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Bleeder System in Virgin Area in a Pittsburgh Coalbed Mine

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BLEEDER SYSTEM IN VIRGIN AREA IN A PITTSBURGH COALBED MINE

by

Stephen Krickovic,[1] T. D. Moore, Jr.,[2] and J. E. Carpetta[3]

ABSTRACT

Air quantity-pressure and methane concentration surveys were conducted by the Bureau of Mines in accessible portions of an area being pillared in a Pittsburgh coalbed mine in West Virginia. These included two mined-out and three active butt headings and a bleeder system. The particular mine workings were started in virgin coal directly from a set of main headings; the main reason for the study was the difficulty usually encountered in adequately bleeding the gobs under such conditions. Although the two separate return airways in each active butt heading and the North and 1 Left bleeders contained acceptable methane concentrations (0.01 to 0.78 percent in the butts and 0.73 to 1.0 percent in the bleeders) with significant total methane removal (109 cfm in butts and 631 cfm in bleeders), there were relatively large areas in the gobs with possible minimal airflows. This condition appears to have developed from lack of systematic regulation of the airflow across the gobs and appears to indicate the existence of considerably more methane in the probably low flow areas in the gob.

INTRODUCTION

While methane exists under pressure in the micropores, joints, and fracture systems of gassy coalbeds, it is also found in the superjacent and subjacent strata. Methane occurs in shales and sandy shales, "rooster" coal, porous sandstones, and in rock bedding planes; methane frequently is liberated in large quantities during caving in conjunction with extracting pillars. Although the in situ gas pressure is important in liberating methane from superjacent strata, the magnitude of this pressure is not known as it is in coalbeds. Surface degasification boreholes drilled ahead of an approaching pillar line or longwall face seldom produce significant quantities of methane until caving occurs at and near the borehole. In some, and perhaps, most cases, the methane liberated during caving of superjacent strata presents a more difficult control problem than does the methane in the coalbed.

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[1] Supervisory mining engineer.
[2] Mining engineer.
[3] Mining engineering technician.

In Section 75.316-2 (g), (h), and (i) of the Mandatory Safety Standards, the 1969 Federal Coal Mine Health and Safety Act[4] states that

> (g) The ventilation pressure differential between the active pillar line and the junction of any bleeder connection to the bleeder entries of such system should at all times be adequate to assure gob gas drainage to the bleeder entries. The pressure differential shall be considered adequate when perceptible airflow exists in all open or regulated bleeder connections, as determined with chemical smoke or other approved means.
>
> (h) The methane content of the air current in the bleeder split at the point where such split enters any other air split should not exceed 2.0 volume percentum.
>
> (i) When the return air courses from all or part of the bleeder entries of a gob area and air other than that used to ventilate the gob area is passing through the return air courses, the bleeder connectors between the return air courses and the gob shall be considered as bleeder entries and the concentration of methane should not exceed 2.0 volume percentum at the intersection of the bleeder connectors and the return air courses.

The aforementioned safety standards can be interpreted to mean that a safely accessible and effective bleeder system is a basic requirement, and that other techniques used for the removal of methane from gob areas are supplementary. This is true even if mined-out butt headings or panels are to be sealed.

The objective of this Bureau of Mines investigation was to determine the effectiveness of a bleeder system in conjunction with mining butt headings in a virgin area of a coal mine.

DESCRIPTION OF STUDY AREA

No bleeder system utilized in the pillaring of butt headings developed in virgin coal off a set of main headings can be considered typical because various mining plans are used. The particular study area considered here consisted of two retreating and one mined-out butt headings on one side of a set of bleeders (North bleeders) and one mined-out and one retreating butt heading on the opposite side of the same bleeders with a set of three bleeder headings at the back end (fig. 1). Mining was in a virgin area approximately 3,500 feet wide and 2,600 feet long; the mouth of North bleeders was 2,900 feet from the main intake shaft and 3,600 feet from the main return shaft. Total static ventilating pressure developed by the fan was approximately 5.5 inches water gage.

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[4]U.S. Code of Federal Regulations. Title 30--Mineral Resources; Chapter I--Bureau of Mines, Department of the Interior; Subchapter O--Coal Mine Health and Safety; Part 75--Mandatory Safety Standards, Underground Coal Mines. Federal Register, v. 35, No. 226, Nov. 20, 1970, p. 17905.

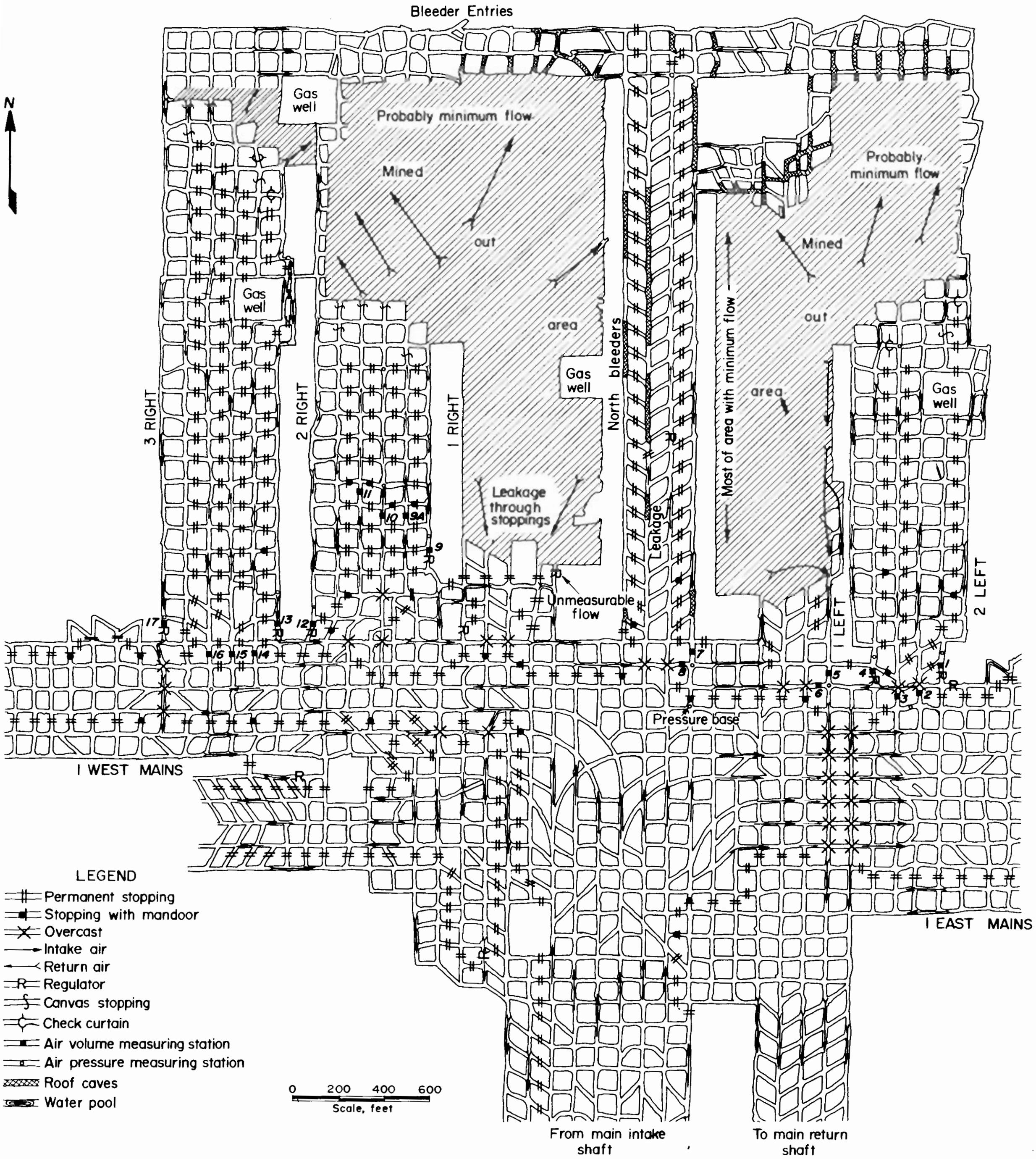

FIGURE 1. - Study area with air, methane, and pressure measuring stations.

MINING METHOD AND EQUIPMENT

The two mined-out butt headings (1 Right and 1 Left) were developed in sets of four headings on 100-foot centers with the breakthroughs driven on approximately 60° angles and on 100-foot centers (similar to the North bleeders). Rooms were turned toward the North bleeders at 90° angles from the outside headings of 1 Right and 1 Left at the end of each 60° breakthrough. Borer-type continuous miners were used to mine a 13-foot width in these butt headings, with the recovery ranging from 72 to 75 percent. Ripper-type continuous miners were used to mine a 15-foot width in the active headings (2 Right, 3 Right, and 2 Left) with average recovery of 85 percent. Height of coal mined was 7 feet. Continuous miners discharged the coal on the mine floor from where conventional loaders transferred it into 10-ton-capacity shuttle cars for loading into belt feeders that, in turn, discharged the coal uniformly onto tail end of belt conveyors. Two shuttle cars serviced each miner.

AIR QUANTITY-PRESSURE AND METHANE CONCENTRATION SURVEYS

Using a station in the main intake airway opposite the North bleeders as the base, air pressure measurements were taken with portable aneroid barometers at the locations shown in figure 1 in 1 West mains and 1 East mains; at the entrance and near the working faces in 3 Right, 2 Right, and 2 Left; and in return airways of the active butts near the mains. A second barometer located at the base was read at 3-minute intervals to obtain the atmospheric changes during the survey. With the main mine ventilation system exhausting, all measured pressure values are negative with respect to atmospheric pressure.

It was deemed inadvisable to travel to the back end of the North bleeders owing to roof falls and pools of water. Therefore, the negative pressure at the back end was calculated by the senior author on the basis of unit resistance developed in many ventilation surveys of 10,000 cfm of air flowing in a 1,000-foot-long single airway having an effective cross-sectional area of 66 square feet. Adjustment was made for the larger cross-sectional area in the North bleeders heading. Using the measured pressure differential from the intake to the return airways at the mouth of the North bleeders (1.02 inches water gage) and subtracting the calculated loss to the back end, the authors obtained the available negative air pressure at that point.

All active sections were ventilated with two splits of air. Air volumes and methane concentrations were obtained by careful measurement of areas at selected locations (fig. 2) and by uniformly traversing each cross-sectional area with a hand-held amemometer. Hand-held methanometers were used at all air velocity measurement stations except for the North bleeders. Since this proved to be a significant location owing to the relatively large volume of air and methane concentration, a recording methanometer was installed at station 7 (fig. 1) to operate continuously during the 2-day study. Periodic readings were taken at all other stations except for the bleeder volume in 1 Left (obtained by difference in table 1). Bottle samples were also taken to check the accuracy of the hand-held instruments.

TABLE 1. - Details of air and methane volumes and methane concentration distributions in the study area

Air measuring stations[1]	Air split volume, cfm		Methane				Airflow to bleeders, cfm	Remarks
			Intake		Return			
	Intake	Return	Pct	Cfm	Pct	Cfm		
3 Right:								
13.....	-	18,600	-	-	0.14	26		
14.....	18,800	-	0.00	0	-	-		
15.....	33,800	-	.05	2	-	-		Flow to bleeder entries.
16.....	22,300	-	.00	0	-	-		
17.....	-	6,800	-	-	.78	53		
Total..	44,900	25,400	-	2	-	79	19,500	-
2 Right:								
9......	-	7,100	-	-	.10	7		
9a.....	3,000	-	.00	0	-	-		
10......	4,900	-	.00	0	-	-		Flow to bleeder entries.
11......	18,900	-	.00	0	-	-		
12......	-	13,500	-	-	.01	1		
Total..	26,800	20,600	-	0	-	8	[2]3,200	-
1 Right...	-	-	-	-	-	-	[2]3,000	Flow to 1 West mains return 1.87 pct and 56 cfm CH_4.
2 Left:								
1.......	-	12,000	-	-	.15	18		
2.......	40,900	-	.00	-	-	-		Flow to North bleeders
3.......	20,700	-	.00	-	-	-		and 1 Left bleeder.
4.......	-	9,700	-	-	.07	6		
Total..	61,600	21,700	-	-	-	24	39,900	-
1 East mains at 1 Left:								Flow in 1 Left bleeder to 1 East mains return 0.73 pct and 124 cfm CH_4.
1 Left..	-	-	-	-	-	-	[3]17,000	
5.......	-	50,900	-	-	-	361		Main return.
6.......	-	80,000	-	-	.38	304		Main return.
Total..	-	130,900	-	-	-	665	-	-
1 East mains at North bleeders:								Flow in North bleeders 1.0 pct 451 cfm CH_4.
7.......	-	-	-	-	-	-	[4]45,100	
8.......	-	68,800	-	-	.13	90		Main return.
Total..	-	68,800	-	-	-	90	-	Main return.

[1]See figure 1.
[2]Estimated flow into 1 West mains return from 1 Right and into bleeder entries.
[3]Bleeder volume in 1 Left = 130,900 - (68,800 + 45,100) = 17,000 cfm.
Methane in 1 Left bleeder = 665 - (451 + 90) = 124 cfm.
[4]Airflow and methane concentration measured at station 7 in North bleeders.

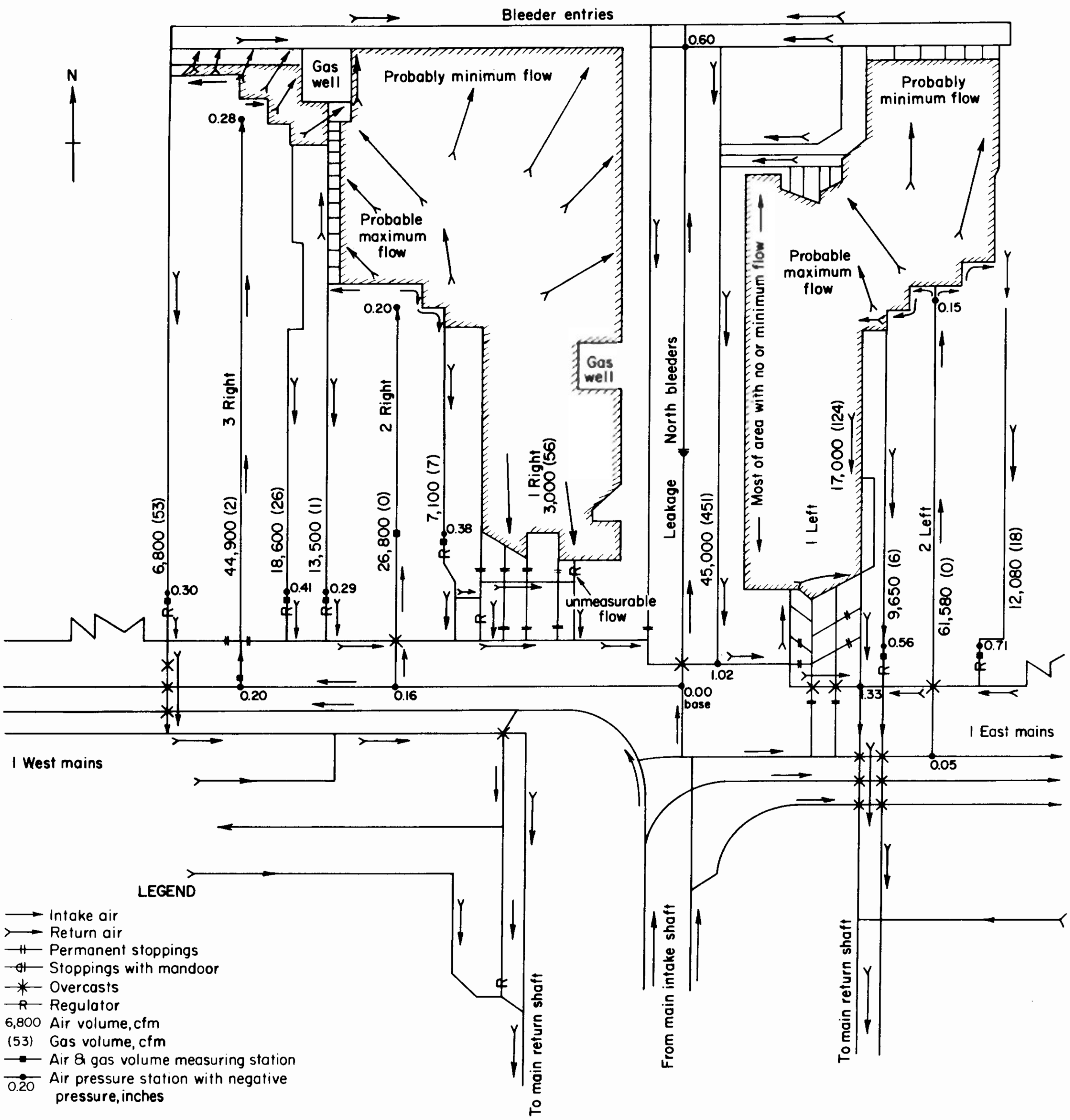

FIGURE 2. - Air and methane volume and air pressure distributions in study area.

The survey was started on March 7, 1972, at a time when the mine was idle due to a strike that had started on March 2. A repeat survey was run on March 8 with one crew mining in 3 Right on the 8 a.m. to 4 p.m. shift. Despite the conditions under which the two surveys were run, the data is valid for evaluation of the bleeder system.

RESULTS

Table 1 shows in detail the measured air volumes with methane concentrations and volumes, and the methane volume and concentration in 1 Left obtained by difference in main returns.

Table 2 shows summaries of air and methane volumes in operating sections and in bleeders as well as the pressure differentials across gobs. Data in table 2 show that only 25,400 cfm (6,800 plus 18,600) of air and methane returned in 3 Right from a total intake of 44,900 cfm. The remainder (19,500 cfm) flowed by a very permeable course with a total pressure differential of about 0.3 inch water gage to the North bleeders. Approximately half the difference of 6,200 cfm (26,800 minus 20,600) between the intakes and returns in 2 Right found a permeable path near 3 Right to reach the North bleeders by a shortcut with estimated 3,000 cfm flowing across 1 Right gob to the main returns. Thus the total volume of 22,700 cfm (19,500 plus 3,200) reached the North bleeders for the most part by shortcuts. This left a large gob area in the back end of 1 Right and 2 Right with little or no airflow.

TABLE 2. - Summary of air and methane volumes in active sections and in bleeders, and pressure differentials in butt headings

Location	Total air volumes, cfm		Methane volumes in return airways, cfm		Bleeder volume, cfm		Pressure differential, inches water gage
	Intake	Return	Left split	Right split	Total	Methane	
3 Right...	44,900	25,400	53	26	[1] 19,500	-	0.32
2 Right...	26,800	20,600	1	7	[1] 3,200	-	.40
1 Right...	-	-	-	-	[1] 3,000	56	.60 approx.
2 Left....	61,600	21,700	6	18	[2] 22,900	-	.45
1 Left....	-	-	-	-	[3] 17,000	124	1.18
North bleeders.	-	-	-	-	[4] 45,100	451	-
Total..	133,300	67,700	60	51	65,600	631	-

[1] Gob flow to bleeders obtained by difference between total intakes and returns in 3 and 2 Rights and 2 Left and by estimated flow from 1 Right.
[2] Gob flow to bleeder entries.
[3] Gob flow in 1 Left as obtained in table 1.
[4] Measured volume in the bleeder; represents 19,500 + 3,200 + 22,900 with an acceptable error of 500 cfm, compared with measured 45,100 cfm in North bleeders.

Total methane liberated from gob areas:

Split returns minus intake methane 111 - 2 =	109 cfm
1 Left bleeder............................	124 cfm
1 Right bleeder...........................	56 cfm
North bleeders............................	451 cfm
Total.....................................	740 cfm

The considerable difference in flows of 39,900 cfm between the intake and returns in 2 Left may be ascribed to two permeable paths. The shorter path was across the gob to the North bleeders with a pressure differential of slightly less than 0.45 inch water gage; the longer path was along the right edge of 1 Left gob and a short bleeder from this portion of gob to 1 East mains with a significant pressure differential of 1.18 inches water gage. The flow in the longer path was 17,000 cfm, and the flow in the North bleeders was 45,000 cfm. Thus, there was little or no gas flow across an appreciable area of 1 Left and 2 Left gobs.

Referring to table 2, 109 cfm (2 cfm intake methane subtracted) of methane were removed from the pillared areas in 3 Right, 2 Right, and 2 Left, and 631 cfm from the portions of the gobs traversed by air, or a total of 740 cfm--1,065,000 cfd. It is not known why the barriers on both sides of North bleeders were left solid.

CONCLUSIONS

Although a significant volume of methane was removed from the study area without recorded violations of the 1969 Act, it is believed that appreciably more methane existed in the gobs. The total area mined out in 3 Right, 2 Right, 1 Right, 1 Left, and 2 Left is approximately equal to slightly more than three full butt headings. In a number of Pittsburgh coalbed mines, one butt heading similar in dimensions to 1 Right has produced the same quantity of gob gases as the total from the study area. While this is not actual proof, it is relatively indicative.

It is always difficult to adequately ventilate and bleed an area mined in virgin coal. However, with the bleeder system established in the area, relatively minor additions would have improved the situation significantly. Three or four regulated "taps" into the North bleeders from 1 Right and 1 Left would have been effective. Also since the two middle North bleeders were arranged for intake air, the system could have been continued into the back bleeders, with the outside heading placed on regulated intake air. This would have provided a safe approach for maintaining the bleeders in open condition (pumping of water and/or cleanup of falls).

With the bleeder arrangement described, more effective regulation could be provided at the back end. As the gobs become more extensive and less permeable, sliding doors in properly located regulators would be completely opened, and total stoppings could perhaps be removed, with additional regulation progressively provided opposite the more permeable gob areas.

Because the bleeder air contained a maximum of 1 percent methane, it is conceivable that the 133,000 cfm of air used here would have removed at least 50 percent more methane without violating the 1969 Act if (1) the bleeder system had been properly arranged and (2) the main fan pressure had been increased.

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