J. F. STEVENS, M. E.

Extract from

Report of Committee on Meters,

of

American

Electro-Therapeutic Association.

Sept. 1897.

KEYSTONE ELECTRICAL INSTRUMENT COMPANY'S METER.- The Committee on Meters has been striving for several years to arouse the meter manufacturers to the consideration and development of milli-ampere meters and volt meters for use on the alternating current circuits, both the sinusoidal and the interrupted or Faradic. In the last report some reference was made to instruments used for this purpose abroad, and it is with feelings of the greatest satisfaction and pleasure that we are able to announce that the Keystone Company has perfected apparatus for these currents. The company submitted a sample milli-ampere meter and volt meter to the committee for examination and test, and has promised to also submit a watt meter for use on similar circuits in time for examination at this convention of the Association. The committee has examined the meters submitted, and is much pleased with the results obtained. While not having any means at hand for determining the absolute accuracy of calibration of the meters, the committee is reasonably assured as to the, at least, approximate accuracy of such calibration. This being the case, it is possible for the physician to now make observations in terms of volts and milli-amperes, instead of in the indefinite manner heretofore necessarily employed, which has usually been stated about as follows: Induced current primary or secondary; slow or fast, interruptions, as the case may be; 1,800, 1,500, 1,200, or less, yards or number of turns, regulated through the rheo-

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stat to the patient's toleration. Or, in the case of a millimetre scale, by indicating the number of millimetres according to the position of the secondary over the ordinary coil. The meaning of this, such as it had, varied with the different make of coils.

Mr. J. F. Stevens, the engineer of the Keystone Company, who has been particularly connected with the development of these meters, has written a description of his apparatus, which is of such interest that the committee feels it wise to embody it in this report in its entirety. This statement has been written since the date of the test:

"At the request of Dr. Margaret A. Cleaves, of New York, our company some months ago undertook the investigation of the subject of milli-ampere meters for use on the interrupted or faradic, and sinusoidal alternating current circuits now so much used by electro-therapeutists. We found that up to the present time no instrument had been designed for this class of work, which was suitable for use by practical operators. While it is true that Messrs. Kipp & Zonen, of Holland, have exploited an instrument for this purpose, it is extremely delicate and would prove in the hands of any but skilled experimenters too difficult to handle; and this, aside from the fact that it contains iron (always a detriment in instruments of this character), and requires time and patience--more of the former than is usually at the disposal of the busy practitioner--to obtain readings reasonably accurate and reasonably free from errors depending on the 'personal equation.'

"There are now on the market a number of milli-ampere meters, for use on the direct or galvanic circuit, which are reasonable in price and sufficiently accurate for all practical purposes. These instruments possess many qualities which it seemed desirable to incorporate in a similar instrument for use on the interrupted or alternating current, and we believe we have covered all but one (the uniform scale

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from zero to maximum scale) and have added several which we feel possess some merit.

"The system which we adopted, and which we submitted for practical test after considerable experimenting in our laboratory, is based on the dynamometer principle. By the employment of this system we are able to obtain readings in virtual or effective milli-amperes, the now accepted standard for alternating or interrupted current work. That is, a dynamometer measures directly the square root of the mean square of the current flow; it integrates the current pulse and gives readings in terms of the unidirectional, non-undulating or galvanic current. Its indications, if the system is properly constructed and with the proper ratio of turns in fixed and moving coils, are entirely independent of the wave form. It at least forms a basis for comparison, so that current administered may be referred to a standard indication and the same results attained no matter what form of alternator or Faradic coil may be used.

"It is not our province to refer to the necessity of such a basis of comparison, but rather to treat of the instrument by which it may be attained.

"The instrument submitted to Dr. Cleaves and afterwards shown the Committee on Meters, read from five to fifty milli-amperes. We found it impracticable to extend the lower range below five milli-amperes without introducing many undesirable features, and are inclined to believe that the minimum division will be found low enough for all practical purposes. Should we attempt to show indications below five milli-amperes, it would be necessary to support the moving coil by means of a filar or bi-filar suspension, which would involve the insertion of a galvanometer suspension tube and make it necessary to carefully level the instrument before taking readings. Further, it would be difficult to damp the oscillations of the needle sufficiently to permit reasonably rapid readings

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without introducing probable errors which might prove quite serious.

"The instrument, as we finally designed it, is mounted in a mahogany case and provided with a carrying handle, so that it is easily transportable. It is not in the least affected by external fields, unless used on the galvanic circuit, when it is advisable to take readings with the current flowing first in one direction through it, then reversed, and the mean reading used. Readings are entirely unaffected by temperature changes, are direct and all indications dead-beat; that is, the point will respond quickly to changes of current without oscillations. The resistance of the instrument is about 200 ohms for the scale reading given above, but this will not affect indications and is but a slight increase of the total resistance in circuit, requiring only a small increase in the electro-motive force to send the same amount of current through.

"Through the courtesy of Dr. Cleaves we were permitted to make a number of practical tests and see copies of clinical reports, from which we were convinced that not only are records of current strength desirable, but also records of the electro-motive force, from the combination of which the work done in watts may be computed. We, therefore, by means of an instrument similar in character, but of high resistance, and intended to be used in shunt to the circuit, read the actual volts employed in sending a given current through the body. So, then, by the use of these two instruments full records of work done may be obtained on the faradic, or alternating current, the same as is now the acknowledged practice in galvanic applications.

"In order to simplify the work for the practitioner, we now propose to offer in one instrument a combination of these two in the shape of a watt meter. By means of such a watt meter the total energy expended

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on a subject may be read directly from one instrument, and by multiplying by the time of application the total work done ascertained. The range of the watt meter we propose to submit for practical test will be two watts, reading from two-tenths watt to full scale. This means that it will indicate the energy with from five to fifty milli-amperes of current flowing at a potential up to forty volts. This range seems to cover all contingencies as we know them at present, and we are quite ready to modify either factor should practice dictate any advantage in so doing.

"The construction of this watt meter will be in general the same as the milli-ampere meter or volt meter already tested, the difference being that the fixed coils will be energized by the current flowing, while the moving coil, in series with a non-inductive resistance, will be in shunt to the circuit. Therefore, there will be four binding-posts on the instrument--two for the voltage readings, which will be in shunt to the circuit, and two for the current readings, which will be in series with the circuit, the combination of these two giving readings directly in watts. We may note in passing that in this instrument the resistance in the series circuit will be about half that of a milli-ampere meter of corresponding range. It may be well to add that the current and pressure coils will contain so nearly the same number of turns that there will be no chance of error by reason of phase displacement. Further, we would say that no iron or magnetized steel is incorporated, and in general nothing subject to change. We also take great care not to have any continuous metallic circuits in the case, frame or system, so that errors due to secondary or induced currents are avoided.

"We would like to have it understood that in all work of this kind with which we may be intrusted, it will be our aim to produce only thoroughly reliable instruments made and calibrated in the most careful manner. Every detail will be closely watched, for we feel that a

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considerable responsibility will rest on us in attempting pioneer work in this line. We could not afford to mislead the profession in any way, and we will at all times welcome suggestions or criticisms from practical users."

(Signed,) Margaret A. Cleaves, M. D.

Edwin W. Hammer, E. E.

Caleb Brown, M. D.

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"The alternating current meters, volt and milli-ampere meters, developed by the Keystone Electrical Instrument Company, have been in use throughout the past year, and have given as far as construction and accuracy are concerned perfect satisfaction."

(Signed,) Margaret A. Cleaves, M. D.
Edwin W. Hammer, E. E.
Caleb Brown, M. D.

J. E. STEVENS, M.

Extract from letter received from

Edward L. Willis,

Box 164,

Richmond, Va.;

10/22/1900

"In this connection it would not be out of the way for me to say that I like the instrument very much and its operation is very neat and accurate."

(Instrument referred to is D. C. Portable Milli-Voltmeter and Voltmeter.)