The establishment of some such system need not be very difficult or long delayed.

The Signal Service proposes to receive by telegraph, from such observatories as choose to co-operate, their respective time-determinations; to combine them, and then to transmit the resulting standard-time daily to every important place in the country; besides this, at every port they would drop a time-ball, at some exact hour of Greenwich time, so that navigators would be able to rate their chronometers.

At present we have a number of more or less extensive and accurate time-services run by different observatories. But the signals sent out are more or less discordant, not unfrequently to the extent of one or two entire seconds, for the simple reason that no clock can be depended on for any length of time unchecked by star observations; and such observations are sometimes prevented by cloudy weather for several days together. Since it would seldom happen that the observatories in widely different parts of the country would all have bad weather at once, the Signal Service plan would obviate the difficulty. The most serious objection to the proposal seems really to be that the observatories which now distribute time would lose the revenue they derive from the work, unless, indeed, as would be only fair, the Signal service should continue to pay them for their observations the same compensation they now receive.

If the Signal Service can obtain from Congress the small appropriation they ask for ($25,000) to carry out their plan, and if the railroad, steamboat and telegraph companies will adopt the standard time and use it *exclusively* in their business advertisements, the thing is done. The community will follow suit and hardly notice the change.

C. A. YOUNG.

PRINCETON, N. J.

THE NEW YORK ACADEMY OF SCIENCES.

December 19, 1881.

SECTION OF PHYSICS.

Vice-president, Dr. B. N. MARTIN, in the Chair.

Thirty persons present.

A specimen of acicular hornblende in quartz was exhibited by MR. W. L. CHAMBERLAIN.

The following paper was read by Prof. W. P. TROWBRIDGE:

ON THE DETERMINATION OF THE HEATING SURFACE REQUIRED IN STEAM PIPES EMPLOYED TO PRODUCE ANY REQUIRED DISCHARGE OF AIR THROUGH VENTILATING CHIMNEYS.

To ventilate a room properly requires the frequent removal ot vitiated air and the introduction of fresh or pure air, the quantity, by weight, of the air introduced and rejected being equal in a given time.

If the process be continuous, and the proper amount of air be admitted and removed every hour or minute, the only other requirements are that the entering air shall be pure, that it shall be properly warmed in cold weather, either before it enters the room or by the mixture and diffusion of warm and cold air in the room; and that the introduction and removal of air shall take place by gentle or inappreciable currents in such a manner that the pure air may be thoroughly diffused throughout the room before it is removed.

These simple rules are easily stated and comprehended. It is also well understood that to produce a movement of air requires force in proportion to the mass moved and the velocity imparted to it.

The problems which arise in ventilation consist mainly in determining the position, arrangement and sizes of the passages through which the air enters and leaves, and the proper adaptation of these passages to the forces which produce the movement.

On the correct solution of these problems, too often misapplied or misunderstood, successful ventilation depends.

The various modes of producing the movement of air for ventilation are:

First.—Ventilating chimneys or flues in which the movement is caused by the difference in weight between the heated air in the flue and the cooler air outside. This requires that the air before entering the flue shall be warmed, and the heat necessary may be that due to the heat of the room when fires are necessary for warmth; or the heat may be imparted by stoves in the base of the flues, by gas jets, or by steam heated pipes.

Second.—The movement may be produced by fans or blowers or by steam jets—the latter being seldom applied.

The object of this paper is to investigate the laws which govern the ventilation when the air is heated at the base of the flues by steam pipes, the air in its passage to the flue receiving heat by its contact with the exterior surface of the pipes. As far as I am informed these laws have not heretofore been developed, and, as this system is a very simple one, capable of very extended applications, it is hoped that the following analysis may at least lead to a full discussion of the subject:

Let it be supposed that the air in a room is to be renewed at the rate of (W) lbs per second. Suppose also that it is to be rejected through a flue whose cross-section in square feet is (A), and height in feet (H). And that it is to be heated by steam coils whose aggregate exterior surface in square feet is (S)

The following notations will be used:

W. Weight of air removed per second (lbs).

H. Height of flue in feet.

S. Exterior surface of steam pipes (sq. feet).

A. Area of cross-section of flue (or flues).

T_a. Absolute temperature of external air (found by adding to the thermometric temp. Fahr. the number 459.4).

T_c. Absolute temperature of air in the flue.

T_s. Absolute temperature of steam in the pipes.

D_a. Weight in lbs. of a cubic foot of the external air.

D_c. Weight in lbs. of a cubic foot of the flue air.

V^1. The theoretical velocity of the air in the flue.

V. The actual velocity.

r. The rate in units of heat per hour, per square foot of the surface (S) (and for each degree difference between T_s and T_a) at which the air receives heat from the pipes.

k A coefficient of loss of velocity such that $kV=V'$.

p The unbalanced pressure (upward) due to the difference of weight between the column of air in the flue and a corresponding column of external air.

Then,

$$p=H.D_a-H\,D_c \text{ or } p=H\,(D_a-D_c) \qquad (1)$$

This pressure may be represented by the weight of a column of flue air of a height—

$$\frac{p}{D_c} = \frac{H(D_a - D_c)}{D_c} \quad , \quad . \quad (2)$$

and the velocity in the flue will be found from the expression

$$\frac{V'^2}{2g} = \frac{H(D_a - D_c)}{D_c} \quad . \quad . \quad (3)$$

or, $$V' = \sqrt{\frac{2g\,H(D_c - D_a}{D_c}} \quad (4$$

But from the Mariotte-Guy Lussac law we have—

$$\frac{D_c}{D_a} = \frac{T_a}{T_c} \text{ or } D_c = D_a \frac{T_a}{T_c} \quad (6)$$

substituting this value of D_c in formula (4) then results—

$$V' = \sqrt{2g\,H.\left(\frac{T_c - T_a)}{T_a}\right.} \quad (7)$$

In this expression the theoretical velocity of flow is expressed in terms of the height of the flue and the absolute temperatures of the flue air and the external air. From formula (7) we have—

$$T_c - T_a = \frac{V'^2}{2g\,H} \times T_a \quad . \quad (8)$$

The quantity of heat transferred to the air may be represented by

$$\phi = W.\,c.\,(T_c - T_a) \quad . \quad (9)$$

in which ϕ represents the quantity of heat in units of heat per second, and c the specific heat of air at constant pressure ($c = 0.238$.)

All of the above formulas are well known. The following are believed to be new:

The quantity of heat imparted to the air may also be represented by $\phi' = \frac{S.\,r.\,(T_s - T_a)}{3600}$ in which is the quantity of heat imparted per second, and as from the nature of the problem $\varphi = \phi'$ we have

$$\frac{S.\,r.\,(T_s - T_a)}{3600} = W.\,c.\,(T_c - T_a) \quad (10)$$

or $$T_c - T_a = \frac{S.\,r.\,(T_s - T_a)}{W.\,c.\,3600} \quad . \quad . \quad (11)$$

combining this equation with (8) we have—

$$S'.\,r.\,\frac{(T_s - V_a)}{3600} = \frac{V'2}{2g\,H.} \times T_a \quad . \quad (12)$$

and $$S' = \frac{V'^2.\,W.\,c.\,T_a}{\frac{2g\,H.\,r.\,(T_s - T_a)}{3600}} \quad . \quad . \quad . \quad (13)$$

This expression gives the total heating surface in the pipes in terms of the velocity, the height of the flue, the weight of air discharged per second, and the absolute temperature of the external air.

If we substitute for V' its value in terms of V, the actual velocity, we have—

$$S' = \frac{K^2\,V^2\,W.\,c.\,T_a}{\frac{2g\,H.\,r.\,(T_s - T_a)}{3600}} \quad . \quad . \quad (14)$$

and since

$$W. = D_c\,V.\,A.$$

$$S' = \frac{K^2\,V^3\,D_c\,c.\,A.\,T_a}{\frac{2g\,H.\,r.\,(T_s - T'_a)}{3600}} \quad . \quad . \quad (15)$$

another expression for S'.

These two expressions exhibit the laws of the movement of the air, giving the quantity of heating surface required under any special conditions of area and height of flue, temperature of external air, and velocity of discharge.

The constant (r) may be found approximately from the experiments of Mr. C. B. Richards, made at Colts Arms Co., of Hartford. The constant K depends upon the frictional resistance which the air encounters in its passage into and through the flues. The velocity V may be assumed, and should not be greater than four or five feet per second. The smaller the velocity and the larger the flues, the less will be the required heating surface, and the greater the economy of the apparatus for ventilation.

The following paper was read by Prof. H. L. FAIRCHILD:

ON A PECULIAR COAL-LIKE TRANSFORMATION OF PEAT, RECENTLY DISCOVERED AT SCRANTON, PENN.

The material which we shall notice this evening has naturally been regarded, on account of its associations, as illustrating in some degree the formation of coal. A brief description of that alteration of peat which has resulted in the formation of coal, is therefore desirable.

Peat results from decomposition of vegetable matter under water. The latter excludes the atmosphere and largely prevents the oxidation, which removes the vegetable debris on the upland, and which if rapid we call combustion, or if slow, decay. In northern regions peat-swamp vegetation is commonly a sort of moss (Sphagnum) which grows upward as it dies below. Great peat deposits are also produced in lower latitudes from the debris of forest trees. The great Dismal Swamp is a fine example, and in the Hackensack and Newark meadows we have examples of peat-formations of great depth, produced by the slow subsidence of the region and the accumulation of salt-marsh vegetation.

In former geological ages, immense peat deposits were produced in the vast lowlands along the borders of the continents, or at the deltas of the ancient rivers. These great swamps were frequently submerged in the sea and deeply buried beneath mud and sand. This event occurred perhaps many times in a single locality. The buried peat slowly decomposed. Much of the hydrogen and oxygen of the vegetable tissue, and some of the carbon, were eliminated. The remainder was consolidated by the weight of the superincumbent strata, and the result is bituminous coal. Thus we have the six to twenty coal beds of Pennsylvania, or the one hundred coal-seams of Nova Scotia.

The evidence that our coals are primarily formed in this manner is abundant, clear and incontrovertible. Few subjects are by our inductive science more definitely settled than this. We find these buried vegetable deposits in every stage of decomposition and alteration. Where the containing rocks are undisturbed, lying in their original positions, the coal contains a large proportion of volatile matter, and is bituminous. But where the rocks are dislocated and folded the coal is, by the pressure and heat, changed to anthracite or perhaps to graphite. The proportion of fixed carbon, or the degree of alteration, is always proportionate to the amount of disturbance which the associated rocks have suffered. Hence anthracite coal is a metamorphosed coal, just as marble is metamorphosed limestone, or quartzyte is metamorphosed sandstone. The metamorphism of coal is still going on. The escape of the volatile matter, in which the change consists, is observed in the mines, in the production of the explosive "fire-damp," and the poisonous "choke-damp."

Running from cellulose through wood, peat, and coals up to graphite we have a complete series; the difference being the loss of hydrogen, oxygen and in a less degree of carbon. This table, after LeConte, exhibits the proportions of the elements *by weight*, the carbon being reduced to a fixed quantity:

	Carbon.	Hydrogen.	Oxygen.
Cellulose	100	16.66	133.33
Wood	100	12.18	83.07
Peat	100	9.83	55.67
Lignite	100	8.37	42.42
Bituminous Coal	100	6.12	21.23
Anthracite Coal	100	2.84	1.74
Graphite	100	0.00	0.00