception of a sensation of light even with the eyes closed. It is also stated that this apparent light flickers.

The report is interesting chiefly because there has apparently been no other observation of an influence of a magnetic field on human sensation.

*Abstract of an address by Mr. D. B. Rushmore before the Pittsfield Section on February 2, 1911.

*A paper presented to the Baltimore Section, American Institute of Electrical Engineers, January 20, 1911.

As the strength of available unidirectional magnetic fields has increased there has resulted no change in the usual absence of all influence on non-magnetic substances, including the human body. With the use of a changing or alternating field, however, induced electromotive forces enter, and since the body has shown appreciable conductivity under other conditions there is apparently nothing surprising in the results of Thompson's experiment.

Since the intensity of the effect is comparatively small the matter is perhaps of less interest to the electrical engineer than to the physiologist and psychologist. In view of the possible psychological interest involved the writer was approached by Professor Knight Dunlap with a request to cooperate in reproducing and possibly extending Thompson's experiment. From Thompson's description the results were not particularly marked and the intensity of the magnetic field not great. It appeared possible therefore that a knowledge that current was in the coil, by its hum or by other means, might by suggestion cause an apparent flicker of the idio-retinal light. Thompson used a coil 9 in. internal diameter, 8 in. long and containing 32 turns. His maximum current was 180 amperes at 50 cycles, thus resulting in a total of 5760 ampere turns. It appeared easy therefore to reproduce and intensify the conditions. Accordingly a coil 10 in. in diameter and 8 in. long was wound with 27 turns of 250,000 circular mil cable. The head can be readily inserted in this coil without touching it at any point, a condition not invariably possible with a coil built on Thompson's specification. This coil was hung with its axis vertical and at such a height that the seated subject could be in a normal attitude. Arrangements were made so that the load of the nearby transformer could be shifted from the coil to a resistance, thus removing the hum of the transformer as an indication that the coil

was excited. The coil itself yielded a slight hum and this disturbance was obviated by keeping a telephone receiver permanently connected to the transformer terminals; this receiver gave a note sufficiently loud to drown the other sounds.

The limits of the first arrangement of transformers were reached at 200 amperes, or 5400 ampere turns, *i.e.*, slightly below Thompson's maximum value. The frequency was 60 cycles. Under these conditions Professor Dunlap with head in the coil and eyes closed was able to state invariably, through many trials, whether or not the current was in the coil, by means of the resulting alteration in the idio-retinal light. The writer on the other hand could detect nothing, and of the several subjects who tried only one or two were conscious of a slight sensation.

With a rearrangement of transformers a current strength of 440 amperes at either 25 or 60 cycles was reached. The effect was now readily perceived by all who tried for it. It appeared to the writer as a flickering blue-white light which filled the entire field of vision. It was also readily perceived with the eyes open in bright daylight though it did not obscure seriously the perception of surrounding objects. The sensation appeared to be greatest in the outer limits of the field of vision. The writer could not detect any difference in the frequency of flicker when the change was made from 60 to 25 cycles. Professor Dunlap, however, considered the flicker to be less rapid at the lower frequency. Several subjects noted slight twitchings of the eyelids and one or two slight subsequent headache.

The most interesting result of the experiments is the variation of the effect with a change of the position of the head relative to the direction of the magnetic field. The sensation is greatest if the head is vertical along the axis of and completely within the coil. It is plainly perceptible however with the head withdrawn so that the lower plane

of the coil is tangent to the top of the head. If, however, the head be placed either at the top or the bottom of the coil so that the axis of the coil passes through the head from front to back or vice versa, *i.e.*, if the axis of the coil and the occipito-frontal axis are parallel, there is a marked lessening of the effect. When the head is placed so that the axis of the coil takes the third direction, *i.e.*, along the line from ear to ear, the effect is restored to the higher intensity.

The general direction of the optic pathway is parallel to the occipito-frontal axis. In the positions of the head in which the effect is greatest this axis is perpendicular to the direction of the magnetic field, and parallel to the same when the effect is least. This therefore suggests the presence of an induced electromotive force in the filament of the optic nerve. This explanation is hardly tenable however since in each of the positions of the head the optic nerve was practically at the center of a magnetic field symmetrical in the horizontal plane. Consequently the induced electromotive force mentioned should only occur when the head is shifted away from the center of symmetry; the coil was not large enough to permit any appreciable movement of this nature. There remains the fact that at the ends of the coil the magnetic field is sharply divergent, and if the sensations are due to a magnetic property of the tissues or nerves of the head, variations would be expected under the conditions in which they are observed. Professor Dunlap to whom are due the initiative and principal labor of the experiments, hopes to carry the investigation further.

Professor Dunlap has published a description of the same experiments in a letter to *Science* (N. S. XXXIII, 68-71, 1911) in which they are described from the point of view of the psychologist. The reader who may be interested in this phase of the subject is therefore referred to Professor Dunlap's letter.

The Legitimacy of the Terms "Decelerate" and "Deceleration"

BY CHARLES P. STEINMETZ

As the propriety of using the terms "decelerate" and "deceleration" has been challenged in the PROCEEDINGS, and as I have used these terms to a considerable extent for some years, a defense of their legitimacy appears appropriate.

Incidentally, it is interesting to note that in the last edition of the *Century Dictionary* the terms "decelerate" and "deceleration" are recognized as correct English.

The justification of these terms depends on the answer to the three questions:

1. Whether it is permissible to introduce new terms into an existing language.

2. Whether there is a need for the terms "decelerate" and "deceleration."

3. Whether these terms are formed correctly.

1. With the progress of the human race, new ideas are evolved, and new expressions for them have to be introduced into the language, and the development of a language thus can be closed only when it has become a dead language. This is not the case with the Latin language, as it is the language of scientific and engineering terminology and certainly not with the English language, and it will therefore be generally conceded that it is legitimate to introduce new terms into the English language, if they are needed.

2. The question thus is, whether the terms "deceleration" and "decelerate" are needed? "Deceleration" is synonymous with "retardation", and thus would not be needed, though it offers some advantage in its antithesis to "acceleration". The noun "deceleration" has been introduced as natural consequence of the verb "decelerate". This is *not* synonymous with "retard". "Accelerate" is a verb transitive and intransitive; "The mo-