Illinois
Coal Mining Investigations
Cooperative Agreement

State Geological Survey
Department of Mining Engineering, University of Illinois
U. S. Bureau of Mines

Bulletin 6
Coal Mining Practice
In
District V

By
S. O. Andros

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University of Illinois
1914
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<td>31</td>
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<tr>
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<td>33</td>
</tr>
<tr>
<td>14.</td>
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Fig. 1. Map showing the area (shaded) of District V.
COAL MINING PRACTICE IN DISTRICT V

By S. O. ANDROS

INTRODUCTION

District V of the Illinois Coal Mining Investigations, as shown in fig. 1, comprises those mines working in Saline and Gallatin counties in bed 5 of the Illinois Geological Survey correlation. A detailed description of the districts into which the State has been divided and the method of collecting the data upon which this bulletin is based is contained in Bulletin I, “A Preliminary Report on Organization and Method.”

Seven typical mines were examined in this District in which there are 33 mines, 21 shipping and 12 local. The total production of the district for the year ended June 30, 1912, was 4,151,702 tons or 7.2 per cent of the total production of the State during the year. The coal mined by machines in District V totaled 3,753,319 tons, 90.2 per cent of the total production of the district. A direct result of undercutting such a large percentage is the use of less powder. The production of the district is 7.2 per cent of the coal output of the State. For the year ended June 30, 1912, only 53,154 kegs of powder, 4.2 per cent of the powder used in the State, were used in the district. There were 78.1 tons of coal gained for each keg of powder used.

In the mines of this district there were employed an average of 4,822 men for an average of 170 days, making a total of 819,740 days’ work performed during the year, or 6.5 per cent of the total days of work in coal mines throughout the State.

Table 1 gives comparative statistics for the district and for the State in 1912.

The operators of the district offered every facility for study of the mines, and the superintendents and mine managers
freely supplied all information requested. Special acknowledgments are due to Mr. William Johnson, General Superintendent of the Saline County Coal Company, and to Mr. Hugh Murray, President of the Gallatin Coal and Coke Company, for their valuable assistance and advice.

Table 1.—Comparative statistics for District V and the State for the year ended June 30, 1912

<table>
<thead>
<tr>
<th></th>
<th>District</th>
<th>State</th>
<th>Per cent of District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total production</td>
<td>4,151,702</td>
<td>57,514,240</td>
<td>7.2</td>
</tr>
<tr>
<td>Tons mined by machine</td>
<td>3,753,319</td>
<td>25,550,019</td>
<td>14.7</td>
</tr>
<tr>
<td>Average daily tonnage</td>
<td>24,484</td>
<td>359,464</td>
<td>6.8</td>
</tr>
<tr>
<td>Average days of active operation</td>
<td>170</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>Total employees</td>
<td>4,822</td>
<td>79,411</td>
<td>61</td>
</tr>
<tr>
<td>Days of work performed</td>
<td>819,740</td>
<td>12,705,760</td>
<td>6.5</td>
</tr>
<tr>
<td>Surface employees</td>
<td>414</td>
<td>7,049</td>
<td>5.9</td>
</tr>
<tr>
<td>Underground employees</td>
<td>4,408</td>
<td>72,362</td>
<td>6.1</td>
</tr>
<tr>
<td>Average number of face workers(\text{a}) (miners, loaders, and machine men)</td>
<td>2,728</td>
<td>53,318</td>
<td>5.1</td>
</tr>
<tr>
<td>Underground employees per each surface employee</td>
<td>10.6</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Tons mined per day per employee</td>
<td>5.1</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Tons mined per day per surface employee</td>
<td>59.2</td>
<td>50.9</td>
<td></td>
</tr>
<tr>
<td>Tons mined per day per underground employee</td>
<td>5.6</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Tons per face worker per day(\text{b})</td>
<td>8.1</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Fatal accidents</td>
<td>28</td>
<td>180</td>
<td>15.5</td>
</tr>
<tr>
<td>Per cent from falling coal or rock</td>
<td>42.9</td>
<td>54.4</td>
<td></td>
</tr>
<tr>
<td>Per cent from pit cars</td>
<td>10.7</td>
<td>18.8</td>
<td></td>
</tr>
<tr>
<td>Per cent from gas explosions</td>
<td>32.1</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Per cent from explosives</td>
<td>7.1</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>Deaths per 1,000 employees</td>
<td>5.8</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Tons mined to each life lost</td>
<td>148,275</td>
<td>319,524</td>
<td></td>
</tr>
<tr>
<td>Non-fatal accidents</td>
<td>65</td>
<td>800</td>
<td>8.1</td>
</tr>
<tr>
<td>Per cent from falling coal or rock</td>
<td>43.2</td>
<td>45.5</td>
<td></td>
</tr>
<tr>
<td>Per cent from pit cars</td>
<td>18.5</td>
<td>26.3</td>
<td></td>
</tr>
<tr>
<td>Per cent from gas explosions</td>
<td>9.2</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Per cent from explosives</td>
<td>4.6</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Per cent from undercutting machines</td>
<td>9.2</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Non-fatal accidents per 1000 employees</td>
<td>13.4</td>
<td>10.1</td>
<td></td>
</tr>
<tr>
<td>Tons mined to each non-fatal accident</td>
<td>63,872</td>
<td>71,893</td>
<td></td>
</tr>
</tbody>
</table>

\(\text{a}\)Compiled from Thirty First Annual Coal Report of Illinois.

\(\text{b}\)Shipping mines only.
DESCRIPTION OF COAL BED

Bed 5 in Saline and Gallatin counties lies at a depth of 25 to 450 feet, being nearer the surface along the southern portion. The bed varies in thickness from 4 to 8 feet, averaging 5½ feet in Saline County and 4 feet in Gallatin County. The coal of bed 5 has a bright luster and is harder than No. 6 coal. Table 2 gives the proximate analysis and unit coal B. t. u. for coal of bed 6 in Perry, Jackson, Franklin and Williamson counties or District VI and coal of bed 5 in District V. No. 5 coal in this district has more sulphur, less moisture, and a slightly higher calorific value than No. 6 coal in District VI.

Table 2.—Analyses of coal in beds 5 and 6.

<table>
<thead>
<tr>
<th>Bed</th>
<th>District</th>
<th>No. Samples</th>
<th>Moisture</th>
<th>Volatile matter</th>
<th>Fixed Carbon</th>
<th>Ash</th>
<th>Sulphur</th>
<th>B. t. u.</th>
<th>Unit coal B. t. u.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>V</td>
<td>27</td>
<td>6.75</td>
<td>35.49</td>
<td>48.72</td>
<td>9.04</td>
<td>2.92</td>
<td>12276</td>
<td>14812</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>38.06</td>
<td>52.25</td>
<td>9.69</td>
<td>3.13</td>
<td>13165</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.21</td>
<td>34.00</td>
<td>48.14</td>
<td>8.71</td>
<td>1.53</td>
<td>11825</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td>37.45</td>
<td>53.02</td>
<td>9.59</td>
<td>1.68</td>
<td>13025</td>
<td>14583</td>
</tr>
</tbody>
</table>

The bed does not contain the numerous bands which characterize the No. 6 coal both to the west and east of the Du Quoin anticline. In some mines a blue band is developed locally, in general where the seam is thickest. In places a hard calcareous shale band may be seen. It is much harder than the blue band and where developed is usually from two to three feet above the floor, as compared with nine to eighteen inches for the blue band.

The mines in this district are more gassy than those in No. 6 coal west of the Du Quoin anticline possibly because the impermeable shale overlying the bed has prevented the escape of gas. They are not so gassy, however, as mines in No. 6 east of the anticline.
The roof of No. 5 in this district is a shale varying in color from light gray to black, and locally may be laminated and interbedded with bone and stringers of coal for a distance of 3 feet above the seam. The roof usually contains also many concretions of iron pyrites called "nigger-heads." These have more cohesion with the rest of the roof material than do the nigger-heads in the Danville district.

The floor is fireclay which in places contains much sand and heaves badly when wet. The bed does not lie as flat as the unfaulted No. 6, but contains many hills and rolls causing grades as high as 15 per cent in the entries of some mines. The coal is not pinched out at these hills, but follows their contours with undiminished thickness.

The district is characterized by the presence of an igneous intrusion identified by Albert Johansen, formerly of the U. S. Geological Survey, as mica-peridotite. This dike in some places penetrates and has its apex in the coal, as shown in fig. 2; in others it extends on through the bed into the overlying strata. The dike varies in thickness at the coal horizon from a few inches to many feet, and can be traced lineally for several miles. Considerable gas and water are generally found in the vicinity of the intrusion.

The coal-dust of this district when air-dried and tested in
the laboratory at Urbana shows moderate explosibility. Comparison of the average pressure developed by this dust when tested in the explosibility apparatus with the pressures developed by the dusts of other districts, is given in Table 3.

**Table 3.**—*Pressure developed by powdered face samples in explosibility apparatus*

<table>
<thead>
<tr>
<th>District</th>
<th>No. samples</th>
<th>Pressure in pounds per square inch at 2192°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11</td>
<td>8.400</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td>5.880</td>
</tr>
<tr>
<td>III</td>
<td>5</td>
<td>7.805</td>
</tr>
<tr>
<td>IV</td>
<td>17</td>
<td>7.700</td>
</tr>
<tr>
<td>V</td>
<td>7</td>
<td>7.105</td>
</tr>
<tr>
<td>VI</td>
<td>16</td>
<td>5.950</td>
</tr>
<tr>
<td>VII</td>
<td>24</td>
<td>7.175</td>
</tr>
<tr>
<td>VIII</td>
<td>6</td>
<td>8.925</td>
</tr>
</tbody>
</table>
SYSTEM OF MINING

In the 30 mines of Saline County there are no slopes or drifts, all of the coal being hoisted entirely through shafts; but in Gallatin County the coal is reached by 5 slopes, 2 drifts, and 3 shafts. Stripping the overburden from the seam is not done in either county.

Fig. 3. Plan of mine with triple main entries.

The output of the average mine in Gallatin County is small. The largest mine produced in the year ended June 30, 1912, only 28,439 tons as compared with 523,583 tons for the
largest mine in Saline County. The method of mining the bed is the same in both counties. The room-and-pillar system is used exclusively in the district. A main haulage entry and parallel air-course were driven in every mine except one. In it triple main entries were driven, two for intake air and one for return air and haulage, as shown in fig. 3.

In the smaller mines and in many of the larger ones of the district the dimensions of workings are unsuitable to the roof conditions. The main entries vary in width from 14 to 16 feet. A few shaft pillars have been gouged. Gouging the room pillars often results in a blow-through, as shown in fig. 4.

The width of the room in the foreground is 26 feet; that of the room in which the men are standing, 22 feet. The width of room-pillar is 9 feet. Room-stumps left when rooms are turned off the cross entries generally are small. The closing of entries by roof falls may often be attributed to local squeezes which ride over the room-stumps. Table 4 gives dimensions of workings for each mine visited.

The custom of driving wide rooms and entries, of leaving narrow pillars throughout the mine, and of obtaining all the coal possible on the advance working without attempting to draw pillars, has resulted in a percentage of extraction of the seam which is high for Illinois mines. The percentages given
<table>
<thead>
<tr>
<th>Table 4.—Dimensions of workings in feet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per cent of coal</strong></td>
</tr>
<tr>
<td><strong>Width of coal cut</strong></td>
</tr>
<tr>
<td><strong>Width of cross</strong></td>
</tr>
<tr>
<td><strong>Width of room</strong></td>
</tr>
<tr>
<td><strong>Distance between room-centres</strong></td>
</tr>
<tr>
<td><strong>Distance from entry to full room width</strong></td>
</tr>
<tr>
<td><strong>Room-neck</strong></td>
</tr>
<tr>
<td><strong>Length</strong></td>
</tr>
<tr>
<td><strong>Width</strong></td>
</tr>
<tr>
<td><strong>Room-pillar</strong></td>
</tr>
<tr>
<td><strong>Width of room-pillar</strong></td>
</tr>
<tr>
<td><strong>Main barrier width</strong></td>
</tr>
<tr>
<td><strong>Entry pillar width</strong></td>
</tr>
<tr>
<td><strong>Cross</strong></td>
</tr>
<tr>
<td><strong>Main</strong></td>
</tr>
<tr>
<td><strong>Entry width</strong></td>
</tr>
<tr>
<td><strong>Cross</strong></td>
</tr>
<tr>
<td><strong>Main</strong></td>
</tr>
<tr>
<td><strong>Depth of shaft</strong></td>
</tr>
<tr>
<td><strong>No. mine</strong></td>
</tr>
</tbody>
</table>
in Table 5 were calculated from measurements made in the mine and checked by figures of tons per acre obtained from the books of the operating companies. The extraction, averaging 67.1 per cent for the 7 mines examined, was accomplished only with greatly increased expense for cleaning up. The cost of coal at the pit mouth in this district would be much lower if entries and rooms were driven narrower leaving wide pillars to be pulled on return working. The heavy roof falls constantly occurring in workings with the present dimensions would be avoided and the haulage ways would be kept free from gob. Fig. 5 shows a typical roof fall, which closed a room that had been driven up only 75 feet.

The shale of the immediate roof is weak, often containing coal fingers, and breaks quickly when unsupported in wide spans. The roof shale is drawn when it shows a strongly developed parting not over 4 inches above the coal; but such a parting rarely occurs, and the coal bed is so thin that top coal cannot profitably be left in place. Consequently when subjected to changes of temperature and humidity in the air current the immediate roof spalls badly; and as timber is used sparingly in this district both the danger of accidents and the clean-up expense are increased. In some mines about 9 inches of bottom coal is left below the blue band, but as this bottom
coal is not of good quality increased facility in shooting recompenses for the loss of the coal.

The igneous dike in the district has not caused a modification of the system of mining, although it has added locally to the expense because of the greatly increased cost of driving through hard rock.

The laborers are of various nationalities, with Americans possibly predominating. Others are English, Scotch, German, Lithuanian, Hungarian, and Russian. The production per capita in the district is higher than the average for the other districts combined; 5.1 tons of coal per day being produced per employee as compared with 4.5 tons per day for all other districts combined. The tonnage per day per face worker is 8.1 for the district and 6.0 for all other districts. The large amount of coal mined by machines in District V accounts for this high individual production. Table 5 gives the per capita production of coal at each mine examined.

<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Average daily tonnage</th>
<th>Employees</th>
<th>Surface employees</th>
<th>Underground employees</th>
<th>Face workers (miners, loaders and machine men)</th>
<th>Underground employees per surface employee</th>
<th>Tons per day per employee</th>
<th>Tons per day per underground employee</th>
<th>Tons per day per face worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>2500</td>
<td>415</td>
<td>30</td>
<td>385</td>
<td>200</td>
<td>12.8</td>
<td>6.0</td>
<td>83.3</td>
<td>6.5</td>
</tr>
<tr>
<td>44</td>
<td>1400</td>
<td>286</td>
<td>32</td>
<td>254</td>
<td>184</td>
<td>8.0</td>
<td>4.9</td>
<td>43.7</td>
<td>5.5</td>
</tr>
<tr>
<td>45</td>
<td>1600</td>
<td>258</td>
<td>16</td>
<td>242</td>
<td>198</td>
<td>15.1</td>
<td>6.2</td>
<td>100.0</td>
<td>6.6</td>
</tr>
<tr>
<td>46</td>
<td>1100</td>
<td>239</td>
<td>14</td>
<td>225</td>
<td>163</td>
<td>16.0</td>
<td>4.6</td>
<td>78.6</td>
<td>4.9</td>
</tr>
<tr>
<td>47</td>
<td>400</td>
<td>50</td>
<td>6</td>
<td>44</td>
<td>40</td>
<td>7.3</td>
<td>8.0</td>
<td>66.6</td>
<td>9.1</td>
</tr>
<tr>
<td>48</td>
<td>800</td>
<td>182</td>
<td>17</td>
<td>165</td>
<td>92</td>
<td>9.7</td>
<td>4.4</td>
<td>47.1</td>
<td>4.9</td>
</tr>
<tr>
<td>49</td>
<td>1100</td>
<td>213</td>
<td>13</td>
<td>200</td>
<td>125</td>
<td>15.4</td>
<td>5.2</td>
<td>84.6</td>
<td>5.5</td>
</tr>
<tr>
<td>District V</td>
<td>24484</td>
<td>4822</td>
<td>414</td>
<td>4408</td>
<td>2728b</td>
<td>10.8</td>
<td>5.1</td>
<td>58.6</td>
<td>5.5</td>
</tr>
<tr>
<td>All other districts combined</td>
<td>334980</td>
<td>74589</td>
<td>6635</td>
<td>67954</td>
<td>50590</td>
<td>10.3</td>
<td>4.5</td>
<td>50.5</td>
<td>4.9</td>
</tr>
</tbody>
</table>

a Year ended June 30, 1912.
b Shipping mines only.
VENTILATION

Considerable marsh-gas is generated in bed 5 but the entries are driven ahead of the rooms in the development of the mines and drain the bed so that usually in rooms there is not much gas, although an amount sufficient to cause as many as 4 or 5 fires per shift after shots in the rooms may be left included in the coal. In this district many of the explosions which have occurred with attendant loss of life could have been prevented by a more careful inspection of the working places before the men were allowed to enter them. An especially careful examination should be made of connections between old and active workings; also of the faces of entries driven in advance of the rooms, as these faces serve as the outlet for the gas drained from the bed.

The comparatively small quantities of gas in the rooms has given rise to the belief that strong ventilation is not necessary, and as a consequence the quantity of air supplied to the mines is generally not adequate. The volume of air is small in this district in proportion to the area to be ventilated. In many mines the insufficient quantity supplied by the fan at the air-shaft is decreased still more by loss through leaky stoppings during the passage of the current through the entries.

One mine operates with proper consideration of the dan-
ger in a combination of gas and explosive dust. Ventilation is ample, the fan delivering an average of 200,000 cubic feet per minute. This volume is subject to little leakage in the entries, the stoppings being efficient. Stoppings are built of hollow concrete blocks set into the rib, roof, and floor sufficiently deep to provide a good joint. The cut is made about 2 inches wider than the bearing side of the blocks, and the joint in rib, roof, and floor is packed with cement mortar with the proportions, 1, Portland cement; 3, sharp washed sand. The rib cut, as shown in fig. 6, is 14 inches deep. The concrete blocks are made on the surface in a mould as shown in fig. 7. The concrete used for the blocks has the proportions: 1, Portland cement; 2, sharp washed sand; 4, crushed limestone. Each block weighs 180 pounds, and has outside dimensions of 8 by 12 by 24 inches. The cost of material is 14 cents per block; labor, 8 cents; total cost at pit mouth, 22 cents. Two men build in one day a stopping 7 by 10 feet, preparing the cuts in the rib and roof and the trench in the floor to receive the blocks, at a total labor cost of $7.25, or 10.4 cents per square foot. The cost of material was 10.6 cents per square foot (53 blocks). With a cost of eight-tenths of a cent per block for transportation from the surface to the location in the mine, the cost of transportation per square foot of stopping was six-

Fig. 7. Mould for making concrete-blocks for stoppings.
tents of a cent. The total cost of a laid stopping, therefore, was 21.6 cents per square foot. Provision is made at this mine for the expansion of an explosion wave, the idea being to prevent the propagation through the main entries of a local explosion in a room or entry. An explosion door (fig. 8) is built into every eighth stopping along the main entries. This door is built of two thicknesses of one inch shiplap boards, and swings vertically on a one-inch iron rod. Uprights and casings are built into the stopping. The width of the door, 4 feet 3 inches, is the same whatever the width of the crosscut, but the height varies with the stopping.

Fig. 8. Explosion-door in concrete-block stopping.

The air-shafts have two compartments, one for ventilation and one for an escapeway. One mine has an exception to the usual small escapeway compartment, the escapement being 4\(\frac{1}{4}\) by 11 feet in the clear. The stairway is 24 inches wide with steel treads spaced on 12-inch centers. Platforms at landings are broad, and ascent through this escapeway is easy. As the air-shaft is of concrete construction the partition between escapement and air compartment does not leak, and there is no short circuiting of the intake current through the partition.

For the year ended June 30, 1912, the coal output of the district amounted to 7.2 per cent of the State; but 15.5 per cent of the fatal accidents in Illinois that year occurred in this
district. The record for the year ended June 30, 1911, shows that although 6.5 per cent of the production of the State was mined in this district, 10.2 per cent of the fatal accidents also occurred there. An analysis of the causes of accidents compared in Table 6 for District V and for all other districts combined shows the necessity for better ventilating equipment. The installation of adequate fans and the employment of sufficient face bosses would reduce the number of accidents.

Table 6.—Causes of accidents to employees

<table>
<thead>
<tr>
<th>Cause</th>
<th>Per cent of fatal accidents</th>
<th>Per cent of non-fatal accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>District V</td>
<td>All other districts combined</td>
</tr>
<tr>
<td>Falling coal or rock.........</td>
<td>42.9</td>
<td>56.5</td>
</tr>
<tr>
<td>Pit cars</td>
<td>10.7</td>
<td>20.4</td>
</tr>
<tr>
<td>Gas and dust explosions</td>
<td>32.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Use of explosives</td>
<td>7.1</td>
<td>7.3</td>
</tr>
<tr>
<td>Undercutting machines........</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

¹Compiled from the Thirty-first Annual Coal Report of Illinois.

In spite of frequent local explosions and the presence of much dry explosible dust, humidification of mine air in winter has not been considered necessary by the local operators on account of the naturally high relative humidity. The relative humidity of the working places in summer varies from 90 to 95 per cent. The average of the return air in summer is 98 per cent; in winter, 96. The introduction of water into the mine is for laying the dust on the roads; the increase in humidity by this means being very slight. At 6 of the mines examined sprinkling is done with a car. In one mine sprinkling with hose is done each night in winter; in another, calcium chloride is put on the floor of entries where the dust is thick. Calcium chloride being a hygroscopic salt absorbs moisture. Coal dust when covered with it becomes moistened and remains damp as long as the calcium chloride continues to absorb moisture. The finest coal dust is thus prevented from being thrown into suspension in the air-current by the passage of trips and by the feet of men and animals. At this mine it was found that by using 1½ pounds of granulated calcium chloride per square yard of floor, fine coal dust lying one inch thick was kept moist for six months. The use of this salt has been so satisfactory
at this mine that a much greater floor area will be covered in the future. In the small quantity bought for experimentation calcium chloride cost $13 per ton. This cost will be considerably less if the salt is bought in large quantity. Table 7 gives the method and frequency of introduction of water at each mine examined.

**Table 7.—Method and frequency of introduction of water**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mine</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td></td>
<td>Sprinkling from car</td>
<td>Weekly</td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>Sprinkling from car</td>
<td>Weekly</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>Sprinkling from car</td>
<td>Irregular</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td>Sprinkling from car</td>
<td>Three times per week</td>
</tr>
<tr>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td></td>
<td>Sprinkling from hose</td>
<td>Daily in winter</td>
</tr>
</tbody>
</table>

In only a few mines in the district is proper precaution against underground fires in the shaft pillar observed. Mules are usually stabled below, and hay is often taken down in open cars and sometimes is allowed to lie for several hours on the stable floor after unloading. Extreme carelessness is tolerated in the use of naked lights in underground stables; enforcement of the provision of the State mining law prohibiting their use in stables being observed in but few mines.

Table 8 gives for each mine examined data about ventilating equipment.

**Table 8.—Ventilating equipment**

<table>
<thead>
<tr>
<th>No.</th>
<th>Depth in feet</th>
<th>Size in clear in feet</th>
<th>Type of fan¹</th>
<th>Diameter of fan in feet</th>
<th>Width of fan in feet</th>
<th>Material of fan house</th>
<th>Lining of air-shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>160</td>
<td>8 by 8</td>
<td>Clifford-capell</td>
<td>13</td>
<td>5½</td>
<td>Timber</td>
<td>Timber</td>
</tr>
<tr>
<td>44</td>
<td>270</td>
<td>11 by 20</td>
<td>Paddle-wheel</td>
<td>20</td>
<td>6</td>
<td>Brick</td>
<td>Concrete</td>
</tr>
<tr>
<td>45</td>
<td>320</td>
<td>6 by 8</td>
<td>Paddle-wheel</td>
<td>12</td>
<td>5</td>
<td>Corrugated iron</td>
<td>Timber</td>
</tr>
<tr>
<td>46</td>
<td>450</td>
<td>8 by 12</td>
<td>Paddle-wheel</td>
<td>20</td>
<td>5</td>
<td>Corrugated iron</td>
<td>Timber</td>
</tr>
<tr>
<td>47</td>
<td>100</td>
<td>6 by 6</td>
<td>Paddle-wheel</td>
<td>10</td>
<td>3</td>
<td>Timber</td>
<td>Timber</td>
</tr>
<tr>
<td>48</td>
<td>76½</td>
<td>5 by 10</td>
<td>Paddle-wheel</td>
<td>18</td>
<td>4</td>
<td>Timber</td>
<td>Timber</td>
</tr>
<tr>
<td>49</td>
<td>337</td>
<td>6 by 10</td>
<td>Paddle-wheel</td>
<td>14</td>
<td>4</td>
<td>Corrugated iron</td>
<td>Timber</td>
</tr>
</tbody>
</table>

¹"Paddle-wheel" refers to straight blade type of fan.
BLASTING

In District V a great proportion of the coal mined is undercut by machines. During the year ended June 30, 1912, there were produced in the district 4,151,702 tons of which 3,753,319 tons, or 90.2 per cent of the total output of the district, were mined by machines. In five of the mines examined electric chain undercutting machines were used; shooting off the solid was done in two mines; and in one mine shooting off the solid was done in one section and undercutting in another. In those mines where the coal is undercut before shooting, it is usually snubbed by hand, increasing the height of undercutting from 15 to 24 inches above the floor. This hand-snubbing not only makes a greater percentage of lump coal, but also makes possible smaller charges of powder. The output of coal per undercutting machine varies from 112 to 200 tons a shift at the mines examined. The number of tons of coal gained per 25-pound keg of powder is high for the district as a whole, averaging 78.1 for the year ended June 30, 1912. This high average was made possible by the performance at the undercutting mines where the number of tons per keg varied from 108 to 125. The solid shooting mines make a poor gain of coal in blasting, obtaining only 18 to 25 tons per keg.

The district uses black powder exclusively, but could op-
erate with fewer explosions and fewer fires after shots if permissible explosives were used. In three of the seven mines inspected, unnecessarily fine powder was used, thereby increasing the amount of slack.

Dangerous blasting practice exists in some of the smaller mines where shooting is done off the solid and drill holes 21/2 inches in diameter are 8 feet long in a seam 53/4 feet thick. Excessive charges of powder are loaded and "bug-dust" tamping is common. The explosibility of the dust in this district should make obvious to the miners the danger in present blasting methods and they should be the first to insist on observance of the State law. The laws now existing in Illinois are sufficient to protect the miners from nearly all preventable accidents, but the enforcement of these laws is very lax. In three of the seven mines examined short-firers are employed, but they ordinarily do not refuse to fire shots tamped with bug dust. In only one mine is clay used for tamping. In those districts where shot-firers refuse to fire charges not tamped with clay the miners soon learn to use clay only.

The powder is transported from the surface to the entries in open pit cars, as is the custom throughout the State. Powder is bought in steel kegs; the paper powder keg not being used. The usual square hole made by a pick point was noticed in the heads of many kegs. The practice of opening them with pick points is, however, no more prevalent in this district than it is in other parts of Illinois.

<table>
<thead>
<tr>
<th>No.</th>
<th>Undercut or shot off solid</th>
<th>Height of hand shoveling</th>
<th>Tons a day per machine</th>
<th>Size of powder</th>
<th>Length of holes</th>
<th>Diameter of holes</th>
<th>Shots fired by</th>
<th>Tons of coal per keg of powder</th>
<th>Per cent of lump over 13/4 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>Undercut</td>
<td>24</td>
<td>112</td>
<td>F</td>
<td>5</td>
<td>21/2</td>
<td>Squib</td>
<td>108</td>
<td>70</td>
</tr>
<tr>
<td>44</td>
<td>Undercut</td>
<td>18</td>
<td>200</td>
<td>FF</td>
<td>6</td>
<td>11/2</td>
<td>Squib</td>
<td>125</td>
<td>70</td>
</tr>
<tr>
<td>45</td>
<td>Undercut</td>
<td>15</td>
<td>150</td>
<td>FF</td>
<td>5</td>
<td>2</td>
<td>Squib</td>
<td>116</td>
<td>....</td>
</tr>
<tr>
<td>46</td>
<td>Shot off solid</td>
<td>18</td>
<td>...</td>
<td>F</td>
<td>51/2</td>
<td>23/4</td>
<td>Fuse</td>
<td>100</td>
<td>3 inches</td>
</tr>
<tr>
<td>47</td>
<td>Shot off solid</td>
<td>None</td>
<td>...</td>
<td>C</td>
<td>6.8</td>
<td>13/4</td>
<td>Fuse</td>
<td>221/2</td>
<td>55</td>
</tr>
<tr>
<td>48</td>
<td>Undercut</td>
<td>18</td>
<td>112</td>
<td>F</td>
<td>51/2</td>
<td>13/4</td>
<td>Fuse</td>
<td>107</td>
<td>70</td>
</tr>
<tr>
<td>49</td>
<td>Shot off solid</td>
<td>None</td>
<td>...</td>
<td>C</td>
<td>8</td>
<td>21/2</td>
<td>Fuse</td>
<td>18</td>
<td>75</td>
</tr>
</tbody>
</table>
Table 9 gives data covering blasting practice in the district. The figures for percent of lump coal over $1\frac{1}{4}$ inches were obtained from the books of the company in each case.

Fig. 9 shows a typical method of placing holes in an undercut face where no rock-band is present.

**TIMBERING.**

This district is characterized by insufficient timbering in entries. The roof spalls badly on exposure to air, especially in those sections where the draw-slate has not been pulled down. The district would profit financially and the number of accidents would be decreased if the timbering expenditure were doubled. It is a false economy which prohibits the purchase of necessary timber in a coal mine, because the money appa-

![Fig. 10. Shaft bottom with steel I-beam roof supports.](image-url)

rently saved is lost twice over in added expense of cleaning-up and hauling. The total timbering cost for the mines examined varies from 1 to 2 cents per ton of coal mined, and averages 1.5 cents. Hundreds of feet of entry with bad roof are supported by props alone; sets are seldom used at any of the mines examined. The quality of timber is poor, and the three-piece gangway set when used is generally constructed of split room-props of small diameter.
In rooms the number of props is inadequate for safe roof support, and the miners are not compelled to keep their props close to the face. In many rooms examined the last prop in place under bad roof was 20 feet from the face. The number of accidents from fall of roof can be decreased in this district if proper supervision is exercised over the working place of the miner. To obtain this supervision it is necessary to have numerous face bosses. The operators should furnish a plentiful supply of good props, and pull them after a room is driven up.

![Figure 11. Sketch of steel roof supports.](image)

The room-props in this district are of poor quality, less than one per cent being white oak. In some mines of the district room-props measure only 2½ inches in diameter at the small tip. Table 10 gives data on timbering. The figures for the number of props per 100 square feet of roof were obtained by counting the props in a measured length in each of several typical rooms of known width. The average number of props per 100 square feet of roof is 3.3 for this district as compared with an average of 5.5 per 100 square feet of roof for the Danville district, which has a similar roof.

The shaft bottoms of all except one of the mines examined are crudely timbered. The exception has a modern bottom permanently timbered with steel, as shown in fig. 10. One end of the 12-inch I-beam is set in a hitch in the rib and the other end rests on a 15-inch I-beam stringer as shown in fig. 11. The stringers are supported by 12-inch steel I-beam legs.
which are riveted with angle-iron to a 7-inch by 14-inch steel plate 3/8-inch thick. Both the hoisting and air shafts of this mine are fire-proof, and are the only concrete lined shafts in the district. Both shafts are concreted through 50 feet of top soil and for a further distance of 20 feet in the sandstone. Fig. 12 shows the plan and vertical section of the hoisting shaft. Excavation through the top soil and sandstone was made, and the lining was built up from the bottom beginning with the water seal at solid rock. The concrete is reinforced vertically with 3/8-inch by 2-inch iron bars, and horizontally by 3/4-inch twisted rods. The proportions of the concrete used are: 1 Portland cement; 2 sharp washed sand; 4 crushed limestone. The linings of both shafts were built with great care, and are excellent examples of fireproof shaft construction under the new State law. Below the concrete the shafts are limestone except the last 91 feet, which is gray shale. The buntons below the seal are placed in hitches cut in the rock. The yellow pine guides are made up to 6 by 8 inches. Where the shaft at a depth of 100 feet from the surface passes through bed 7 it is bricked by a wall 9 feet high and 12 inches thick. The fireproofing of new shaft linings now demanded by a provision of the State law is now done in Illinois, but only a few shafts have been sunk since the law went into effect.

HAULAGE.

Hauling the coal from the working places to the bottoms

Table 10.—Timbering

<table>
<thead>
<tr>
<th>No.</th>
<th>Total timber cost per ton of coal mined</th>
<th>Does mine use steel timbers?</th>
<th>Room Props</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cents per ton of coal mined</td>
<td></td>
<td>No. per 100 square feet of roof</td>
</tr>
<tr>
<td>43</td>
<td>1½</td>
<td>No</td>
<td>5.7</td>
</tr>
<tr>
<td>44</td>
<td>1</td>
<td>Yes</td>
<td>2.5</td>
</tr>
<tr>
<td>45</td>
<td>Yes</td>
<td>1.6</td>
<td>9.2</td>
</tr>
<tr>
<td>46</td>
<td>No</td>
<td>2.4</td>
<td>12.0</td>
</tr>
<tr>
<td>47</td>
<td>1</td>
<td>No</td>
<td>2.3</td>
</tr>
<tr>
<td>48</td>
<td>2</td>
<td>No</td>
<td>2.7</td>
</tr>
<tr>
<td>49</td>
<td>1½</td>
<td>No</td>
<td>5.1</td>
</tr>
</tbody>
</table>
Fig. 12. Plan and section of concrete-lined shaft.
is beset with more difficulties in this district than in most Illinois mines because the rolls and pitches of the bed make numerous grades as high as 15 per cent. As the grades are casual it is impossible to locate the hoisting shaft in such a position that they shall be in favor of the loads; consequently haulage costs are higher than in those districts where the bed is flat or has a uniform grade in favor of the loads from rooms to hoisting shaft. The haulage expense is further augmented by sharp curves, and by the presence of gob on the track due to roof falls in sections insufficiency timbered.

The standard electric locomotive is used for hauling from the partings to the shaft at 5 of the 7 mines examined; mules are used at the other two. Mules gather in all but one of the mines. In this one mine 6-ton electric locomotives gather the loads from the rooms, running to the face for the pit car if the room lies flat and pulling the car out of the room by a winch called a "crab", or, in exceptional cases, with a block-and-tackle where grades into the rooms are steep against the loads.

![Fig. 13. Main entry and wide pit car.](image)

Steep grades, sharp curves and gob on the roadways have combined to prevent a high ton-mileage for locomotives. (Table 11.) The figures for locomotive ton-mileage in this table were computed for each mine from the performance of the heaviest locomotive when more than one operated on the main
### Table 11.—Haulage equipment

<table>
<thead>
<tr>
<th>No.</th>
<th>Kind of haulage</th>
<th>Main</th>
<th>Secondary</th>
<th>No. of locomotives of each weight*</th>
<th>Locomotive daily ton mileage</th>
<th>Rail weight in pounds per yard</th>
<th>Percent of total load which is car weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Weight of locomotive in tons</td>
<td>Average no. miles traveled per day</td>
<td>Total ton mileage per day</td>
</tr>
<tr>
<td>43</td>
<td>Electric</td>
<td>Mule</td>
<td>Three 15</td>
<td>15</td>
<td>20.8</td>
<td>1508.6</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Electric</td>
<td>Electric</td>
<td>One 10; Six 6</td>
<td>10</td>
<td>14.2</td>
<td>1167.0</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Electric</td>
<td>Mule</td>
<td>One 10; Three 7</td>
<td>10</td>
<td>18.6</td>
<td>675.0</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Mule</td>
<td>Mule</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>Mule</td>
<td>Mule</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Electric</td>
<td>Mule</td>
<td>One 6</td>
<td>6</td>
<td>21.8</td>
<td>575.4</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>Electric</td>
<td>Mule</td>
<td>One 8</td>
<td>8</td>
<td>42.3</td>
<td>888.3</td>
<td></td>
</tr>
</tbody>
</table>

*Figures refer to weight in tons.
haulage. The average distance in miles traveled each shift multiplied by the average weight of cars and coal hauled over this distance gives the locomotive's total ton-milage. The superiority of the heavy locomotive is clearly shown. Although the light locomotive travels a greater number of miles a day, its daily ton-milage is low on account of inability to haul many loaded cars in a trip.

Entries are driven so wide in this district that a wide pit car can be hauled. (Fig. 13.) The capacity of pit cars varies from 2100 pounds to 8000 pounds. The weight of pit cars is in reasonable proportion to that of the coal carried, the weight of coal varying from two to four times that of the empty car. The function of the pit car is to act as carrier of coal, and any weight in excess of that necessary for a strong car increases the cost but not the efficiency of haulage. It is not uncommon in Illinois to find that 50 per cent of the weight of the load hauled to the bottom by locomotives or mules is pit car. The per cent of empty car weight in the total load of a trip in this district varies from 20.0 to 46.2.

In Illinois sufficient attention is not paid to the running gear of pit cars. The cost of hauling could be reduced considerably by keeping wheels and axles in better condition.

The mules in this district are kept in excellent condition. The policy of one company operating a number of mines could be advantageously followed throughout the State: whenever a mule begins to show inability to do a standard days' work it is taken out of the mine and sold. The average period of usefulness of a mule in the mines of this company is 3 years. Mules bought for $175 a head are sold for $40 after 3 years work underground. It was impossible to get figures for ton-mileage of mules in this district. In the best managed mines the cost of feeding a mule averages $10 a month with corn at 60 cents a hundred and hay at $15 a ton. For the working year 1911, consisting of 164 working days, the cost of feeding a mule at one of these mines averaged $11.50 a month. At one mile with a 2 per cent grade in favor of the loads a spike team of 3 mules hauls trips of 17 cars each weighing empty 1800 pounds and holding 2100 pounds of coal, making a total weight of 3900 pounds per loaded car and approximately 33 tons for the trip. No record of mules on grades against the loads was available.
Rail weight in the district varies from 16 to 40 pounds on the main haulage where locomotives are used. For secondary haulage 2 mines have 20-pound rails and 5 mines 16-pound rails. Track gage varies from 29 to 42 inches. At those mines where haulage details are best considered the ties are of sawed white oak 4 inches by 6 inches by 5 feet. The average cost at these mines is 14 cents per tie.

HOISTING.

As the tonnage of the mines in this district is comparatively small the hoisting plants have the ordinary equipment of mines with moderate outputs and small two-compartment shafts. Table 12 gives data on hoisting arrangements at each mine examined.

<table>
<thead>
<tr>
<th>No.</th>
<th>Kind of lining</th>
<th>Hoisting shaft Depth in feet</th>
<th>Size in feet</th>
<th>Hoisting engine First motion?</th>
<th>Size of cylinders in inches</th>
<th>Drum Diameter in feet</th>
<th>Length in feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>Timber</td>
<td>160</td>
<td>14 by 12</td>
<td>Yes</td>
<td>18 by 32</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>44</td>
<td>Concrete</td>
<td>270</td>
<td>10 by 20</td>
<td>Yes</td>
<td>24 by 36</td>
<td>6</td>
<td>3½</td>
</tr>
<tr>
<td>45</td>
<td>Timber</td>
<td>320</td>
<td>8 by 14</td>
<td>Yes</td>
<td>22 by 36</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>46</td>
<td>Timber</td>
<td>450</td>
<td>9 by 13½</td>
<td>Yes</td>
<td>20 by 36</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>47</td>
<td>Timber</td>
<td>90</td>
<td>7 by 4</td>
<td>No</td>
<td>12 by 24</td>
<td>5½</td>
<td>8</td>
</tr>
<tr>
<td>48</td>
<td>Timber</td>
<td>76½</td>
<td>12½ by 8½</td>
<td>Yes</td>
<td>16 by 32</td>
<td>4½</td>
<td>4</td>
</tr>
<tr>
<td>49</td>
<td>Timber</td>
<td>337</td>
<td>9 by 13½</td>
<td>Yes</td>
<td>22 by 36</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

The shaft-bottoms are usually too short for ample storage of loaded cars to be hoisted and empties to be taken in by, but this lack of storage capacity at the bottom is common to all districts in the State. One mine has provided room for storage, as shown in fig. 14, which is a plan of the shaft-bottom with track arrangements.

Every mine examined has self-dumping cages. Six mines hoist with a direct-connected engine; a second-motion hoist is used in only one mine. All drums are cylindrical, varying in diameter from 4½ to 6 feet, and in length from 3½ to 8 feet. The hoisting engine cylinders are of comparatively small diameter and short stroke, only one mine having an engine cylinder 24 by 36 inches.
PREPARATION OF COAL

In the smaller mines in the district the preparation of coal for market consists only in passing the mine-run product over short and narrow shaking-screens and in the district generally, although no run-of-mine coal is shipped, little attention is given to cleaning and to close separation into sizes. The commonest sizes of coal made are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump</td>
<td>Over 6 inches</td>
</tr>
<tr>
<td>Egg</td>
<td>Through 6 inches and over 3 inches</td>
</tr>
<tr>
<td>Nut</td>
<td>Through 3 inches and over 1(\frac{1}{2}) inches</td>
</tr>
<tr>
<td>Screenings</td>
<td>Through 1(\frac{1}{4}) inches</td>
</tr>
</tbody>
</table>

Table 13 gives tipple equipment for each mine. In three of the mines examined all coal under 1\(\frac{1}{4}\) inches is rescreened,
making a further separation of sizes between $3\frac{3}{4}$ inches and 1$\frac{1}{4}$ inches. The rescreener consists of a revolving screen 5 to 6 feet in diameter and 24 feet long, usually set at a pitch of 1 inch in 4 feet, and making about 20 r. p. m. One mine washed its coal in a washery of the Luhrig type. A description of this

<table>
<thead>
<tr>
<th>No.</th>
<th>Material of tipples</th>
<th>Shaking screen</th>
<th>Is coal rescreened or washed?</th>
<th>Percent of coal over $1\frac{3}{4}$ inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>Wood</td>
<td>14 feet</td>
<td>7 feet</td>
<td>4 inches per foot</td>
</tr>
<tr>
<td>44</td>
<td>Steel</td>
<td>48 feet</td>
<td>5 feet</td>
<td>3 inches per foot</td>
</tr>
<tr>
<td>45</td>
<td>Wood</td>
<td>38</td>
<td>7 feet</td>
<td>4 inches per foot</td>
</tr>
<tr>
<td>46</td>
<td>Wood</td>
<td>30</td>
<td>8 feet</td>
<td>3 inches per foot</td>
</tr>
<tr>
<td>47</td>
<td>Wood</td>
<td>38</td>
<td>6 feet</td>
<td>1$\frac{1}{2}$ inches per foot</td>
</tr>
<tr>
<td>48</td>
<td>Wood</td>
<td>40</td>
<td>6 feet</td>
<td>8 inches per foot</td>
</tr>
<tr>
<td>49</td>
<td>Wood</td>
<td>30</td>
<td>6 feet</td>
<td>4 inches per foot</td>
</tr>
</tbody>
</table>

a. 45 over 3 inches.

Table 13.—Preparation of coal.

![Typical surface plant](image)

Fig. 15. Typical surface plant.

washtery is given in Bulletin 69, Coal Washing in Illinois, by F. C. Lincoln, published by the Engineering Experiment Station, University of Illinois.
Six of the 7 mines examined had the common surface plants of frame construction found at mines of small production. The power plants of these 6 mines had nothing out of the ordinary. Fig. 15 shows a typical surface plant of frame construction. One of the 7 mines, however, had a well-arranged and fire-proofed plant and modern equipment. The tipple was of steel construction and the boiler-house, fan-house and magazine were of brick.

Table 14 gives data on surface equipment at the mines examined.

<table>
<thead>
<tr>
<th>No.</th>
<th>Storage capacity for empty R. R. cars</th>
<th>Boilers</th>
<th>Electric generators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>Type</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>42</td>
<td>Fire tube</td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>35</td>
<td>Fire tube</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>30</td>
<td>Fire tube</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td>40</td>
<td>Fire tube</td>
</tr>
<tr>
<td>47</td>
<td></td>
<td>20</td>
<td>Fire tube</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td>24</td>
<td>Fire tube</td>
</tr>
<tr>
<td>49</td>
<td></td>
<td>37</td>
<td>Water tube</td>
</tr>
</tbody>
</table>