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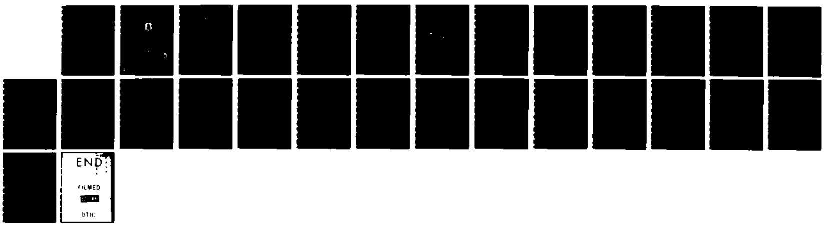

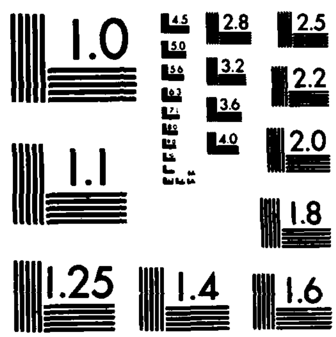

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THE AUTOMATIC REMOTE SENSING SYSTEM ON A 320 METER METEOROLOGICAL TOWER

by

L. Xing-sheng, Z. Da-zhou, et al

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The Automatic Remote Sensing System on a 320 Meter Meteorological Tower*

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(Institute of Atmospheric Physics, Academia Sinica)

ABSTRACT

The emphasis of this paper was to introduce the automated equipment used to measure the vertical gradient of a homogeneous field on the 320 meter meteorological observation tower in Beijing. It also introduced the characteristics of the instruments installed on various levels to measure the wind direction, wind speed, temperature difference, and ground temperature. The large amount of data on the tower was sent into two automated processing systems. One of them is to record the average wind speed, wind direction, and temperature difference of various levels in the form of vertical profiles on an electronic potentiometer. The other is to send the aforementioned instantaneous data points and other fast signals into a DJS-130 electronic computer for further processing.

I. INTRODUCTION

The use of a meteorological tower or an existing tower to carry out experimental studies in atmospheric boundary layer physics and monitoring studies in atmospheric pollution is a direct measuring technique with a relatively high accuracy. It has the advantages of continuity in time, synchronization in the vertical direction, weatherproofness, and multiple purposes. It is mostly used to study the structure of the atmospheric boundary layer and to monitor the atmospheric environment in and out of our country. It is also used in the comparison of direct sensing instruments to remote sensing instruments, as well as in the study of the low level structure in heavy weather. In military applications, it is used to study the propagation and forecasting of low level explosion waves, the forecasting of the dispersion of a nuclear missile test, the effect of special precipitates and suspending objects of underground nuclear tests, etc.

The study of atmospheric boundary layer physics requires that the measuring instruments on the tower should have relatively higher accuracies. There are many important factors. In order to reach this goal, there are numerous types of sensors to be used on the tower at the present moment.[1] In addition, the large amount of measuring data output requires that the data processing system and recording system should have a higher degree of automation. Presently, a large number of recording devices are used to record the instantaneous values of various important factors.[2] However, most of them use fast electronic computers for processing.[3,4] We adopted a method to transmit the data measured through shielded cables to two data processing systems: one is to separately record various measured signals using an automatic program controlled sampling device on several automatic balancing electronic potentiometers in the form of profiles; and the other is to directly send the instantaneous quantities of various measured signals through a scanning analog to digital conversion device to a DJS-130 minicomputer for further processing.

At the present moment, the measuring instruments installed at various altitudes on the 320 meter meteorological tower include wind direction, wind speed, temperature difference between levels, and absolute temperature on the ground. In addition, on some levels, humidity, vertical speed, and ultrasonic pulse wind speed instruments were also installed. The characteristics of the sensor in the latter case could not be described in detail in this paper. It will be introduced in another paper. A regular meteorological observation station was also set up on the ground.

II. BRIEF CONDITION OF THE OBSERVATION TOWER

The 320 meter meteorological tower is located near Madian outside Tesheng Gate in Beijing. The foundation of the tower is 49 meters above sea level. The body of the tower is an equilateral triangle. The length of each side is 2.7 meters. It has a steel tube structure. The ventilation characteristic is very good. A platform was installed at each level. An elevator for two has been

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**The collaborating organizations participating in the fabrication of the mean field instruments included the Shanghai Meteorological Instrument Plant. Comrades Zheng Shuzhen, Pan Shuiquan, Zhang Bingeng, Zhang Yuanlong, etc. also participated in the specific work.

installed in the middle of the tower (Figure 1) /71

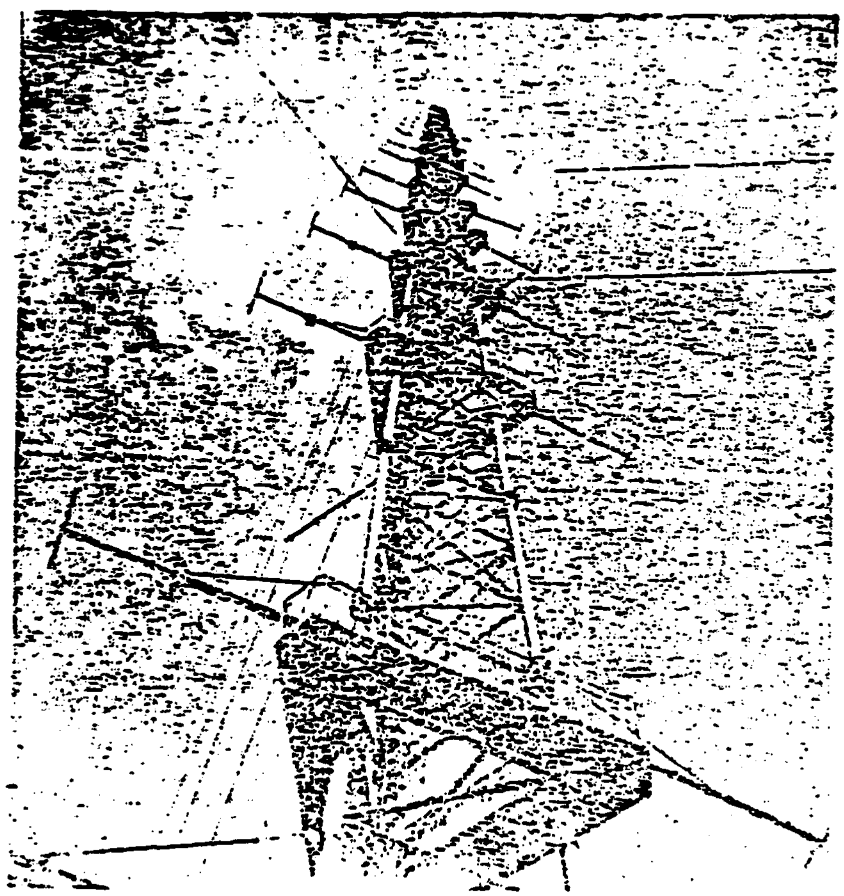

Figure 1. The External Structure of the 320 meter Meteorological Tower

Sensors for wind direction, wind speed, and temperature difference were installed on moveable arms at 15 levels 8, 15, 32, 47, 65, 80, 102, 120, 140, 160, 180, 200, 240, 280, and 320 meters above the ground. The tower body itself has an effect on the wind measuring sensors.[5] In order to minimize and overcome the effect of the circular flow created by the air current passing through the tower on the wind measuring sensors, we carried out a wind tunnel test on the 320m tower model. The results of the wind tunnel test showed[6] that the effect of the tower on the weather is closely related to the position of the wind measuring sensor away from the tower (Figure 2). When the distance of the sensor away from the tower (R) is one half or one times the length of the side of the tower (D), the tail flow wind created downwind from the tower is approximately 70°. The wind speed in the tail flow zone is decreased by approximately 50%. The increment of the wind speed on either side of the tower can be 10%. The maximum can reach 20%. When the distance of the wind sensor away from the tower is one and a half and twice the length of the side of the tower, the tail flow angle downwind from the tower is within 50°. The wind speed is reduced by approximately 30% in the tail flow zone. The tower itself does not have any significant effect on the wind speed in a 180° arc facing the incoming flow. The maximum increment of wind speed on the other 180° arc is about 5%. Therefore, there are two moveable extension arms at each level on this survey tower. Each arm is 4 meters long. It is in the northwest and southwest direction which is consistent with the most common statistical meteorological wind direction year round in Beijing. In addition, an absolute temperature measuring device and a temperature difference meter have been installed on the ground.

The external structure of the wind direction, wind speed, and temperature difference sensors and the positions of installation on the extended arms are shown in Figure 3.

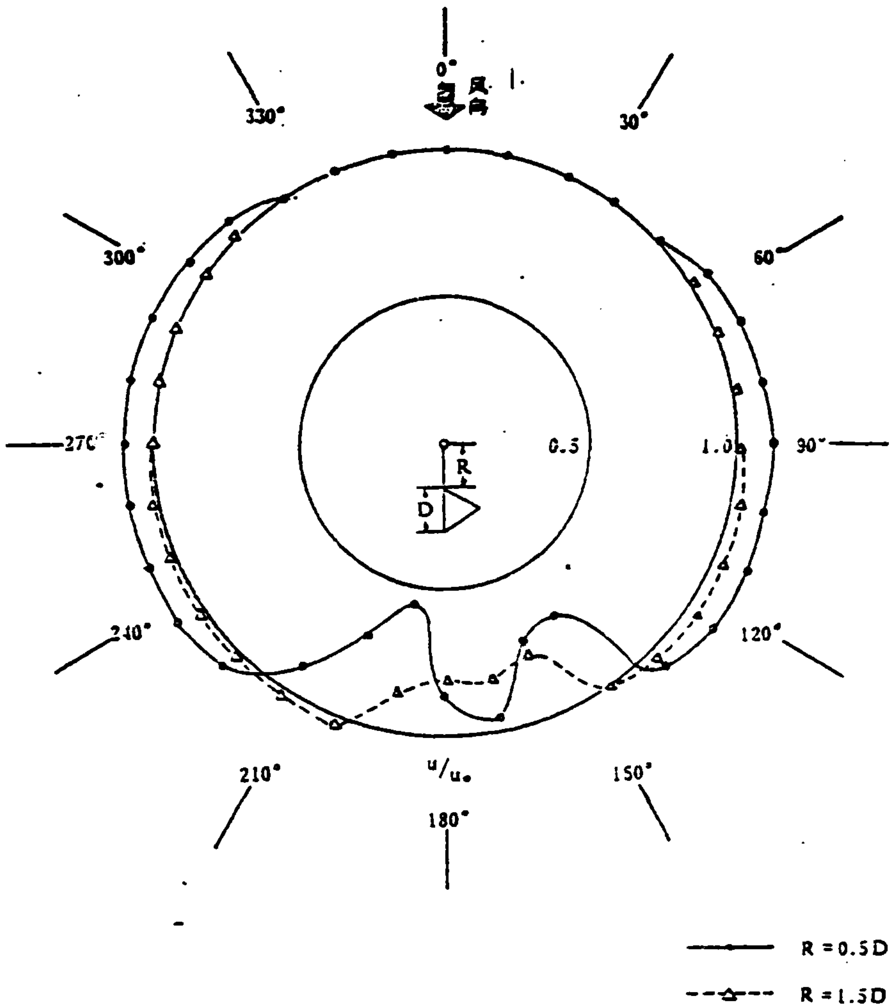

Figure 2. Effect of the tower on the wind speed measurement /72
1. wind direction

III. SENSOR CHARACTERISTICS

1) The wind guage: An aluminum triple cup sensor is used. The wind cup diameter is 60mm. The rotating arm length is 90mm. The wind cup is on the same axle as a gear. Along the outer edge of the gear, there are 24 teeth at equal distance. On both sides of the gear, there are light sources and light sensitive transistor diodes. When the wind cup drives the gear into rotation, the optical path is completed intermittently. As the gear turns by a revolution, it emits 24 light pulses. Through

the use of a light sensitive transistor diode and an emitter coupled trigger, the light pulses are converted into electrical pulses. The correlation between the rotating speed of the wind cup and the wind speed in the wind speed range of 0-50 m/sec has been proven to be linear through many wind tunnel tests.[7] The consistency among the wind speed sensors is also relatively good. An inertia test of the wind cup was carried out in a wind tunnel to measure the distance constant of the wind cup.[8] First, the wind cup was stopped by a small rod in a wind tunnel at a given wind speed V_t. After the wind speed was stabilized, the small rod was quickly withdrawn and the wind cup began to rotate. At this moment, the high speed light spot recorder was turned on simultaneously to record the waveform. On the waveform curve, the time T corresponding to 63.2% of the wind tunnel wind speed V_t was found. By multiplying the wind speed V_t by the time T, the wind speed sensor has a distance constant at approximately 4 meters.

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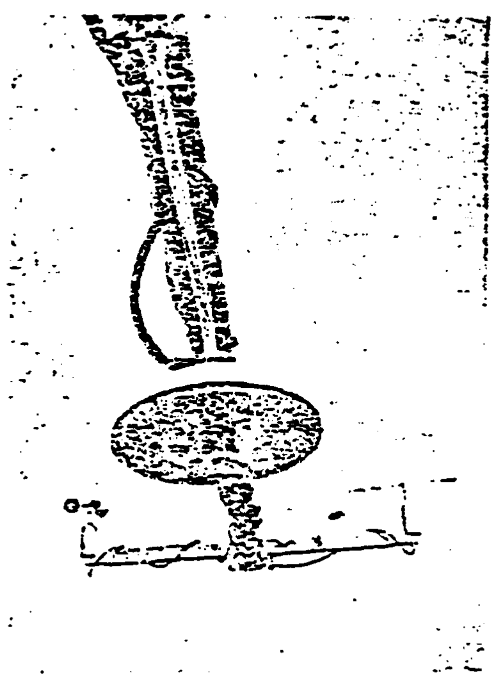

Figure 3. The external appearance of the wind direction, wind speed, and temperature sensors and the installation positions on the extension arm.

The start-up wind speed of the wind speed sensor is 0.4m/sec. The measuring range is 0.4-50m/sec. The measurement accuracy is ± (0.2 ± 0.02 actual wind speed). The wind speed sensors were tested in a constant temperature chamber in a range from -60° - +50°C. The output waveform and working condition were found to be normal.

2) The anemoscope: a double piece aluminum wind vane was used. The entire length of the weather vane is 47cm. The wind vane and the moveable arm of a special potentiometer share the same axle. Hence, the wind direction is expressed by the potential:

$$\hat{\vartheta} = f(V) \quad (1)$$

The structure of the potentiometer is different from the usual triple terminal type. This is because a triple terminal type potentiometer frequently exhibits a discontinuity when the wind direction is at 360°. In order to avoid this disadvantage, a paint covered nickel-chromium wire was wound around a bakelite ring to form two sets of resistance at 5000 ohms. The moving contact adopted was a five element alloy approximately Ø 0.8mm in diameter. A copper spring was used to connect to the rotating axle. The 360° potentiometer was equally divided in halves. The end of each opening is connected to a stable voltage source controlled by a voltage control circuit. Based on this, the measurement of wind direction is continuously extended to 720° so that the recording has a better continuity.

The inertia of a wind direction sensor is usually expressed by the damping ratio of the wind vane[9]: at a given wind tunnel wind speed, the relative position of the wind vane and the potentiometer is adjusted so that the amplitude of the record is situated in the middle of the recorder paper. Then, the wind vane is turned so that the incoming direction of the wind is around 20 degrees. After the wind speed is stabilized, the wind vane is released and the damping curve of the oscillation is drawn on the recorder paper. The damping ratio can be defined as

$$k = \frac{\theta_2}{\theta_3} = \frac{\theta_3}{\theta_1} \quad (2)$$

where Θ_0, Θ_1, Θ_2, and Θ_3 are the amplitudes of neighboring peaks (and troughs) of the damping curve. The test result showed[7] that the damping ratio of a wind direction sensor is approximately 0.3.

The start-up wind speed of the wind direction sensor is 0.4m/sec. The measurement error is less than ±5°.

3) The temperature difference meter: here, a differential type device is used to measure the temperature difference between two altitudes in a bridge form.[10] In order to increase the sensitivity of the bridge output, platinum resistor sensing elements have been installed on the four bridge arms. At this moment, the output voltage of the bridge is: /74

$$e=E_s(R_1-R_2)(2R_s+R_1+R_2)^{-1} \quad (3)$$

where E_s is the voltage of the power source. R_1 and R_2 are the bridge arm sensing elements located at two altitudes, respectively. R_4 is a current limiting resistor. It is also used to improve the non-linear effect of an unbalanced bridge under a wide range of conditions.

The sensitivity of an electrical bridge can be defined as

$$S=\frac{de}{dT}=\frac{\partial e}{\partial R_i}\frac{dR_i}{dT} \quad (4)$$

If $R_s = R_0\ (1+\alpha T)$, when R_1 and R_2 are relatively close, equation (4) can be rewritten as

$$S\approx E_s\alpha R_0[2(R_s+R_1)]^{-1} \quad (5)$$

where α is the temperature coefficient of the platinum resistor, and R_0 is the resistance of the platinum sensing element at 0°C.

If we choose E_s = 12 volts, R_s = 2.3 kiloohm R_0 = 100 ohm, R_1 = 100 ohm, and $\alpha = 4 \times 10^{-4}\,°C^{-1}$, and substitute them into equation (5), we get

$$S = 10^{-3} \text{ volt/°C} \quad (6)$$

The measurement requires that the range of the temperature difference should be within $5°C \geq |\Delta T| \geq 0.1°C$. According to the sensitivity given by equation (6), the range of the electrical bridge output is $5 \times 10^{-3}\ V \geq |\Delta T| \geq 10^{-4} V$.

The accuracy of an electrical bridge measurement is totally dependent on the cumulated error brought about by various factors. In order to ensure that the temperature difference accuracy between the two levels at the maximum distance apart on the 320 meter meteorological tower is within 0.1°C, a detailed analysis on the possible error factors in the aforementioned route was carried out according to Reference [11]. Both theoretical calculations and experiments showed that the measuring accuracy of this electrical bridge can be more than 0.1°C.

An eight line compensation method as described in Reference [10] was used among the sensors. The platform resistor sensors were placed inside the radiation proof masks in an electrical ventilator.

4) The ground thermometer: an imbalanced temperature measuring bridge circuit introduced in Reference [12] was used here. In order to increase the sensitivity of the measuring electrical bridge, two platinum sensors are used in the bridge circuit as two arm on the opposite sides of the electrical bridge. The other two arms are made of fixed resistors with a very small temperature coefficient. In order to overcome the non-linear output of the electrical bridge, we introduced a fixed resistor R_s and a thermistor R_t. On one hand, they have a current limiting effect; on the other hand, they have an effect on overcoming non-linearity. For simplicity, let us assume that $R_t = (R_k - kt)$. R_t is the limiting value of the thermistor at a temperature t. R_k is its resistance at 0° C. K is the variation of thermister resistance with temperature.

Output:

$$e' \approx E_0 \frac{\alpha R_0 t}{2(R_s + R_0)} \left\{ \left(1 - \frac{R_s}{R_s + R_0}\right) + t\left(\frac{\beta}{\alpha} + \frac{k}{R_s + R_0} - \frac{\beta R_s}{\alpha(R_s + R_0)} - \frac{\alpha R_0}{2(R_s + R_0)}\right) \right\} \qquad (7)$$

where E_0 is the voltage of the power source. R_0 is the resistance value of the platinum resistor, i.e., $R_1 = R_0(1+\alpha t+\beta t^2)$ where R_1 is the resistance value of the platinum resistor at temperature t, t is the relative temperature, and α, β are the temperature coefficients of the platinum resistor.

In order to make the variation of the output voltage of the electrical bridge with temperature follow a linear relation, it is necessary to satisfy the following in equation (7)

$$\kappa = \frac{1}{2}\alpha R_0 + \frac{\beta}{\alpha} R_k - \frac{\beta}{\alpha}(R_s + R_0) \quad (8)$$

The sensitivity of the electrical bridge is obtained from equation (4)

$$S_1 \approx E_0 \frac{\alpha R_0}{2(R_s + R_0)}\left(1 - \frac{R_k}{R_s + R_0}\right) \quad (9)$$

If we chose E_0 = 6V, $\alpha = 4 \times 10^{-6}\,°C^{-1}$, R_1 = 100 ohm, R_s = 2247 ohm, and R_k = 50 ohm, then

$$S_1 \approx 5 \times 10^2 \text{ microvolt/°C} \quad (10)$$

A detailed analysis on the possible error factors was done for the above route according to Reference [12]. Both theoretical calculations and experiments showed that the measuring accuracy of this electrical bridge could be more than 0.1°C. /75

Here, the sensing elements used were glass platinum resistors produced experimentally by the Beijing Glass Research Institute. The model number is WZB. The lag coefficient is 45 seconds when the temperature is rising. It is slightly larger when the temperature is decreasing. It is around 1 minute.

IV. AUTOMATIC CHECKING AND DETECTION OF SIGNALS

There are 76 signal output channels in total for the wind direction, wind speed, temperature difference, and ground temperature data points from 15 levels. A multiple strand shielded electrical cable was used to input into the data processing system. In addition to considering the synchronism of these signals, the major requirements are accuracy and reliability. This system has an automatic checking device for the wind direction, wind speed, and temperature difference ventilator.

1) The pulse transmitted from each wind speed converter is sent to the frequency to pressure converter circuit through a cable. The circuit includes an emitter coupled trigger, an amplitude limiting device, and a pumping circuit. The function

of the emitter coupled trigger is to re-shape the pulse distorted after transmitting through the electrical cable. Because the pulse amplitude at the input of the pumping circuit is required to be stable, therefore, an amplitude limiting device was installed in front of the pumping circuit. The pumping circuit is the core of this converter, which has the function of pressure to frequency conversion. The linearity is relatively good.

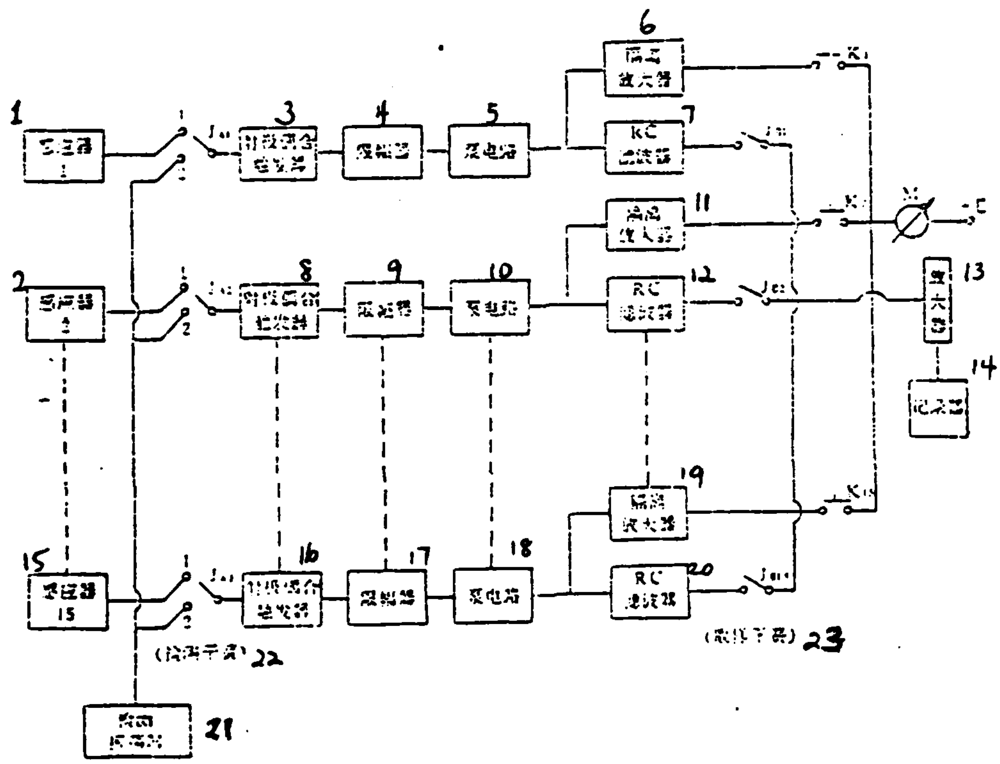

Figure 4. Block Diagram of Automatic Checking of Wind Speed

1. sensor
2. sensor
3. emitter coupled trigger
4. amplitude limiting device
5. pumping circuit
6. isolating amplifier
7. RC filter
8. emitter coupled trigger
9. amplitude limiting device
10. pump circuit
11. isolating amplifier
12. RC filter

13. amplifier
14. recorder
15. sensor
16. emitter coupled trigger
17. amplitude limiting device
18. pumping circuit
19. isolating amplifier
20. RC filter
21. checking oscillator
22. sampling switch
23. sampling switch

The fifteen channel wind speed signals are sent from the sensors to the data processing system by first passing through a checking and converting spring relay (Figure 4), which can be used to cut off the sensors in various channels. Furthermore, it connects the frequency to pressure converting circuit for each channel to the checking oscillator. The working condition of each channel is checked out in sequence. The consistency of the output is adjusted, and the accuracy is calibrated. By using the diagnostic device, it is very easy to separate the breakdown region in the sensors and the measuring circuit. It is capable of discovering the channel and position of the disorder in time.

Through the contact between the checking relay and the sensor, the fifteen channel wind speed signals are transmitted to the computer processing system through the corresponding fifteen frequency to pressure converting circuits and the output of the isolating amplifiers in the fifteen channel signals are /76
smoothed out by a resistor-capacitor filter so that the signals are synchronized within a sampling time period. Then, they are sent into an automatic program controlled sampling device to be sampled according to a certain sequence. The fifteen channels become a single channel. Therefore, it is only necessary to use an isolating amplifier and a simulating recorder to record the 320 meter wind speed profile.

2) The potential on the fifteen channel wind direction potentiometer is required to be accurate. For each wind direction potentiometer within the range from zero to 720 degrees,

the potential must change at the four terminals. In other words, each potentiometer must ensure the permanent accuracy of eight potentials. There are 120 potentials in total in a fifteen channel wind direction potentiometer. The requirements of accuracy and speed can only be accomplished by automatic measurement. In order to save the equipment and to simplify the circuit, a wind direction inspection device (Figure 5) has been formed by the automatic program controlled sampling device and the automatic program controlled sampling device and the automatic balancing electronic potentiometer used in the data processing system, together with some spring relays. When the wind direction inspection key is pressed, both J_A and J_B will move. J_A is connected to terminal (2). Consequently, the input end of the amplifier and the voltage controlled power source are in contact with ground through R_2, i.e., the zero potential. J_B is in contact with terminal (2). The voltage controlled power source, which is selected by the four 15 blade single throw mutually locking push button switches P, is delivered to the program controlled sampling device. When the P_1 key is depressed, the fifteen channel voltage controlled power source V_1 is connected to the sampling device. When P_2 is pushed, the

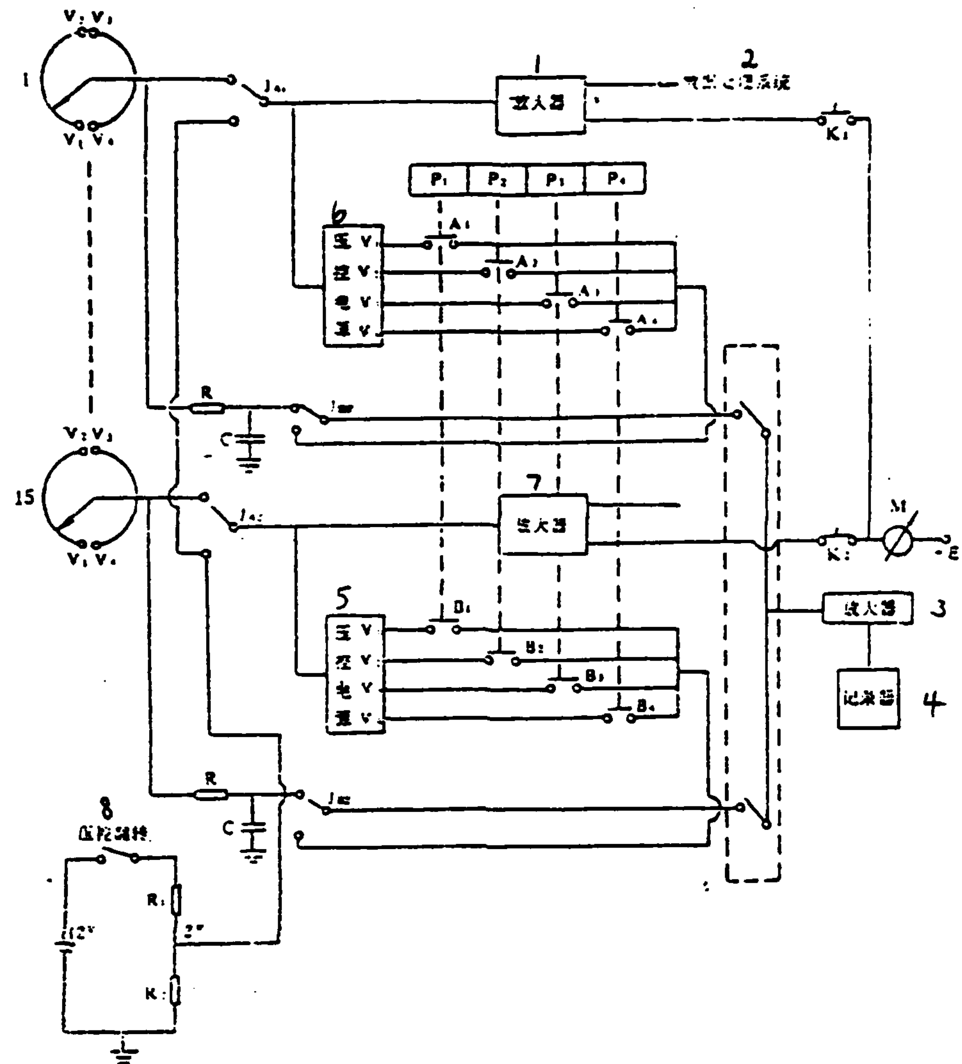

Figure 5. Block Diagram of the Wind Direction Automatic Inspection System

1. amplifier
2. data processing system
3. amplifier
4. recorder
5. voltage controlled power source
6. voltage controlled power system
7. amplifier
8. voltage controlled switch

fifteen channel voltage controlled power source V_2 is sent to the sampling device. Therefore, by depressing P_1-P_4 individually, it is possible to check out V_1-V_4. Because the sampling device is tansmitting 15 identical potentials into the recorder, therefore, if the voltage controlled power source in each channel works normally, then the recording obtained is a straight /77 line. Thus, it is easy to discover where the problem is. At this time, because the input of the voltage controlled power source is at the zero potential, the voltage controlled switches are not functioning. V_1, V_2, V_3, and V_4 are 0, 0.6, 0.6, and 1.2 volts, respectively. If the voltage controlled reversal switch is pushed, then there is a 2 volt voltage on the input end of the amplifier and the voltage controlled power source. Therefore, all the voltage controlled switches are functioning. At this moment, V_1, V_2, V_3, and V_4 are 1.2, 1.8, 1.8, and 2.4 volts, respectively. Therefore, using P_1-P_4, the "wind direction checking" switches and "voltage controlled reversal" switches, it is possible to check out the 120 potentials rapidly.

The 120 potentials, after being checked out carefully, are connected to the fifteen channel wind direction sensors through the inspecting spring relays individually. The output of the wind direction potentiometer is divided into three circuits: one is the input of the voltage controller so that the potential distribution on the potentiometer satisfies the requirement in expanding the range. The insolating electrode in front of the voltage controller is a source follower which has a very high input impedance in order to prevent any effect of the voltage controller on the other two circuits. It ensures the accuracy of the measurements. The resistance-capacitance filter in front of the isolating electrode has an interference-resistance effect in order to avoid the wrong moves of the voltage controller due to pulse interference. In the second circuit it inputs into the electronic computer processing system through an isolating amplifier in the form of instantaneous quantities. The third circuit filters out the high frequency part through an RC filter so that the signals are synchronized in a certain sampling period. They are then sent into an automatic program controlled sampling device. The fifteen channel wind directions, after sampling, enter a common isolating amplifier. Finally, the signal enters the automatic balancing electronic potential difference apparatus to plot the wind direction profile.

3) The temperature difference ventilating machine is in a continuous working state when the temperature difference sensor is sampling continuously. When sampling is carried out at a certain time period, the sampling device can be program controlled. The control can be executed by a silicon switch circuit. Whether the fifteen channel machine works normally or not can be checked out by the electrical device automatic inspection circuit (Figure 6).

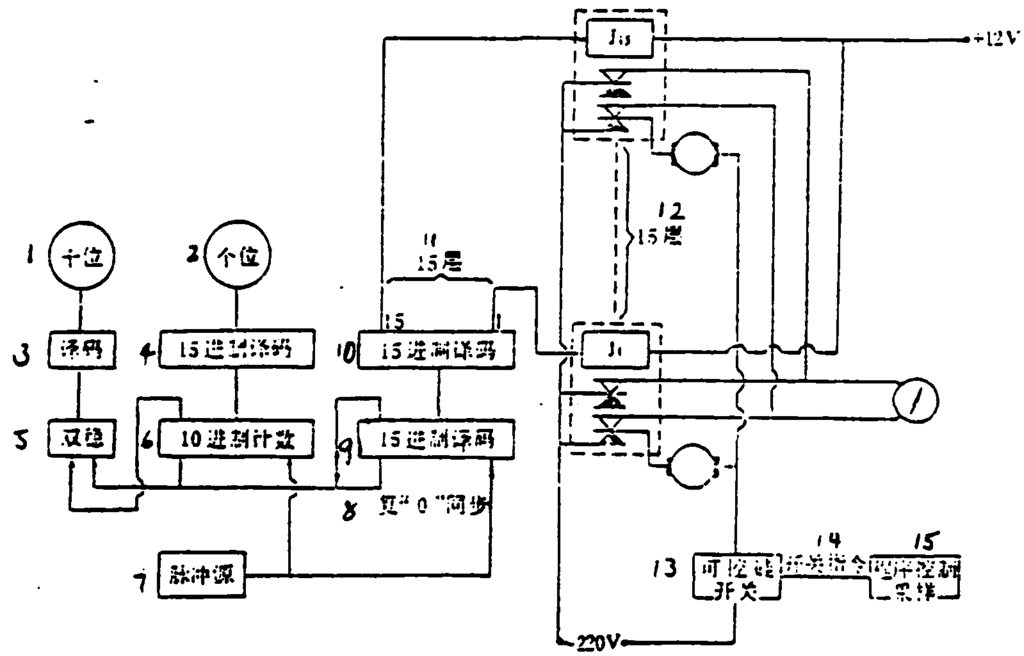

Figure 6. Temperature Difference Ventilating Machine Self-inspecting Block Diagram

1. the second digit
2. the first digit
3. decoding
4. decoding in the pentadeca system
5. dual stability
6. counting in the deca system
7. pulse source
8. dual "0" synchronism
9. decoding in the pentadeca system
10. decoding in the pentadeca system

11. 15 levels
12. 15 levels
13. controllable silicon switch
14. switch command
15. program controlled sampling

V. DATA PROCESSING SYSTEM /78

The 76 channel sensing signals are sent into the following two sets of data processing systems through a multi-strand shielded electrical cable. Its working principle block diagram is shown in Figure 7. Its external structure is shown in Figure 8.

1) The 76 channel instantaneous quantities are placed on the same voltage level through a data amplifier. Then, the automatic sweeping inspection system will input the signals by sequence into the analog to digital conversion system. The scanning rate of the automatic sweeping inspection system is ten thousand times per second, which is able to completely ensure the synhronism of the gradient measurement. After the conversion, digitized quantities are directly sent into a DJS-130 high speed minicomputer to conduct an initial data organization. The internal storage capacity of the machine is 32K. The computation speed is 300 thousand times per second. Its results can be given by a wide line printer and a three-pen automatic plotter. The data can be stored on magnetic disks. The system is controlled in coordination with a clock. It is possible to sample continuously or at fixed time intervals.

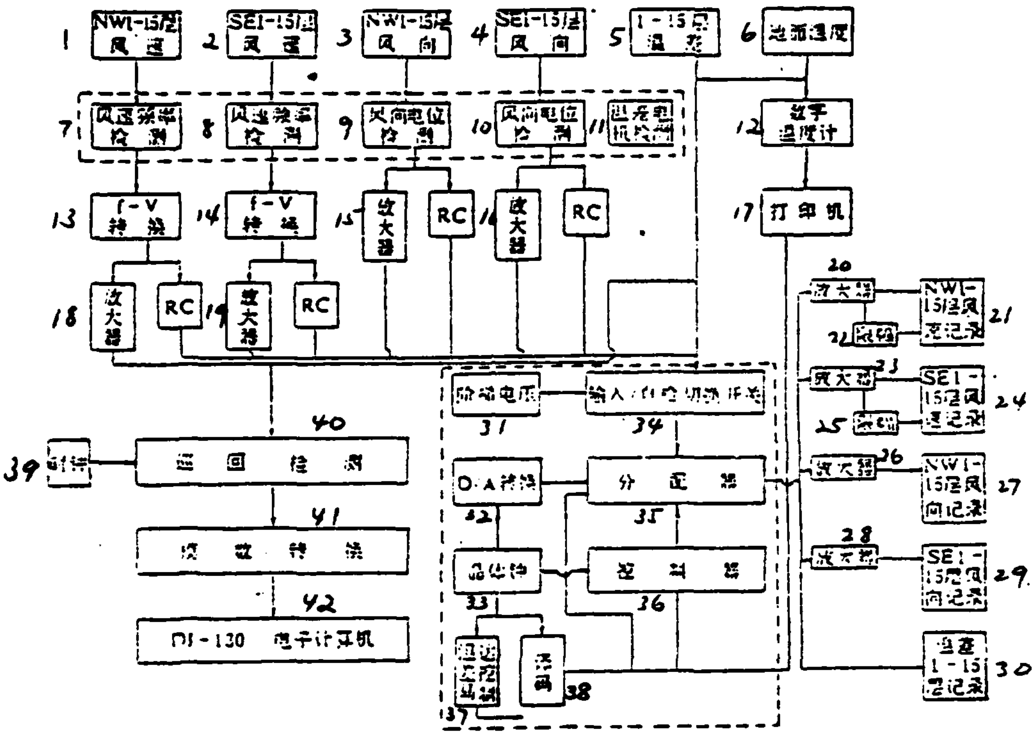

Figure 7. Block Diagram of Working Principle of Automated Data Processing System

1. NWI-15 level wind speed
2. SEI-15 level wind speed
3. NWI-15 level wind speed
4. SEI-15 level wind speed
5. 1-15 level temperature difference
6. ground temperature
7. checking wind speed.frequency
8. checking wind speed frequency
9. checking wind direction potential
10. wind direction potential checking
11. checking temperature difference machine
12. digital thermometer
13. f-V conversion
14. f-V conversion
15. amplifier
16. amplifier
17. printer
18. amplifier
19. amplifier
20. amplifier
21. NWI-15 level wind speed record

22. limited amplitude
23. amplifier
24. SEI-15 level wind speed record
25. limited amplitude
26. amplifier
27. NWI-15 level wind direction record
28. amplifier
29. SEI-15 level wind direction record
30. record of temperature difference between 1-15 levels
31. voltage steps
32. D/A conversion
33. crystal clock
34. input/self-checking switch
35. distributing device
36. controller
37. control of temperature difference motor
38. decoding
39. clock
40. sweeping checking
41. analog to digital conversion
42. DJ-130 electronic computer

2) In addition to using an electronic computer to process the preliminary data and other computations, this device is also equipped with a relatively simple automated data processing system. Its result is more straight forward. First, the 76 channel instantaneous signals are checked out. Then, the wind speed, wind direction, and temperature difference are sent into the automatic balancing electronic potential difference meter through an automatic program controlled sampling device. The ground temperature is sent to the printer. Those plotted on the electronic potential difference meter are profiles of wind speed, wind direction, and temperature difference. The wind speed profiles are recorded by the pens. The range of one pen is 0-50 m/sec and that of the other pen is 0-20 m/sec. The purpose of the latter recording is to increase the resolution at low wind speeds.

In the automatic program controlled sampling device,[13] the controller is given time control signals provided by a crystal clock so that the paper motion and sampling are coordinated. The crystal digital clock also provides time signals to two circuits. One circuit goes to the distributing device which marks the time on the simulated recording on the recorder.

The other circuit provides the printing time

Figure 8. External Outlook of the Data Processing System /79

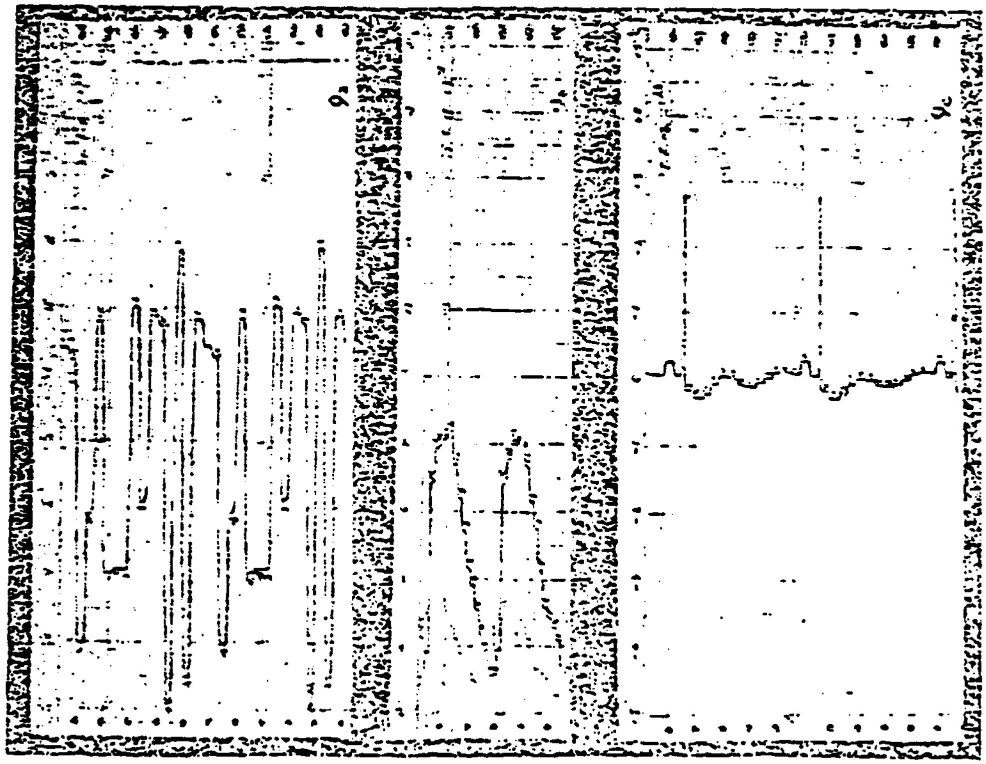

Figure 9. The Observation Record on August 10-11, 1979, a) wind direction profile; b) wind speed profile; c) temperature difference profile. (in the figure, 0,1,2,..... 15 represent the level number)

for the printer. In addition, the crystal clock also provides /80
control signal to turn on and off the temperature difference ventilating motor at a pre-determined time.

The automatic program controlled sampling device can sample automatically either continuously or at a fixed time. In order to satisfy the traveling time of the pen tip of the electronic potential difference apparatus, it requires approximately fifteen seconds to scan the signals obtained from fifteen levels. Before the instantaneous wind speed and wind direction signals are sent into the automatic program controlled sampling device, they pass through a RC smoothing circuit in order to ensure that the signals are synchronized within the sampling period of one profile. The lag coefficient of the sensing elements for temperature difference and ground temperature is apporximately one minute. Therefore, within a scanning period, it is already automatically synchronized. This system, in addition to being capable of sampling automatically and continuously, has an automatic timed sampling feature which requires the beginning of recording at ten minutes before each hour. It sweeps once a minute. In ten minutes, it plots ten profiles. Figure 9 is the real time observation record obtained on August 10-11, 1979. The step curves in the figure represent the wind direction, wind speed, and temperature difference profiles obtained by first order gradient sampling.

In order to guarantee that the automatic program controlled sampling device works normally, this system is equipped with a self-checking device. When the data is input into the processing system, it reaches the distributor through the input/self-checking switch. The distributor is capable of recording the data obtained at the 15 levels on the tower in a stair form on the corresponding automatic balancing electronic potential difference meter. When the input switch is turned to the "self-checking" button, the data in the corresponding circuit is replaced by the standard step voltage in the machine. The regular step pattern is recorded on the recorder. Based on this, one can check whether the distributor works normally or not. The distributor is controlled by the controller, which determines whether it works and the working form.

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REFERENCES

[1] Kaimal, J.C., Sensors and techniques for direct measurement of turbulent fluxes and profiles in the atmospheric, Atmos. Technol., 7, 7-14, 1975.

[2] Клинов. Ф. Я., Об автоматических Метеорологических Измерениях в нежнем 300-Метровом слое Атмосферы. Тр. Всесоюзного Научного Метеорологического обвешания. Том 7, 124—143, 1963.

[3] Kaimal, J.C., D.A. Haugen and J.T. Newman, A computer-controlled mobile micrometeorological observation system, J. Appl. Meteor., (5), 411-420, 1966.

[4] Hall, Freeman F., Jr., The boulder atmospheric observatory, Optics News, 3(2), 14-18, 1977.

[5] Horn, J.D., Structural-induced Interference on wind sensor measurement, symposium on the theory and measurement of atmospheric turbulence and diffusion in the planetary boundary layer, SC-M-68-191, 125-142, 1978.

[6] Hong Zhongxiang et al, Wind Tunnel Test of Wind Measurement Error Caused by Meteorological Towers (to be published).

[7] Zheng Dayuan et al, Physical Characteristics of Gradient Wind Measuring Instrument, (to be published).

[8] Gill, G.C., and P.L. Hexter. Some instrumentation definitions for use by meteorologists and engineers, second symposium on meteorological observations and Instrumentation, 166-171, 1972.

[9] Mazzarella, D.A., An Inventory of specifications for wind measuring instruments, second symposium meteorological observations and instrumentation, 172-177, 1972.

[10] Stevens, D.W., High-resolution measurement of air temperatures and temperature difference. J. Appl. Meteor., 6(1), 179-185, 1967.

[11] Li Xingsheng, Estimation of Error in Temperature Gradient Measurement, (to be published).

[12] Li Xingsheng and Yang Baozhong, A Highly Accurate Temperature Measuring Method, Acta Meteorologica Sinica, Vol. 3,

No. 2, 170-174, 1979.

[13] Zhang Weihua, Automatic Program Controlled Sampling Element in Data Processing Systems, (to be published).

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