METEOROLOGICAL MAGAZINE

December 1941 to February 1942

AEOLIAN TONES

by P.A. Wells.

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NOTE.

It is regretted that, owing to the sudden and prolonged illness of Miss D. Figgins it was not practicable to prepare separate issues of the typescript "Meteorological Magazine" for December 1941 and January 1942. A combined issue for December to February is circulated herewith.

During the illness of Miss Figgins the magazine will be sub-edited by Miss M.J. Mardles, M.O.3, to whom contributions should be addressed.

Matthew Young(5), Bishop of Clonfert, [illegible] strings but one from a Weather Harp but still heard a great variety of notes. His conclusion was that the air particles which struck the middle of the string, moved it from its normal position. Unless, however, the wind was very strong and constant in strength it would not be able to maintain the string in its bent position, since the latter would return to its former position on account of its elasticity. Then, in virtue of the acquired velocity, it would swing past it, then back again and so on. In this way, he said, the string excited pulses in the air

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The sounds produced by wind blowing against a taut string have been known from very early times and were called Aeolian tones after the mythical god of the winds. Later Tyndall(1) described how a "gentleman of Basle" constructed an instrument with iron wires which he called a "Weather Harp" and which, according to its maker, sounded as the weather changed! The first to attempt an explanation, however, seems to have been Athanasius Kircher(2), who in 1620 described how an instrument constructed of stretched strings, used commonly to be hung before an open window or a fire, so that the draught would cause it to sound. He ascribed the variety of notes heard to the wind blowing on different parts of the strings.

In order to investigate the phenomenon experimentally, Matthew Young(3), Bishop of Clonfert, in 1784 removed all strings but one from a Weather Harp but still heard a great variety of notes. His conclusion was that the air particles which struck the middle of the string, moved it from its normal position. Unless, however, the wind was very strong and constant in strength it would not be able to maintain the string in its bent position, since the latter would return to its former position on account of its elasticity. Then, in virtue of the acquired velocity, it would swing past it, then back again and so on. In this way, he said, the string excited pulses in the air

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thereby producing the tones. Young's theory appears untenable, however, in view of the fact that the sounds are due to the transverse vibrations of the string in a direction at right angles to the wind stream.

Michael Faraday(4), in 1831, considered that the vibration of the strings of a Weather Harp was analogous to the oscillations produced in water by a wind, but the first quantitative experiments were not made until some time later, in 1878 when the following investigation was carried out by V. Strouhal(5). He rotated a stretched wire about an axis in such a way that it traced out the curved surface of a cylinder. He then found that not only the fundamentals of the wire, but also the harmonics would appear at the appropriate speeds. From his results it appeared that the pitch "n" of the note emitted was given by the equation $v/nd=\text{constant}$, where "v" was the speed of the wire through the air, and "d" was the diameter of the wire.

According to more modern theory, the periodic detachment of vortices from alternate sides of a string placed in a wind stream imposes periodic cross forces, alternating in direction, on the string. If the string is free to move in a direction at right angles to the stream, transverse vibrations, producing Aeolian tones, will be set up when the frequency of detachment of a pair of alternate vortices corresponds to one of its natural tones.

On these lines F.Krüger and A.Lauth(6) established a theoretical basis for Strouhal's formula. Briefly the frequency of the vibration represents the number of vortices formed on one side of the wire in one second. If the wireswings with the vortices, the frequency must be $(v-u)/x$, where "v" is now the velocity of the vortex system relative to the stationary wire, and "x" is the distance between two successive vortices in the same row. Hence $v/nd=v/d.\quad x/(v-u)=\text{constant}$, where it has been established that, except for small values

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of "v" or "d", the constant has the value 5.

It is interesting to note that if the relation is expressed in terms of the viscosity (j) of the medium, it becomes vd/j=constant,

so that the critical value of the constant, in this case 5, is the "Reynolds' number," well-known in aeronautics.

For reference numbers see Page 6.

REVIEW.

Experimental Studies of Anemometers, by S.P. Fergusson. Harvard Meteorological Studies No.4. Blue Hill Meteorological Observatory. Harvard Univ. Press and Oxford Univ. Press, 1939.

Few things can have led to more serious errors in meteorological observations than the wide application of Dr.Robinson's original factor of 3.0 to cup anemometers of diverse types, to many of which it is entirely inapplicable. American meteorology must have been one of the chief sufferers from this practice since cup anemometers are in wide use on the North American continent at meteorological stations. It is therefore of great importance that the factors of the instruments in common use there should be known with certainty. Much work has been done on this subject during the past 10 or 15 years in Canada and the United States by Patterson, Marvin, Fergusson and others, and in the present paper Mr. S.P. Fergusson brings together the results of his own extensive researches. Some 40 different cup anemometers were subjected to tests either in wind tunnels, on a whirling arm or in the natural wind, and a great deal ofinformation is presented to the reader in the 36 tables which set out the results obtained. It is a drawback of the paper that the data are not very adequately summarised in the text and the reader is to a considerable extent left to draw his own conclusions. The main conclusion is, however, clearly stated by the author namely that three-cup anemometers with beaded edges to the cups and relatively short arms are much superior to the

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four-cup type which has been widely used in the past. If a three-cup type of good design is used with a suitable factor its errors can be kept within 1 per cent. or 2 per cent. over the whole range of velocity likely to be experienced in meteorological work, excluding of course those very light winds which are inadequate to turn the cups. As against this the errors of the old four-cup type used in America with the factor 3.0 ranged up to 33½ per cent. at high velocities. The errors of the four-cup type can obviously be much reduced by adopting a more suitable factor than 3.0 but the factor with this type varies with the wind speed so that it is not possible to get accurate readings at all speeds. The behaviour of cup anemometers is affected by the gustiness of the wind and tests made in the steady current of a wind tunnel are not therefore entirely satisfactory. An apparatus for introducing gustiness into the air stream in a wind tunnel has been designed by the author and is described. It should prove of great value in anemometer research. A section of the paper contains useful notes on points which should be attended to in the design of cup anemometers for everyday observatory use. Certain instruments of other than the cup type were tested in the course of the work and among these the author has formed a high opinion of the Richard Anemo-cinemograph. The paper ends with an extremely comprehensive bibliography containing 265 entries. It is interesting to note that the author with most entries to his name is Mr.W.H. Dines with 18 papers, while Prof. C.F. Marvin comes second with 15.

J.S. DINES.

A LOAN COLLECTION OF METEOROLOGICAL INSTRUMENTS.

Mr. S. Morris Bower of Oakes, Huddersfield has formed a loan collection of instruments in connection with the Thunderstorm Census Organization. Mr.Bower reports that this has proved very popular and he asks to be informed of any instruments for disposal.

In special circumstances the Royal Meteorological Society also loans instruments to observers from time to time.

Thunderstorm on October 6,1941.

The following notes on an unusual thunderstorm observed by Mr.W.G. Gray of Linlithgow are of interest and may perhaps be put on record:-

"From 1515 to 1600 I travelled from Fauldhouse here via Whitburn and Armadale. Dense fog hid the landscape and locally there seemed to be "smoke banks" above as evidenced by the somewhat irregular gloom. On reaching Linlithgow the fog was less dense and drizzle (d_o) threatened. At 1600 there was a brilliant flash of lightning to west-south-west followed by thunder which was evidently about a mile and a half away. About four peals followed but I did not see any discharges. At 1610 there was d_od_o but at Falkirk it could be described as a "cloudburst."

Rumbling of distant thunder was heard again about 1620, the former storm having gone to northwards. Precipitation here was less than .05 in. with shade temperature 56°F. By 1700 the sky was clearing with stratocumulus patches moving south-west to north-east, and to northward could be seen a reddish mass of anvil cirrus.

Mr. C.K.M. Douglas has added the following note to the above:-

"The thunderstorms broke out in the south-west on October 5~~th~~ and the area of thunderstorm activity moved northwards across western and northern districts, finally reaching even the Shetlands. They were certainly of unusual type in the extreme north-east, and even as far south as Linlithgow. It is certainly unlikely that anything really similar has occurred since 1909, so that Mr. Gray's remarks are substantially correct, (though the actual pressure was about 1024 mb).

The outbreak was associated with a patch of cold air moving north at high level. The cold patch was

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associated with an upper depression or trough which had a south-east upper current ahead of it during the period of falling upper air temperature, and a south-west to west upper current behind it, when upper air temperature was recovering."

REFERENCE NOTES TO "AEOLIAN TONES" BY P.A. WELLS.

1. Tyndall, " On Sound," p.51, 1867.

2. Kircher, "Phonurgia," p.148, and "Musurgia Universalis," Vol.2, p.273, 1620.

3. Young, "An Enquiry into the principal Phenomena of Sound and Musical Strings," 1784.

4. Faraday, Phil Trans., p.338, 1831.

5. Strouhal, Ann. d. Physik, Vol.5, p.216, 1878.

6. Krüger and Lauth, Ann. d. Physik, Vol.44, p.801, 1914.

METEOROLOGICAL STATIONS.

Bramley, Hants. A climatological station has been set up by the Deputy Commander, Royal Engineers (Major Sir John F. Payne Gallway Bt.). Summaries of the records will be published in the Monthly Weather Report 1942.

Ipswich (Belstead Hall). The instruments formerly at Copdock has been transferred to Belstead Hall and summaries of the records are being published in the Monthly Weather Report.

SCHWEIZERISCHE METEOROLOGISCHE CENTRALANSTALT ZURICH.

The Director Dr. P.L. Mercanton retired on September 30th 1941, and is succeeded by Dr.Robert Billvilter.

OBITUARY.

Dr. J.S.Owens died on Dec.6th 1941 after an operation. He was trained in the medical profession and later in mining engineering and was for many years consulting engineer to the Rio Tinto Company. He is probably best known for his work for the Atmospheric Pollution Committee not only for the co-ordination and investigation of the observations but more especially for his ingenuity in devising the necessary instruments.

He wrote many papers on atmospheric pollution and allied subjects; his works include "The smoke problem of great cities" (in collaboration with Sir Napier Shaw) and "Twenty-five year's progress in smoke abatement." Dr.Owens was always very ready to share his ~~great~~ wide knowledge and experience and his kindly personality will be missed.

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Professor Wladimir Köppen died on June 22nd 1940 in his 95th year. He was appointed meteorologist to the Deutsche Seewarte in 1875 and in 1876 was responsible for the first daily weather notes in Germany. He was connected with this Office until his retirement in 1919. Professor Köppen published nearly 400 meteorological papers and exerted a great influence on his contemporaries and also on the younger generation of meteorologists. His wind charts are still the standard charts of the circulation of the atmosphere over the globe. He started the publication of the five volumes of the "Handbuch der Klimatologie" when he was over eighty.

Dr.W. van. Bemmelen, for many years Director of the Observatory of Batavia died on January 28th 1941. He was the pioneer of upper air work in the Dutch East Indies and his works include many papers on the subject, notably on cloud motion, and on magnetism.

William Cyril Kaye died in December 1941. Born in 1889, Kaye became a schoolmaster soon after he had taken his degree in 1908 at Birmingham University, but the war of 1914-18 called him from his career and in July 1915 he volunteered for service in the army. He was gassed in France and was invalided home in April, 1916. In 1917 he was transferred to the Meteorological Section R.E., and received a commission in April, 1918, and after the war elected to join the Meteorological Office. His career as a Meteorologist was mainly confined to the forecast side, and in 1928 when a meteorological station was required at Cardington for the operation of airships he was promoted to Assistant Superintendent and put in charge. Seven years later after he had been transferred to the Forecast Division his health began to fail. He struggled on but in June 1937, by which time he was a permanent invalid, he retired from the Office. In 1919 he married Miss E. Cotterill and he leaves one daughter.

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Such, in bald outline, is the record of Kaye, but such a record leaves out of count the courage, reliability and kindliness which were Kaye's characteristics. His time at Cardington was probably the peak of his career. There invigorated by the enthusiasm which Giblett infused, he had to train a team of forecasters from the very beginning, and by his tact and patience he did the job well. There were two essential qualities in the station at Cardington, enthusiasm and happiness. It was essentially what would be called at sea "a happy ship" and it was largely to Kaye that that latter quality was owed.
