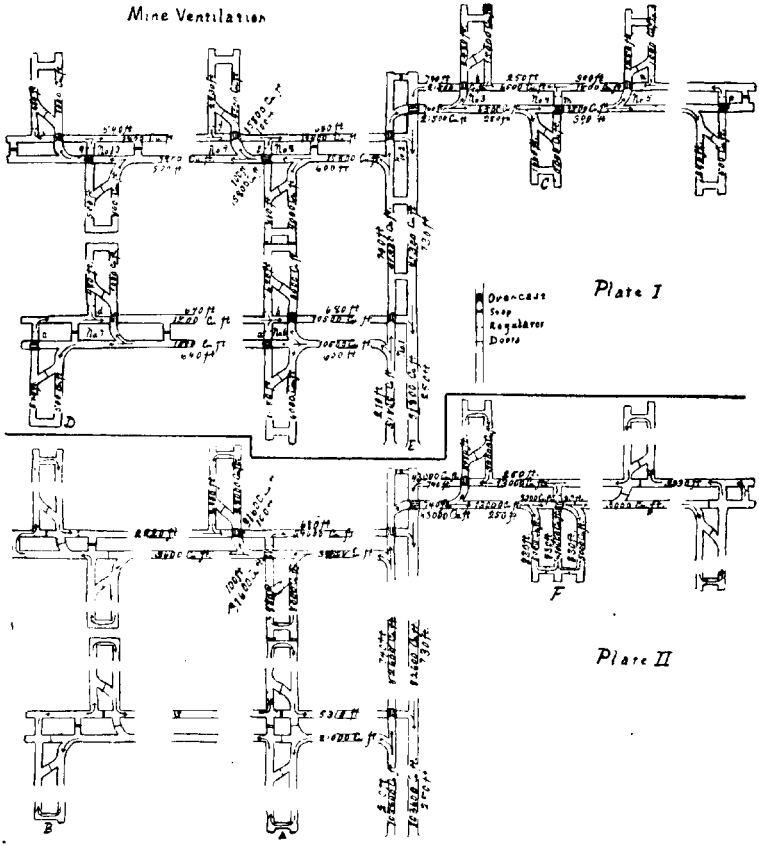
SPLIT AIR COURSES vs. CONTINUOUS CURRENTS.

BY F. W. SPERR.

If the comparison between the continuous current and the split current be made on eqnal volumes of air passing through the mine by each method, the best ventilation will be by the continuous current; but if the same power be expended in each case, a much larger volume can circulate by the split current. A large mine, requiring a large volume of air, can be better ventilated by splitting the current. Take for example a mine which passes 51,800 cubic feet of air to split No. 1 through an air way 5½x10 feet x210 feet long. Split No. 1 takes off 10,500 cubic feet. 41,300 cubic feet continue 740 feet to split No. 2, which takes off 19,800 cubic feet. 21,500 cubic feet continue 740 feet to split No. 3, which takes off 6,500 cubic feet. 15,000 cubic feet travels 2,480 feet, at the end of which it picks up split No. 3 on the return. 21,500 cubic feet then travel 740 feet, at the end of which split No. 2 is taken up. 41,300 cubic feet then passes through an air way 5½x15x730 feet long to where split No. 1 returns, making 51,800 cubic feet to the exit through an air way 5½x15x250 feet long.

The pressure necessary to accomplish this ventilation, according to the co-efficient of friction allowed by Atkinson, is 203.44 feet of air column.

To force 51,800 cubic feet of air through the mine in a continuous current would require a pressure of 3,206 feet of air column, or about sixteen times as much as by the split current. The pressure which would pass 51,800 cubic feet by the continuous current, would pass about four times that volume by the split current; or, if two-thirds of the power be applied to the split current it will give twice the volume of air. This, however, is dependent somewhat on the kind of fan employed. If we neglect the passive resistances and assume that the "orifice of passage" of the fan is equal to eight times the equivalent "orifice" of the mine by continuous current, power $= V H_1$. ⅔ power $= 2 V H_2$. $H_1 = h + h_0 = \frac{65}{64} h$. $H_2 = \frac{1}{4} h + 4 h_0 = \frac{20}{64} h$. $H_1 = \frac{65}{20} H_2$. $\frac{2 V \times 20 H_1}{65} = \frac{2}{3} V H_1$ nearly.


Mine Ventilation
Plate I
Plate II
Overcast
Stop
Regulator
Door
A
B
C
D
E
F

The depressions of air column necessary at different points of the mine have been calculated from the formula $h=\frac{ksv^2}{a}$ where h is the column of air producing ventilation, $k=0.26881$ the co-efficient of friction, s the rubbing surface, v the velocity of air in thousands of feet per minute, and a the area of the cross section of the air way in square feet. If the volume in thousands of cubic feet per minute be represented by V, $v=\frac{V}{a}$ and $h=\frac{k\,s\,V^2}{a^3}$. The air column necessary to take 51,800 cubic feet from the entrance of the split to No. 1 is $0.26881 \times 210 \times 31 \times 51{,}800 \times 51{,}800 \div 55^3 = 28.3$ feet. In the same manner we find the air column necessary to take 41,300 cubic feet to split No. 2, to be 63.3 feet; to take 21,500 cubic feet to split No. 3 reqnires 17.2; to take 15,000 cubic feet to No. 3 return requires 28.5 feet; to take 21,500 cubic feet to No. 2 return requires 17.2; to take 41,300 cubic feet to No. 1 return requires 31.8 feet; and to take 51,800 cubic feet to the exit at E requires 17.14 feet of air columns. Altogether then, to make this circuit, it requires $28.3+63.3+17.2+28.5+17.2+31.8+17.14=203.44$ feet of air column. The air colnmn required by this circuit is greater than by any other, therefore regulators will be necessary in each of the other splits. To determine the required opening in the regulator at A, we find that the air column necessary at No. 1 return, by the calculation just made, is 186.3 feet; and the column necessary at the same point by way of No. 6 split to the left, is 37.4 feet. A regulator may then be placed at A with the opening so adjusted that there shall be a difference of pressure of 148.9 feet between the two sides of the regulator. The opening required to pass 6,000 cubic feet per minute with 148.9 feet of pressure is $a=\frac{V}{0.65\sqrt{2\,g\,h}+v}=\frac{100}{0.65\sqrt{64.4\times 148.9}+\frac{100}{56}}=$ 1.53 square feet.

a is the opening in regulator in square feet.

V is the volume of air in cubic feet per second.

g is gravity 32.2.

h is height of air column.

v is the velocity of air in approaching the regulator in feet per second.

On Plate No. II, the portions of the mine requiring small volumes, are shown as ventilated by continuous currents and with no greater power used than if split up as shown on Plate No. 1. However, additional sets of doors in the haulage ways are required. By driving three butt entries as at F, no doors whatever are required in the haulage ways. There may be a question as to whether the overcasts and regulators should be put in as

soon as the place is made for them in advancing the mine; or whether the continuous current system should be used until large volumes are required in the section to be isolated by an overcast. On the one hand there is the cost of erecting and keeping extra doors, and, on the other, the use of the cost of the overcast for a certain lenght of time, together with the cost of handling a little additional volume of air for a certain distance.

THE CHAIR: Gentlemen, is there any discussion on the paper of Mr. Sperr or any question to ask him?

SECRETARY HASELTINE: Mr. President, Prof. Sperr has gone into this matter scientifically. I could not at this distance follow him closely enough, so that I did not quite understand his explanation in full, and I may be entirely wrong in what I gathered from it, but as I understand now his figures demonstrate that it will take sixteen times the motor column to ventilate it by continuous current than to make ten splits of air. I agree with him exactly on his last proposition that on the last "butt entry" the maximum impurity will appear in the air, and at that point of course, an accident might occur from striking the blower, or an unusual rush of gas at that place might overcome such a current of air as to render it explosive at any point of the mine.

Now the difficulty we have experienced—we have split air in a great many places but I don't think there is a mine in Ohio in which we have ten splits—is that we have thousands of splits caused by leakages.

PROF. SPERR: But those splits you don't get any benefit of. They do not often make the air go where you want it to go.

SECRETARY HASELTINE: As electricians say "short circuit."

PROF. SPERR: Yes sir, that is it.

SECRETARY HASELTINE: There is not so much trouble in the want of knowledge of people as to how to split the air, as to have them attend to it and do it. It is what you get a man to do and not how. There are a majority of them that don't begin to do as well as they know how, and the trouble is that they neglect their ventilators or regulators and in some places where they are intended to have a certain amount of air they don't have it by

reason of some breaking of a door or some fall occuring. A coal mine is just like the human system. It will be all right to-day and all wrong to-morrow, and for the same reason that the human system becomes deranged. Sometimes you know why it is, and sometimes you could have avoided it if you hadn't been too careless, and sometimes it occurs from the reason that they don't know enough about it, and then if a current of gas comes or if the mine generates large bodies of black damp, we get an atmosphere that is either dangerous or unwholesome. Some way or another the impression has got out by some people that we never split air in Ohio. Now that is not true, and I don't advocate it.

PROF. SPERR: The continuous current has the same deficiencies that the split air current has, by reason of breaks in doors and by reason of the greater number of doors required with a continuous current, the chances of accident are increased and if triple entries are driven on the butts, no doors whatever are required in the haulage ways, as shown at F, Plate II.

SECRETARY HASELTINE: But they don't suffer so much as the others?

PROF. SPERR: That depends upon where the break occurs. If the stop at No. 7 should be broken down, more damage would be done in the case of the split current than in the case of the continuous current. But if the door between the right and left hand entries at No. 6 should be broken down, in the case of the continuous current more damage would be done than could be done by the breakage of any door or regulator in the split system.

SECRETARY HASELTINE: Not only in a small portion of the mine.

PROF. SPERR: You would lose it entirely in the portion of the mine where your regulator was broken down.

SECRETARY HASELTINE: But in our small mines, mines that are run for instance for only the summer trade, and that stand idle the greater portion of the season, I would be pretty slow to adopt very much split air with them.

PROF. SPERR: You don't need it in a small mine.

SECRETARY HASELTINE: They would keep the current continuous.

PROF. SPERR: It is only for large mines that the split air is advocated.

SECRETARY HASELTINE: And gaseous mines. It don't matter whether it be split air or continuous current. If you can keep a safe current upon the working faces, sweeping through them, it makes no difference whether the air is split or continuous, and when your continuous air current becomes so long that the power is inadequate to produce it, then you can increase it by splitting the current in a considerable number of places as your judgment will dictate. There are no two mines in the State of Ohio that are alike. There are no two of them that could be regulated with the same number of doors or the same shape of regulators on account of these different conditions, and therefore you cannot lay down a rule that you can send out to the 700 or 800 bank-bosses that each one of them can follow. You have to establish some general system, and then you have to improve it under the conditions.

PROF. SPERR: Mr. President, the indication of a general system is what is intended by the plan under discussion. When the question arises as to whether the air should be split at any given point we can calculate with sufficient accuracy what the advantages and disadvantages will be. But, Mr. President, it seems that Mr. Haseltine has lost sight of what I tried to demonstrate in behalf of the continuous current, namely, that it is necessary to put more air through the mine if you split the current than if you don't split it. Now that fact to my mind, is the most important point made in favor of the continuous current. If the law requires that a mine pass 30,000 cubic feet of air per minute, the mine will be better ventilated if the 30,000 cubic feet circulate in a continuous current than if it is split into two or more currents.

SECRETARY HASELTINE: I don't mean to say that.

PROF. SPERR: If you split the current you increase the chances of explosion by just the number of splits made, unless the volume of air is increased at the same time.

THE CHAIR: Now, if I understand your proposition, you say by splitting the air you do get more.

PROF. SPERR: With the same expenditure of power more air can be handled by splitting the current. But it may happen that a fan is worked to its utmost capacity to produce, say 60,000 cubic feet of air per minute by a continuous current; and the current is split to relieve the fan. Then, if just 60,000 cucic feet per minnte is put through the mine, as the law in the case may require, the chances of an explosion, it seems to me, are increased by just the number of splits made.

THE CHAIR: But to drive 60,000 cubic feet continuously, if the same power goes on all the time, you will increase the volume.

PROF. SPERR: If the fan is kept working with the same maximum capacity as before, more than twice the volume will be obtained in the case of the problem before us. Of course, under different conditions we shall obtain different results. Now I wish to make clear this point in favor of the split air system; vis.: that more air can be furnished, and that the mines can be made purer and better to work in at less cost than by continuous current. For instance, if we require 60,000 feet to make the mine of certain degree of purity in the last workings, 120,000 feet will make every part of the mine twice as pure as that requirement. Of course explosions may occur under any conditions.

MR. HARRY: Now you want to split this up into ten sections. You have 50,000 feet of air and you propose to split it in ten sections. That gives you 5,000 feet for each section.

PROF. SPERR: Some more and some less.

MR. HARRY: Well, now we will take 5,000 feet in each one of the sections. How long will it take that 5,000 feet to travel through that air course the length of one of those entries.

PROF. SPERR: But that takes 10,000 or more cubic feet.

MR. HARRY: Well, you propose here at the point marked C to take 5,000 cubic feet. If I understand you expect to put a regulator here at M and take 5,000 feet from this section of the mine.

PROF. SPERR: If that is enough it is all I would take.

MR. HARRY: How long would it take that air to travel through there and bring smoke out of that section, to clear that section of smoke.

PROF. SPERR: It would take about nine minutes.

MR. HARRY: Now, while I don't object to splitting air to a certain extent, yet I feel that you can make too many splits in air. Now with the continuous current running around, we have ten times the amount of air that you have by the split current. Now I claim that the air traveling so much faster than by the split current, that it does better work than if split.

PROF. SPERR: You want greater velocity.

MR. HARRY: Yes sir, I think ten splits is too much for that mine.

PROP. SPERR: I could make six splits without changing the results as to power required.

THE CHAIR: Your plan is on the theory that it is necessary to have 60,000 feet for the whole mine, and you split your air according to the number of workings in the split. That is, it might be necessary to have 10,000 feet in one and 4,000 in the other.

PROF. SPERR: And in some split, where perhaps no work is going on, 500 cubic feet may be enough. Where more air is required, it can be obtained by opening the proper regulator and slightly increasing the work on the fan.

CAPT. MORRIS: The idea after all would be to get fresh air to the working faces.

PROF. SPERR: If under a change of conditions 5,000 cubic feet should be required at D, where only 500 cubic feet is now circulating, the additional volume would be felt upon the fan for a distance of only 460 feet, the distance of the first split and return; but with a continuous current such an additional volume would be felt for a distance of 23,780 feet. And to take up Mr. Harry's question again, 5,000 cubic feet would take powder smoke out of

the workings from D in about three and a half minutes. It would take a continuous current twenty minutes to clear the workings of the smoke from D. The velocity, especially through the dangerous portions, should not exceed 300 feet per minute, which would give 16,500 cubic feet as the maximum to be allowed in any one split. Therefore doubling the volume as indicated in Plate II, without changing any of the regulators, might give more than a safe volume in two of the splits, (Nos. 2 and 9).

MR. BLOWER: The total volume traveling through there would be 200,000 cubic feet per minute, that is with the fan running with the same pressure as produced 50,000 feet without splits; and that would make sufficient in every split under any circumstances, and also the velocity would be large enough to carry away the smoke.

THE CHAIR: Well gentlemen, is there anything else? This is a very interesting subject of Prof. Sperr's. I believe personally what he is guiding at thoroughly, and I believe he is correct, no doubt but what he is.

MR. BLOWER: I might say that the mine I had charge of last year had 27,000 cubic feet of air passing per minute, which was not enough for the number of men, and I arranged for an overcast at the furuace. I didn't stay there sufficiently long to see it work, but I got a mine report this year, and I see the mine is credited from that alone with about 8,000 cubic feet more per minute.

SECRETARY HASELTINE: Mr. President, I move you we extend a vote of thanks to Prof. Sperr for this very instructive paper.

A MEMBER: I second the motion.

The question coming on, Secretary Haseltine's motion prevailed.

THE CHAIR: The next thing on the program is a paper by Secretary Haseltine on the subject "The Wasteful Methods Being Practiced in Mining Coal in Ohio." That is to say that in all the other States of the Union they don't waste any, so Ohio is behind the balance of the States.

SECRETARY HASELTINE: Before I attempt to read this paper and before we forget it, let me call your attention to the petitions for membership which we have here. (The Sectetary then read the following list of names).

H. M. Lyman, *Electric Engineer*.....Canton, O.
William James, *Superintendent Mines*.....Pigeon Run, O.
J. Edward English, *Mine Boss*.....Pigeon Run, O.
John Cassingham, *Coal Operator*.....Coshocton, O.
W. H. Turner, *District Mine Inspector*.....Cambridge, O.
S. F. Croyle, *Mine Boss*.....Dillonvale, O.
William B. Rennie, Jr., *Engineer*.....Columbus, O.
Chalkley Dawson, *Mining Engineer*.....Bellaire, O.
Adam P. McDonald, *District Mine Inspector*.....Corning, O.

I move, in order to save time, that the Secretary be instructed to cast the vote of the Institute for their election. (The motion being seconded, prevailed).

SECRETARY HASELTINE: I have been impressed by some allusions as to what this paper should contain. I want to say in explanation of it that I was unable to get the statistics which I expected to put in it from all portions of the State, but I will fill in the details afterwards.