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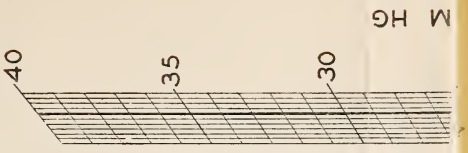

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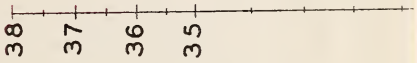

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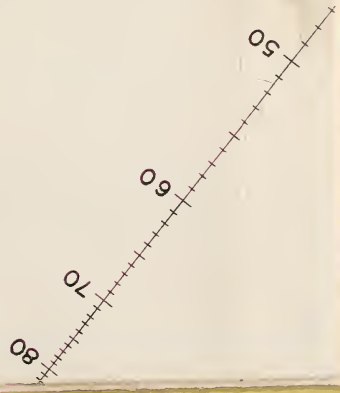

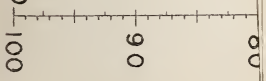

U.S. DEPARTMENT OF COMMERCE
Daniel C. Roper, Secretary
BUREAU OF STANDARDS
Lyman J. Briggs, Director

Bureau of Standards
Miscellaneous Publication
No. 143
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PSYCHROMETRIC CHARTS

By Donald B. Brooks

These charts were developed for use in the determination of the pressure of water vapor from psychrometric observations and are based on the psychrometric formula. In their development it was found that the addition of two scales permitted the accurate evaluation of relative humidity as well. In comparison with the customary double interpolation tables it has been found that the use of these charts increased the precision and halved the time required.

To use either chart, place a straightedge so that it intersects the extreme left scale at the value of the difference between wet- and dry-bulb temperatures, and intersects the wet-bulb scale at the value of the wet-bulb temperature. Extend this line to the right to its intersection with the vertical line which represents the barometric pressure, and read the pressure of water vapor on the scale at the extreme right. This value includes all necessary corrections.

EXAMPLE (Centigrade Chart)

Suppose a psychrometer reads 35° C. on the dry bulb and 21° C. on the wet bulb when the barometer is 77 cm Hg. To find the pressure of water vapor, place a ruler so that it intersects the "dry bulb minus wet bulb, °C" scale at 35−21=14. Adjust so that it meets the "wet bulb, °C" scale at 21, and note the point at which it intersects the 77 cm barometer line (first line right of heavy vertical line marked 76); the value of the humidity so obtained is 11.5 mm Hg. A computation from the psychrometric formula gives 11.486 mm Hg.

To determine the relative humidity, transfer the value of the pressure of water vapor obtained as described to the corresponding point on the central heavy vertical line representing standard barometric pressure (76 cm on the centigrade chart, 30 in. on that for Fahrenheit). Connect by straightedge this point and the point representing the dry-bulb temperature on the diagonal line marked "Dry Bulb." Extend the line to its intersection with the vertical line on the left, and read relative humidity on the inner left scale.

EXAMPLE (Centigrade Chart)

Continuing the example started above, locate the point on the heavy vertical 76 cm barometer line which represents 11.5 mm Hg pressure of water vapor, and connect this point with the point at 35° C., near the middle of the diagonal line marked "Dry Bulb, °C." By extending this line to its intersection with the vertical line at the left, the value 27.2% relative humidity is obtained, reading the "Relative Humidity, percent" scale on the inner side of the left vertical line. Note that this scale reads from 0 at the *top* to 100 at the *bottom*. By computation, the relative humidity for the example selected is found to be 27.20%.

In obtaining the pressure of water vapor when the wet-bulb temperature is below freezing, the scale marked "Wet Bulb" is employed if the psychrometer was used with either supercooled water or a frozen wick. However, more accurate results can be obtained with an ice-coated thermometer, and the "Ice Bulb" scale (to the right of the "Wet Bulb" scale) is used in place of the "Wet Bulb" scale.

The Fahrenheit chart is based on Professor Ferrel's psychrometric formula, which is used in the United States Weather Bureau's Psychrometric Tables.[1] This formula is

$$e=e'-0.000367P\ (t-t')\ (1+\frac{t'-32}{1571})$$

in which t and t' are the temperatures of the dry- and wet-bulb thermometers, in degrees Fahrenheit; P is the barometric pressure at the psychrometer, in inches of mercury; e' is the saturation pressure of water vapor in inches of mercury at the temperature t' of the wet bulb; and e is the atmospheric humidity in inches of mercury.

The centigrade chart is based on the analogous formula

$$e=e'-0.000652P\ (t-t')\ (1+0.00102t')$$

in which P, e', and e are expressed in millimeters of mercury, and t and t' in degrees centigrade. The constants used in this formula are based on recent data,[2,3] which are believed to be more accurate, rather than on the values corresponding to those used by the United States Weather Bureau, and employed in constructing the Fahrenheit chart, which would be 0.000660 and 0.00115, respectively. The two charts will not agree exactly; however, the difference will obviously be of the order of the experimental error.

[1] Psychrometric Tables, W.B No. 235, 10 cents.
[2] Feuchtigkeitsmessung, by Dr. Hermann Bongards.
[3] Journal of the Washington Academy of Sciences, March 15, 1933.

U. S. GOVERNMENT PRINTING OFFICE: 1933 8357

For sale by the Superintendent of Documents, Washington, D.C. ..... Price, 5 cents

DRY BULB MINUS WET BULB, °C.
RELATIVE HUMIDITY, PERCENT
DRY BULB, °C.
WET BULB, °C.
ICE BULB, °C
PRESSURE OF WATER VAPOR, MM HG
BAR. CM
DETERMINATION OF PRESSURE OF WATER VAPOR
PRESSURE OF WATER VAPOR
CALIBRATED BAROMETER
DETERMINATION OF RELATIVE HUMIDITY
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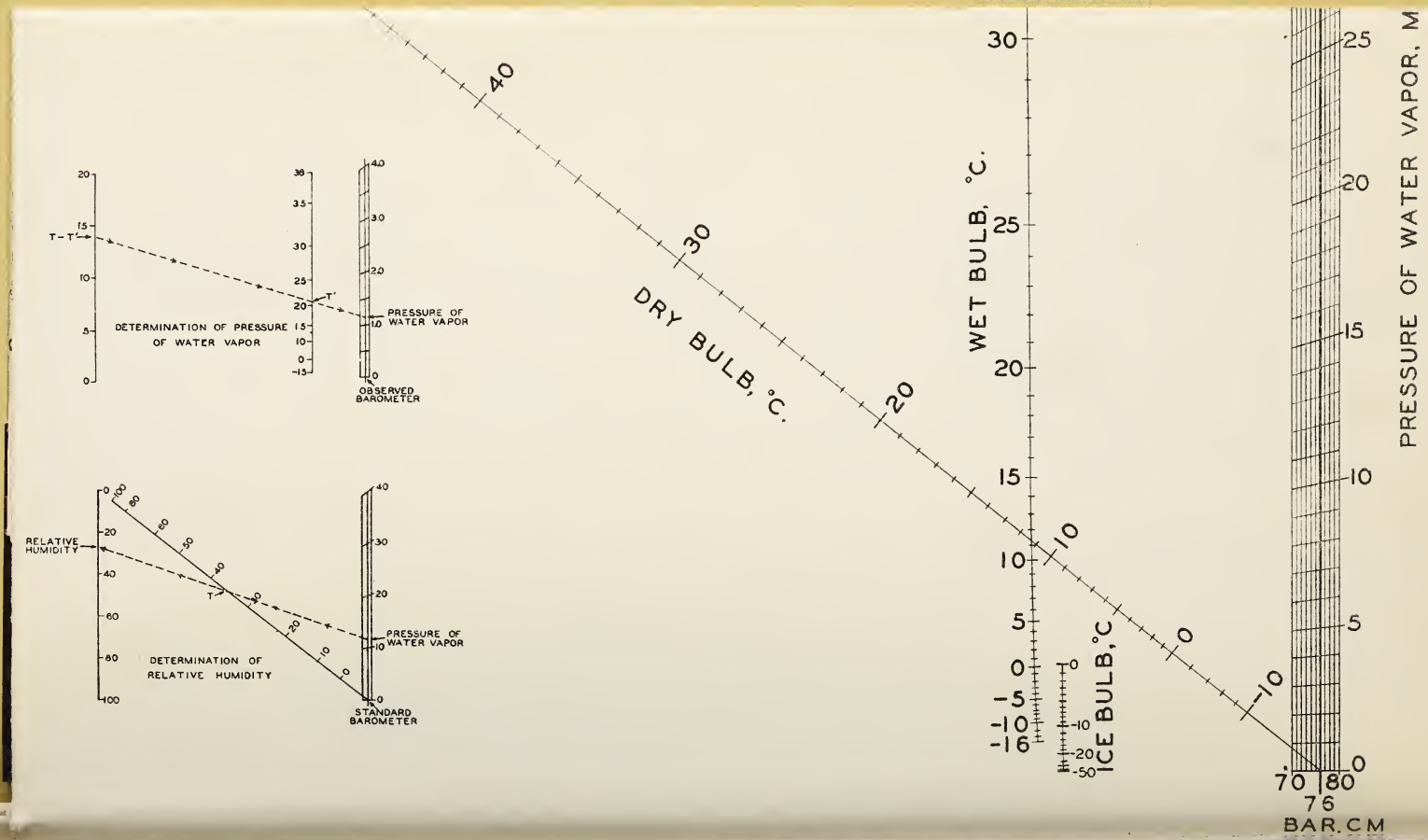
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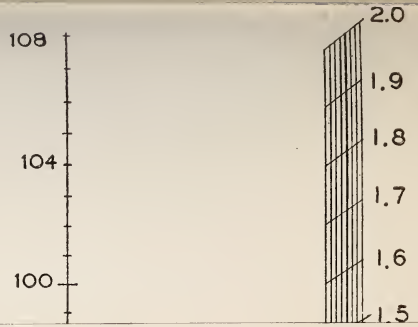
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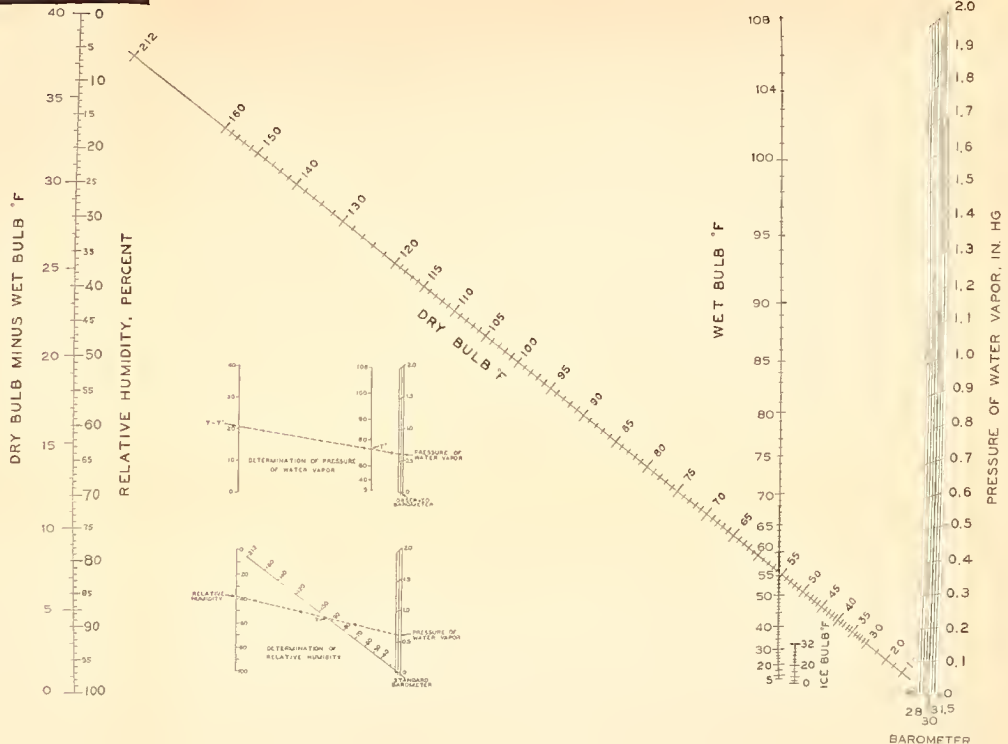
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