COAL AGE

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DEVOTED TO THE OPERATING, TECHNICAL AND BUSINESS PROBLEMS OF THE COAL-MINING INDUSTRY

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Susquehanna Number

THIS ISSUE of *Coal Age*, describing the operations of the Susquehanna Collieries Co., is the twelfth in a series of Annual Model-Mining Numbers and the third issue in the series to feature an anthracite operation. Consideration of the achievements of a company such as Susquehanna seems particularly appropriate at this time, since they emphasize both the spirit of progress which is transforming the coal industry to meet present-day conditions and the development of a sound policy of continuous modernization.

Modernization and Prosperity

STAGNATION in the capital goods industries, where current sales volume approximates only 20 per cent of 1929 figures, is acting as a brake on sound recovery of all commercial enterprise. This brake would be released if industry generally would go forward at this time with the many improvements in plant facilities which have been ignored or postponed during the past three years. Adoption of such a modernization program would have beneficial repercussions throughout industry and trade from the mine to the corner grocery store.

Business in the mass will subscribe unhesitatingly to this thesis, just as in the mass it will indorse other broad, fundamental plans for the general good. Hard-boiled management of individual industries, however, will not underwrite acceptance of this program by direct action and participation unless such management can see reasonable promise of direct benefits. Coal-mine executives, for example, are not going to make new capital expenditures from purely altruistic motives.

This fact is frankly recognized by the recently organized national Committee on Industrial Rehabilitation, which, without bunk or ballyhoo, is campaigning to accelerate the purchase of capital goods. While creation of additional employment to relieve the present national emergency is the goal, the committee seeks its objective by convincing the individual business man that his participation will be profitable. The appeal carries weight as no other would, because modernization that does not yield a profit is capital waste.

Why Modernize Now?

IN STUDYING the necessity for modernization, shrewd management inevitably must consider certain basic trends which vitally affect the future stability of business, whether it be mining coal or manufacturing widgets. Since 1929, there has been a tremendous deflation in capital values in industrial enterprises, but the destruction of physical capacity for production has not kept pace with this capital liquidation. Indications of a genuine revival in business will bring back a swarm of optimistic marginal producers who can be eliminated only by price competition.

To contemplate the establishment of some of the slaughter-house quotations of today as the future maximum prices of coal would be tragic indeed; to entertain the hope, however, that price levels again will approach the averages of the war and post-war boom periods would be futile. Internal competition from undigested and indigestible capacity and external competition from oil and gas destroy such rosy expectations. Only the plants that follow a program of continuous modernization to lower costs can long survive this dual competition.

The producer or the manufacturer who thinks he can outsmart his modernized com-

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petitor by progressive wage reductions is building his future on treacherous sands. Readjustments to remove competitive inequalities cannot be avoided. But, in the long run, wage levels must move upward because the wage earner as a group is the biggest customer American industry has, and without increasing consumption there can be no increasing production. Producers burdened with the high cost of obsolescent equipment will be crushed between rising wages and low prices.

Modernization has many aspects — all dynamic. Whether the immediate job prove to be one of complete scrapping of existing equipment or methods, the addition of a single machine or the revision of one operating practice, wise management will reach its decision only after an intensive analysis of every phase of plant production and distribution, and begin modernization where the need appears greatest. Frequently modernization in one department highlights weaknesses in other departments and so points the way to the next step.

No study of the problem is ever finished, because managerial skill and inventive genius are constantly uncovering new roads to profit. The fact that it is the plants that stand out from their competitors in methods and equipment that are always the first to welcome further improvement is eloquent of the profit possibilities of change. Only the plants which expect to be out of business soon can afford the luxury of not modernizing.

Sanity in Progress

There is no general pattern for modernization. The fundamental principles remain unchanged, but their application in each case must be adapted to the specific needs of the individual organization. This is clearly shown in the history of the Susquehanna Collieries Co., where slavish imitation of the "Joneses" has been eschewed for a careful analysis of those particular points which, by modernization, would lead to greatest profit. Other operations might find major economies in other directions, but Susquehanna chose those lines which best answer its needs for cost reduction. Each section of each mine has been diagnosed and its problems studied to find just what changes would effect the greatest reduction in cost under the conditions that section presented.

Looking back over its long and eventful past, the Susquehanna Collieries, the Lytle Coal Co., and their distinguished forbears have many claims to leadership. They introduced electric haulage wherever desirable. They developed gangways in solid rock. They divided their coal gangways into sections where to maintain them of length proved likely to be difficult or dangerous. They were early in their introduction of turbines and alternating current. They were the first to pulverize their coal for burning, thus utilizing reserves of potential fuel too fine for sale on the market. They also were among the leaders in mechanical loading.

Though mechanization could not be general, no opportunity to use loading mechanization where suited was overlooked. In every department one finds sanity in progress rather than progress for its own sake, or progress adopted because other mines or other companies had found it advantageous under ruling conditions of another character than theirs. Alive to the importance of experiment, the history of the Susquehanna Collieries has rarely been marked by experiments that proved abortive. The record is one which can be studied with profit by both anthracite and bituminous operators.

Master or Slave?

Down in Georgia, before the Civil War, Uncle Noel worried himself into an early grave trying to support 1,800 slaves, of whom only 500 were able-bodied bucks capable of doing a full day's work on the huge plantation. An intensely human Southern gentleman, he was unwilling to sell his superannuated or nonproductive slaves to buyers less kindly than himself, and the suggestion that "Massa" Noel free them and turn them loose to shift for themselves left the slaves panic-stricken.

Too many mine owners today are in the same predicament as Uncle Noel — without Uncle Noel's humane justification for his inaction, because the superannuated slaves that are devouring the substance of these operators are not creatures of flesh and blood but obsolete equipment. Although continued use of this old equipment is daily burdening them with heavy costs which wipe out all chances of a reasonable profit, they still cling to it with a passion fatal to healthy net earnings.

HIGHLIGHTS

+ In Susquehanna History

WHEN the M. A. Hanna Co. interests, of Cleveland, Ohio, organized the Susquehanna Collieries Co. in 1917 and purchased the anthracite operations of the Susquehanna Coal Co., a subsidiary of the Pennsylvania Railroad Co., the new corporation and its affiliate, the Lytle Coal Co., came into control of anthracite properties whose history stretched back to the early days of mining and transportation in three of the four major hard-coal fields.

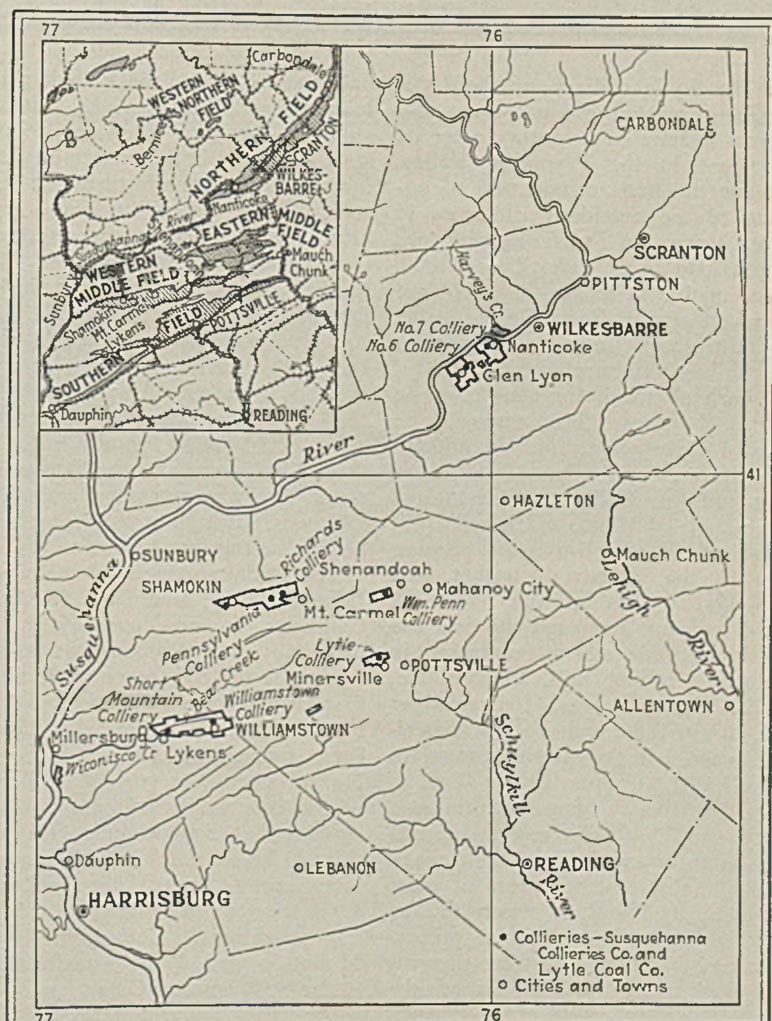
The Nanticoke and Glen Lyon operations, originally owned by the Susquehanna Coal Co., are in the region which saw the birth of the industry. It was near Wilkes-Barre, ten miles from Nanticoke, that the Indians mined anthracite as early as 1742, and it was in this part of the Wyoming Valley that Abijah and John Smith opened a mine early in the nineteenth century, shipping 55 tons of coal by boat down the Susquehanna River to Columbia in 1807. Nobody would buy their coal, but the next year, following Judge Fell's practical demonstration of the combustion of anthracite in an open grate, the Smiths made several more shipments to Columbia and sent masons with the coal to construct fireplaces and show consumers how to use the new fuel. By 1812, the market had so widened that the Smiths were able to ship "stone coal" via Havre de Grace, Md., to New York. The enterprising brothers continued in the infant industry until 1826, and their pioneering efforts were a spur to others entering the field.

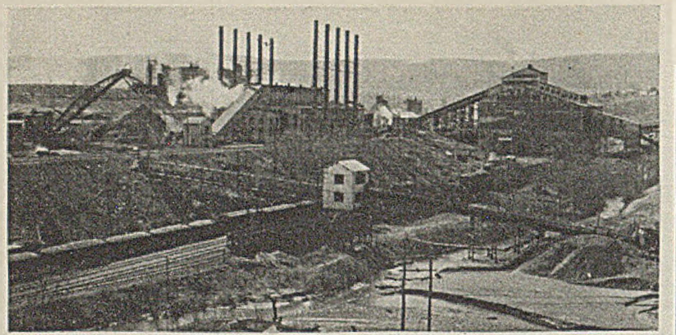
The seams worked by the Smiths apparently were known as far back as 1774, for Obadiah Gore, Jr., the Wilkes-Barre blacksmith who used anthracite in his forge as early as 1769, in a letter to the proprietors of the Susquehanna Co., May 16, 1774, declared that there was "a large quantity of good stone coals" in the Harvey lands, which were purchased by the Susquehanna Coal Co. nearly 100 years later.

Although the presence of coal near Shamokin and Mahanoy City, in the Western Middle field, where the Pennsylvania, Richards and William Penn collieries are located, was marked on Schul's map of 1770, discovery of anthracite around Shamokin is credited to Isaac Tomlinson, who began to use it in his forge in 1810. First coal from the Shamokin district was taken to market by a 14-year boy, John Thompson, who mined a two-horse load on Quaker Run and sold it to a shoemaker in Sunbury for $5. The first shipment on a commercial scale took place in 1826, when coal was floated down the Susquehanna River to Columbia.

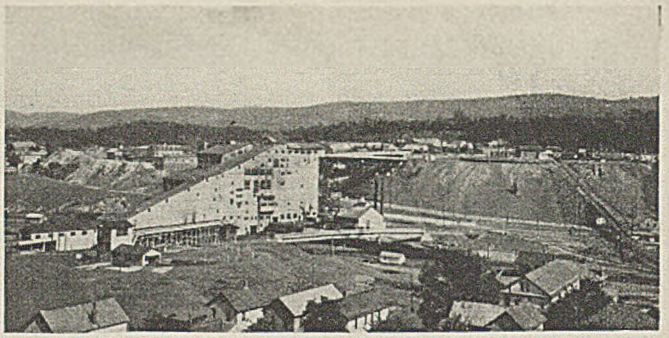
While coal from the Southern field,

Map of Anthracite Fields, Showing Properties of the Susquehanna Collieries Co.

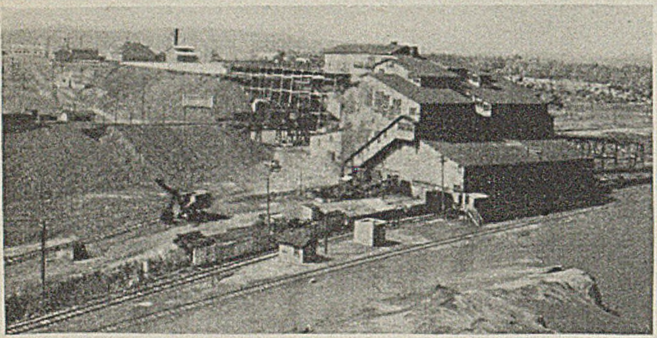




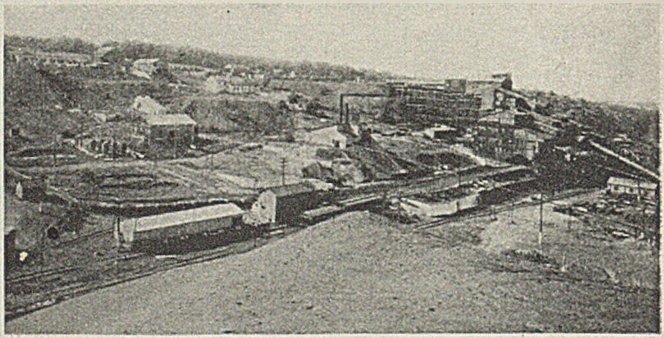
No. 7 Colliery, Nanticoke



No. 6 Colliery, Glen Lyon



Pennsylvania Colliery, Shamokin



Richards Colliery, Mt. Carmel

where the Lytle colliery of the Lytle Coal Co. is located, did not come into use for a quarter of a century after its employment in the Wyoming Valley, credit for the first introduction of anthracite to the outside world goes to William Morris, of Pottsville, who took a wagon load to Philadelphia in 1800, but was unable to sell it. Col. George Shoemaker, also of Pottsville, made the second attempt to introduce anthracite in the Philadelphia market in 1812. Despite sharp criticism for attempting to palm off worthless "black stones," he succeeded in demonstrating how anthracite could be burned successfully in the rolling mill of Mellon & Bishop and the wire mill of White & Hazard. Col. Shoemaker's efforts drove the opening wedge in the industrial market, and the Mellon & Bishop and White & Hazard incidents presaged the first use of anthracite for steam generation in Thompson's rolling mill, Phoenixville, in 1825, its use on the Hudson River ferryboats in 1836, and the first experiments in the firing of steam locomotives on the Beaver Meadow R.R. in 1836.

By 1830, the cheapness, cleanliness, smokelessness, and relatively higher efficiency of anthracite boomed the demand to such heights that operators of those days found it difficult to supply the demand. A rush for anthracite properties ensued, bringing about the pressing question of transportation. Early shipments, following the flow of the streams, had been largely to the Philadelphia district and adjacent regions, with occasional cargoes to tidewater transshipment points. But the uncertainty of navigating the frequently turbulent streams soon turned people to canals, which offered slack-water transportation free from the usual stream hazards. Most of the key canals in the region, including the Schuylkill River, Lehigh, Delaware and Hudson, Morris, Pennsylvania and Delaware Division waterways, were proposed and completed between 1800 and 1830. As the canals, in a great many cases, could not be brought to the mines themselves, some intermediate transportation link was necessary, and the early railroads, using animals for motive power, sprang into being.

The initial shipment of coal from the Lykens Valley, where the Susquehanna Collieries Co. now operates the Short Mountain and Williamstown collieries, was made in 1836, seven years after the first survey for a railroad from Millersburg. The track consisted of light timbers, topped by $\frac{1}{2}$x$1\frac{1}{4}$-in. strap iron. Horses drew the coal to Millersburg, where it was loaded into flats, taken across the Susquehanna River, and shipped by canal. The first steam locomotive, the "Lykens Valley," appeared in 1848, the year the Franklin Coal Co. began operations. Coal from the Short Mountain and Williamstown collieries of the Susquehanna Collieries Co. still is sold as Franklin anthracite.

Steam railroad transportation developed rapidly after the historic trip of the "Stourbridge Lion" in 1829, and within a space of a few years forced the reconstruction of a number of canals to enable them to compete more effectively. This reconstruction, however, could not save the day, although the Susquehanna Coal Co. continued to ship by canal from Nanticoke until early in the present century.

The rise of the railroads brought about the early formation of the Pennsylvania R.R., which, like most of the original carriers, depended to a considerable extent on transportation of anthracite for its revenues. To safeguard their traffic, the roads not organized as subsidiaries to or direct affiliates of existing mining companies began to take over control of coal lands and operating properties. Following this precedent, the Pennsylvania acquired control of the Mineral R.R. & Mining Co. (1864); Susquehanna Coal Co. (1869); Summit Branch R.R. Co. (1876); and the Lytle Coal Co. (1891). The Summit Branch R.R. Co. later acquired control of the Summit Branch Mining Co., and the latter took over the Lykens Valley Coal Co.

The Mineral R.R. & Mining Co., shortly after 1870, took over the Cameron colliery (opened in 1840 and now leased to another company) and the Luke Fidler colliery (abandoned). Both of these were in the Shamokin district.

In 1878, the Union Coal Co. was organized, leasing lands from the Mineral R.R. & Mining Co. The Union Coal Co. started a number of operations in the Shamokin region, including the present Pennsylvania and Richards collieries and several others now abandoned. The Union Coal Co. gave up its lease in 1903, and from that time on its properties were operated by the Susquehanna Coal Co. as agent for the Mineral R.R. & Mining Co.

The Pittston R.R. & Coal Co., chartered in 1869, changed its name to the Susquehanna Coal Co. a few months after its incorporation. This company, however, was not the first to bear that corporate name, as early records of development in the Wyoming Valley mention the formation of the Susquehanna Coal Co., a limited partnership, to dig and transport stone coal from Pennsylvania to New York or other proper markets. A map of the company's holdings included lands earlier owned by Obadiah Gore, Jr. Apparently, the original Susquehanna company went out of existence in the depression following the War of 1812, though no record remains.

Two-thirds of the stock of the Susquehanna Coal Co. of 1869 was owned by the Pennsylvania R.R., and the remainder by the Pennsylvania Canal Co. In making purchases in accordance with the terms of its charter, the Susquehanna company secured the old Lee, or Broderick, mines. These were originally opened by Washington Lee, who shipped 1,000 tons of anthracite down the Susquehanna River to Baltimore in 1820.

Between the date when the Lee mines were purchased and the opening of canal navigation, the Susquehanna Coal Co. mined and stocked 1,191 mine cars of lump, 790 cars of fines, and 2,110 cars of mixed coal. Sizes apparently were little changed from those prevailingly shipped from the same operations in 1855, when coal was prepared by pounding it through bars with a hammer, after which it was passed over screens to produce lump. A small breaker roll was installed in the original Lee breaker between 1858 and 1863. In 1874, however, the Susquehanna Coal Co. was marketing lump, steamboat, broken, egg, stove, chestnut and pea. No. 1 buckwheat was added to the list in 1884, and No. 2 buckwheat in 1886.

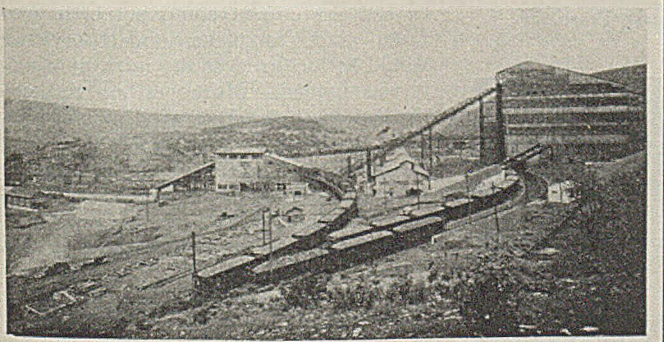
The present William Penn colliery, which was opened by S. E. Griscom & Co. in 1864, was leased by the Susquehanna Coal Co. from the Girard Estate in 1899.

Present operations of the Lytle colliery of the Lytle Coal Co., taken over by the Pennsylvania R.R. in 1891, are largely in what is known as the Lytle tract, near Minersville and Pottsville. The colliery also works to some extent the old Wolff Creek and Manhattan tracts, the scene of operations before 1844, when Gideon Bast built what probably was the forerunner of the present anthracite breaker. Bast's breaker was located at Wolff Creek, and employed a system of rolls, patented by Joseph Batten, Philadelphia, for breaking the coal. The original Batten equipment consisted of cast-iron rollers with projecting teeth, and while roll design and construction have been improved since his day, the principle is still the same.

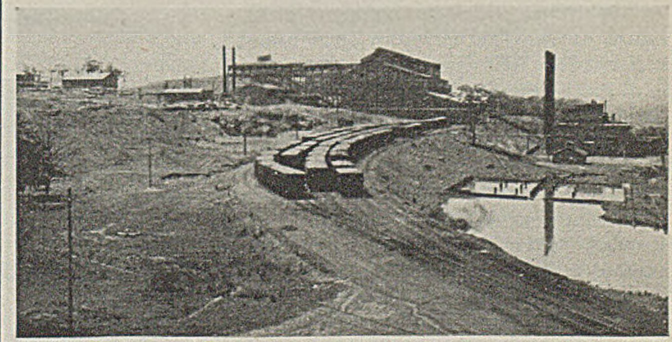
For many years after the Pennsylvania R.R. acquired control of its various anthracite properties, they were operated as entirely separate organizations. It was not until 1885 that the management of the various companies was centralized in Wilkes-Barre, with Irving Ariel Stearns as general manager. Even so, the different operating companies retained their separate corporate identities until they were purchased by the Susquehanna Collieries Co. in 1917.

Present properties of the Susquehanna Collieries Co. and the Lytle Coal Co., embracing eight collieries operating fee and leased coal lands totaling 16,269 acres, are the outgrowth of a long history of acquisition of coal lands and development, operation and abandonment of collieries, culminating in the assemblage of a group of operating properties stripped for action in today's competitive markets. What these properties are doing to meet present-day demands on management, operating and sales policies is told in the following pages.

William Penn Colliery, Shenandoah

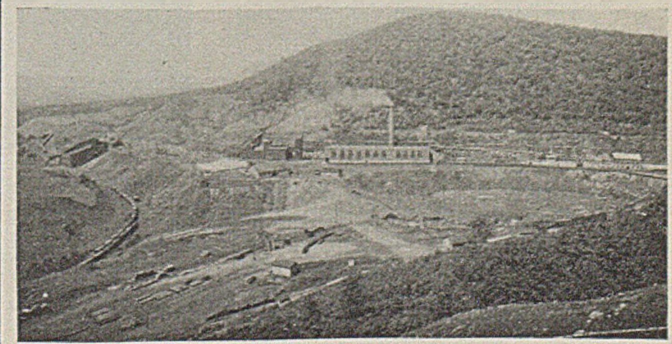


Lytle Colliery, Minersville



Williamstown Colliery, Williamstown

Short Mountain Colliery, Lykens



MANAGEMENT

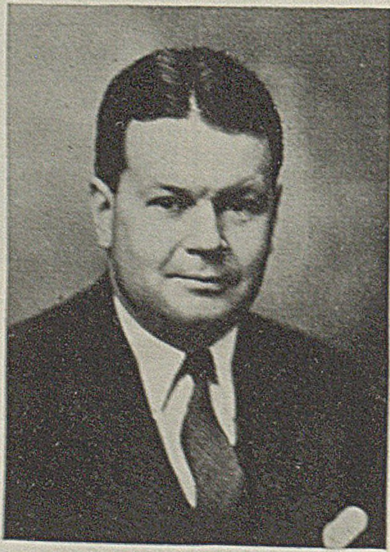
+ At Susquehanna Collieries

MANAGEMENT at the Susquehanna Collieries Co. is one which embraces the delegation of authority among six separate operating units, with control by a headquarters staff. In all large companies, of course, regardless of their respective theories of management, will be found both staff and line officials. Such companies differ only in the degree in which their authority has been centralized in the hands of a dominating staff. The division of companies into line organizations like the Susquehanna Collieries Co. and into staff organizations of which there are many models is, after all is said, only relative.

Some companies have a large staff of experts in all the several lines of engineering technique, who practically direct every detail of the operations at all the various mines which the company owns. Local, or line, authority in such mines is limited to following the express rules laid down by the staff. While, with such an organization, there is, and must be, some responsibility in the local management, it is strictly limited. The staff feels that if it does not have a rule regulating every action and does not forecast every unfavorable circumstance, it lacks prescience and fails of its duty. Any initiative in the line officials, on the other hand, is likely to be regarded as a motion of lack of confidence in the judgment of the staff officials. Even lacking this attitude on the part of the staff, the line officials in such companies are discouraged from deviating a hair's breadth from the "thus and thus" of higher authority.

In consequence, the local superintendent and his assistants feel they are provided with a "perfect alibi" if the mining cost be too high, if production falls, if the yield of prepared sizes per ton is low, or labor troubles disrupt operation. The plans are not theirs, and the failure rests not on them but on the planners. They realize that they are rated, at least as far as their immediate superiors are concerned, on their unquestioning and undeviating compliance with the rules laid down for their guidance rather than on their success in the handling of the helm.

James Prendergast, President

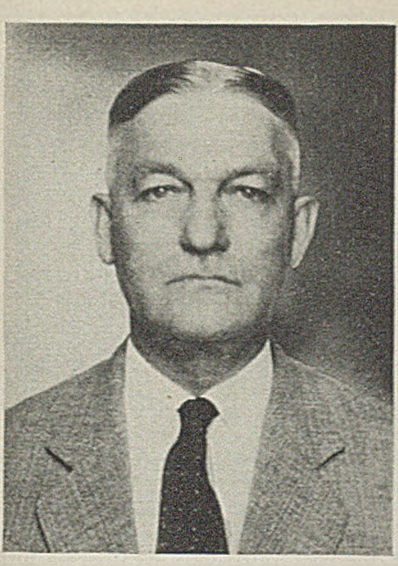


C. A. Gibbons, General Manager

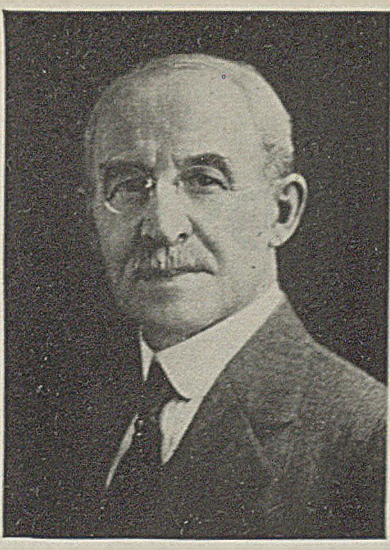
With the Susquehanna Collieries Co., on the other hand, effort is made (*a*) to break down such defenses by delegating authority to the colliery superintendents, each in his own bailiwick, holding them strictly responsible for costs; also (*b*) to save the expense of employing a staff of experts who, when employed, usually are so busy traveling from mine to mine that they can give only cursory study to details at the many and widely scattered mines under their control. It is recognized that the interposition of the authority of such staff officers must inevitably cause delays in execution because of the many places at which their investigations and decisions are simultaneously in demand.

However, no company with many mines can entirely escape the necessity of providing staff officials, no matter how competent the local officials may be. The advantage of coordination would be lost, equipment could not be moved from place to place, and experience would be localized at the mine at which it was gained. Moreover, no superintendent has quite so well balanced a mind that he is equally expert in design, construction, electricity, ventilation, mine layout, steam raising and pumping, to mention only a few of his duties.

Consequently, a small staff is maintained by the Susquehanna Collieries Co. headquarters at Nanticoke—the general manager, who, of course, is in charge of both staff and line officials; an assistant to the general manager, who is also purchasing agent; a chief engineer; an electrical engineer; a supervisor of safety and compensation; and a chief coal inspector, all of whom report directly to the general manager. Development and operation are in the hands of the colliery superintendents, who also report to the general manager, but if equipment has to be moved, such matters come up to the chief engineer and the electrical engineer. They transfer equipment from mine to mine and make provision for movements of equipment even within any mine, and, if they cannot see eye for eye with the colliery superintendent, the general



E. B. Worthington, Chief Engineer



C. K. Gloman, Assistant to the General Manager

C. H. Matthews, Electrical Engineer

manager—if he has not already discussed the matter—comes into conference and decides the point. In all matters, he is the final arbiter.

Colliery superintendents have their own mining and mechanical engineers to prepare plans, make estimates and survey mines. They also have their own clerical force to prepare payrolls, pay the men, and keep cost accounts and records.

Subject to the general manager, they hire their own working force, act with others in tax cases and make their own local sales. Even where large expenditures have to be made, the plans and designs are made by them and their engineers, so that they are responsible in a large measure for the effectiveness and economy of these undertakings. All colliery plans, however, are first discussed with the general manager and his staff and, before execution, must be approved by the former. The actual operation of the mines, their permanent organization, and output are under the control of the colliery superintendents, yet always subject to the intimate and close supervision of the general manager and his staff.

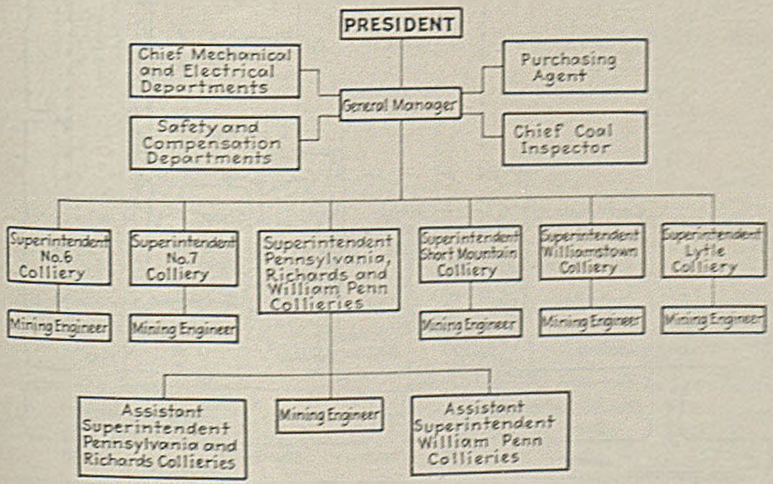
Such men have to be capable, and, in general, mining engineers of experience have been chosen for these responsibilities. Care is taken to see that they have a progressive spirit and minds so trained that they will not leap at conclusions, but rather will marshal all the facts and base their conclusions on them. But, even this is recognized as insufficient. There also must be a driving incentive to excel. The Susquehanna collieries have so many and such varied problems that comparisons as to mining costs and labor quotas are not so illuminating as with companies with mines having more uniform conditions. Nevertheless, the costs of each mine are made known to all of the colliery superintendents for comparison. If any costs are out of line, they must be ready to explain why, not only to headquarters but, what is far more important, to themselves. They are informed as to their costs, not as to labor and supplies only but as to all overhead charges from the depths of the mine to the office at Cleveland, Ohio.

If they make an expensive improvement, they are kept in constant mind of it by an increase in the interest, replacement and depreciation charges. This keeps them from regarding everything as "velvet" that is not covered by the two items, labor and supplies. Thus the colliery superintendents, fortified by these confidential statements, take unconsciously the executive viewpoint. It becomes their responsibility to keep their units "in black ink." They know without question whether their particular operation is an asset or a debit—one to be kept in operation or discontinued.

Payrolls are, of course, prepared at the several mines twice monthly, and from these is evolved monthly a distributed cost statement which is forwarded to the general manager for distribution to the president and secretary of the company. The latter prepares a general analysis, which is sent to the president and general manager, and by the latter sent to the six colliery superintendents. They can see, and so can the general manager, if they are out of line—so high as to raise the cost of coal unduly or so low in places as to jeopardize future production. In these cases, each colliery superintendent must justify his costs. Development costs that are out of line must be defended by producing a forecast of future needs, for every mine has such a forecast, the preparation of which falls on the colliery superintendent and the colliery engineer.

Traveling auditors, one for the outside and one for inside operations, test the details of all colliery records—time books, yardage records, payrolls, etc.—and report to all concerned. A daily report of hoist and shipments is made at Nanticoke from telephonic advices.

Organization Chart, Susquehanna Collieries Co.



(Turn to page 382)

MINING METHODS

+ At Susquehanna Collieries

ONE might estimate the degree of contortion of a coal field by the number of its folds and faults, and describe contortion as great when the folds are many and shallow; another might regard sharpness of folding and depth of basin as a measure of contortion.

Judged according to the first point of view, the Lykens Valley basin, in which may be found only Williamstown and Short Mountain of the Susquehanna Colleries Co. and Brookside of the Philadelphia & Reading Coal & Iron Co., is the least contorted of all the basins. It has a single profound sharp synclinal fold which lies in the northern and shorter of the two important "fish-tail basins" that extend across the line from Schuylkill into Dauphin County toward Dauphin and Millersburg, respectively (see map on p. 351). It is the profundity of these synclinal folds that has protected the coal from erosion.

Williamstown and Lykens lie in the valley of Wiconisco Creek, in which, indeed, there is no coal. The great syncline in which the Lykens and Short Mountain mines are located lies to the north over a mountain and is roughly bisected by Bear Creek Valley. The two Williamstown shafts are located on opposite sides of Bear Creek, No. 1 being on the northern slope of the synclinal and No. 2 on the southern slope. No. 1 has been temporarily abandoned. No. 2 still has many years of usefulness.

Bear Creek was so steep that to build a railroad up its bed was out of the question. Consequently, from their construction, both shafts have been approached from the Wiconisco Valley by a tunnel driven through the rock and 3,700 ft. long. Thus the breaker and main buildings are located in the Wiconisco or Lykens Valley, and the mines in the valley of Bear Creek, a relatively smaller depression in the summit of a lofty mountain.

This single-track tunnel passes through solid measures of the Pottsville Conglomerate Series and Lower Productive Coal Measures, and needs, accordingly, but little timbering. The south portal is bricked, and the north portal has about eighty semicircular steel arches. At the far end, a switch leads off along a Skidmore level to the shaft, the cars not being hoisted to the surface.

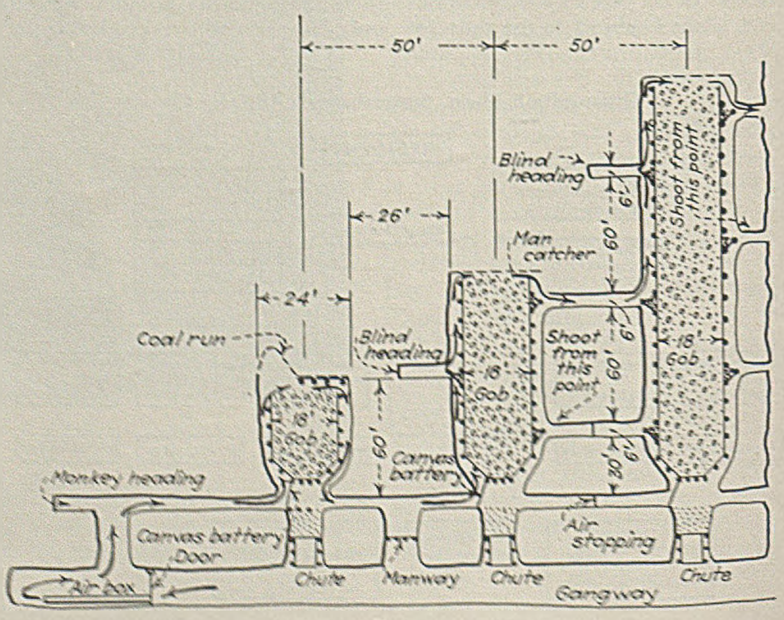
The collar of No. 2 shaft at Williamstown colliery is at an elevation above sea level of 1,317.5 ft. Its bottom landing is 281.3 ft. below sea level. No. 10 slope, which is driven off the bottom landing, has its first level 500 ft. below the sea level. Here the roof gives little trouble, but has been provided with steel sets, especially in that part of the tunnel near the slope. To support the roof, wood sets were first used, and they functioned until they began to rot. Thus they took up the initial settlement, which, apparently, was not great.

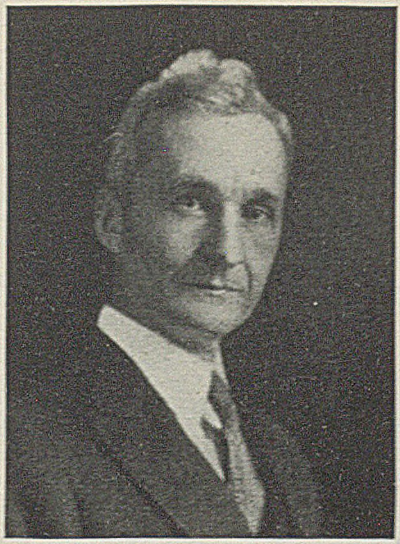
Steel sets were then erected, with their posts suspended above the floor. Concrete was run in forms under and around the posts, a few inches of wood being laid under the posts to allow for roof settlement. H-sections, 7½ ft. long, were used for posts and I-beam girders for collars, the lagging being of 40-lb. per yard steel rail. This form of support seems to have given entire satisfaction, doubtless because the gangway is in solid rock of unusual strength.

In the unsupported parts of the tunnel, the roof apparently weathers a little in course of time and gradually arches to a height from 2 to 3 ft. above the driven cross-section, but in places it has been found advisable to use a coating of gunite about ½ in. thick, which has prevented further weathering. When the roof in these tunnels gives way, it bumps. Some sand falls; sometimes as much as two bucketfuls. Thereafter the roof breaks and falls, forming an arch which is not high and stands well thereafter.

A different condition is confronted where the north tunnel reaches the lower bench of the Mammoth, known as No. 9, bed, and a gangway is driven in the coal. As the seam pitches consistently at an angle of 85 deg., coal forms the roof of the gangway. The footwall is sandstone and the hanging wall is the sandy slate rock which lies between the lower and middle members of the Mammoth, 5 ft. of which is excavated to make gangway width, the coal bed being only 7 ft. thick and not wide enough to accommodate a full-sized roadway.

Fig. 1—How Breasts Are Normally Driven, Ventilated and Made Safe in Lykens Division





W. B. Geise, Superintendent, Short Mountain Colliery

Here, heavy 12-in. round white oak timbers are used for posts and caps, set at 5-ft. centers. Two forepoles are used, one on either side of the gangway. The forepoles, as they are driven forward, are covered by 1-in. smooth white oak boards, called locally "shingles," which extend clear across the opening.

After the front set has been placed, always close up to the coal face, a lagging of poles is laid under the shingles for the protection of the gangway. Lagging usually is placed also behind the timbers. In almost all cases the coal is mined by picks and bars, usually without shooting, and always without mechanical cutting, the holes for shooting being drilled by jackhammers.

Coal is dug off the face of the gangway and loaded into cars. A parting 3 ft. from the footwall and the rock from the hanging wall are also loaded with the coal, to be removed later in the breaker. Sometimes the face is lightly shot, not so much to dislodge the coal as to shake it and release the gas, which often causes bumps and makes the coal fly off the face. Sometimes as much as two cars of coal will be bumped off the end of the gangway by gas pressure, but dust is never discharged, as it is in the coal bursts of British Columbia and Scotland. The sides, being in rock, do not bump but occasionally slab off, giving heavy side pressure.

If the coal is left unmined for any length of time, this tendency to fly is exhausted, and the face is said to become "dead," the coal not being in any way physically affected by the draining off of the pent-up gas. The Mammoth bed consists here, as elsewhere, of conchoidal coal with little evidence of stratification. Breasts are driven up the coal bed, but a description of these is left till later.

All the development of No. 9 bed is provided by level rock tunnels driven from the gangways in the Middle Split of the Mammoth, which is known locally as the No. 9½ bed. It is found necessary, for safety and permanence, to haul coal and ventilate the workings either through tunnels in solid rock or through gangways driven in a thin seam which is not being weakened by any mining other than that necessary for gangway extension. This No. 9½ bed, with its 28 in. of coal, well performs this ancillary purpose for bed No. 9. It lies about 125 ft. from that bed, the separating strata being sandy slate and sandstone. The few inches of coal in the bed makes the construction of the gangway less expensive than it would be if it had to be made in solid rock.

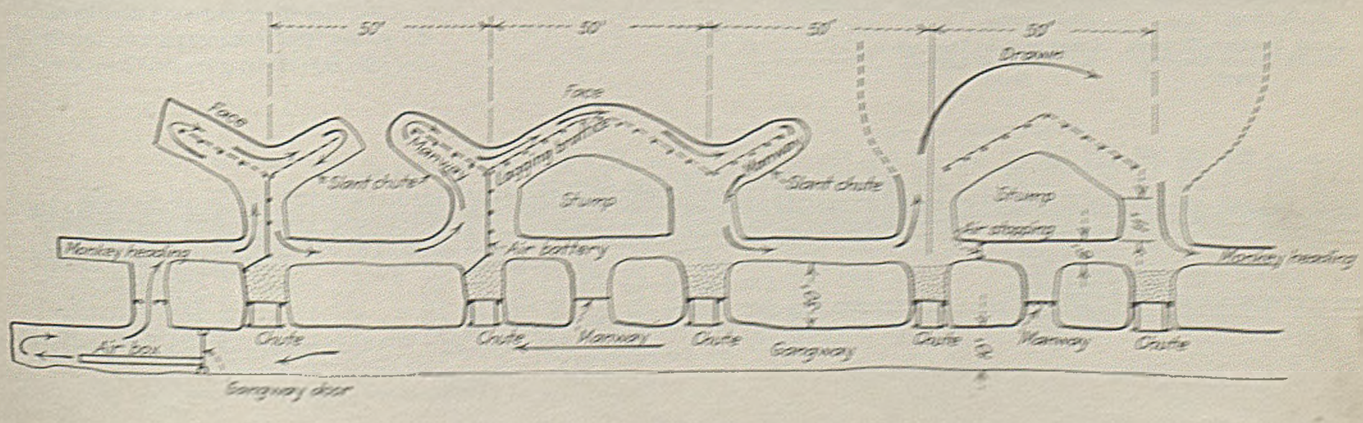
By means of these gangways, driven mainly in undisturbed measures, the bed that is being mined, and consequently is in danger of collapse and sure to be kept with difficulty in condition for haulage, can be divided into sections. In case of movement and resultant danger, the men can retreat to the gangways in No. 9½ bed, where they will be in safety. Objection might be raised that the upper bed is in danger of collapse because the bed below it is worked, but that risk is only apparent, for while geologically above the Bottom Split—as both are on a slope of 85 deg.—the Middle Split is really not superimposed on the Lower Split but is side by side with it. As the measures are tilted, it is possible to go from one bed to the other without the driving of planes.

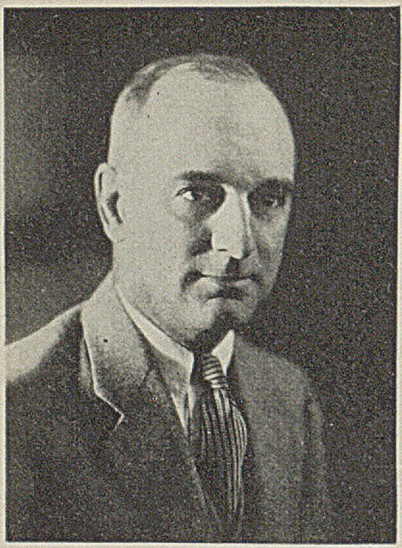
R. A. Hedland, Superintendent, Williamstown Colliery

No. 2 bed of the Lykens Valley measures, known as the "Big Lykens," is 9 ft. 6 in. thick and has a roof of conglomerate without any intervening slate. It is a remarkably clean coal bed, containing less than 1 per cent of removable refuse. The interval between the two Lykens Valley seams is slate. The Lower Lykens Valley bed, or No. 1, is 2 to 15 ft. thick and is brought out with No. 2. These Lykens Valley beds are sectionalized by rock tunnels driven in the Pottsville Conglomerate at a point geologically about 150 ft. under them. At every 800-ft. interval, a tunnel is cut across to the Lykens Valley seams and, at every 4,000 ft., tunnels are driven at right angles to the basin as far as the Mammoth bed.

In both the Lykens Valley beds and in the lower split of the Mammoth, breasts are driven 150 to 270 ft. up the pitch, with the upper level as the objective, but unmined coal may run out of the breast before that goal is reached and put a stop to further extension of the working. The breasts are driven at 50- to 55-ft. centers, dependent on the position of the timber sets. As the pressure and gas tend to cause the coal in the gangway pillar to run, it is impor-

Fig. 2—Preparing a Running Coal Face for Shooting, Lykens Division





E. Y. Randall, Superintendent, Lytle Colliery

W. W. Williams, Superintendent, Shamokin Division

tant that the opening for the chute be made narrow. Hence it is not possible to provide room for a manway alongside the chute near the opening, so a separate crosscut is made between the chute openings for the passage of the men.

A 50-ft. pillar is left above the gangway and a 6-ft. airway is provided connecting the breasts. Above this monkey heading, or airway, breasts are widened to 24 ft., including manways 3 ft. on either side, with a box in the center which is filled with coal as the place advances, excess coal being removed in the usual manner so as to maintain a bed of coal or "gob," on which the men stand and work.

Man-catchers, devices first introduced by the Susquehanna Collieries Co., are placed at each "heading." These are wing projections outside of the box which catch falling coal and become filled, so that, should a man fall down the manway, the man-catcher would arrest the fall and he would slide into the "heading." Should the breast have reached up to the "heading" above, the fall would be extremely severe, the drop being about 60 ft. and, although cushioned, would be of doubtful value; but betweenwhiles the fall would be much less, and the man-catchers have proved to be quite helpful in reducing fatalities. Without them, the men might fall to the bottom of the manway, with results that could not fail to be fatal.

If the coal on one side of the face begins to free itself and "run," timbers are set against the face and lagged if necessary. By removing the lagging in places, the coal can be mined across —say, from left to right—and retimbered as the advance proceeds. On reaching the right rib the coal is mined from right to left, timbering and lagging being provided as progress is made. This goes on till solid coal is found. If, however, the coal persistently runs and is dangerous, driving of the place is discontinued, the face is drilled and then shot from the gangway, with the result that the place runs itself clear, probably bringing both pillars with it.

There are many instances, however, where the coal proves ready to run from the very beginning of operations. In such cases, the breasts are driven up only about 30 ft. above the airway, and wing "headings," or "slant chutes," from adjacent chutes are driven to meet each other, so as to leave a stump above the airway and a long continuous face extending over two or more breast openings. The face is then shot heavily from the gangway, starting a "run" which brings down thousands of tons of coal, the place widening out to unknown widths and usually continuing up to the next level. Some breasts are being driven up and some continuous faces, such as described, have been known to deliver as much as 3,000 tons before the coal ceased to flow.

Every little while the coal will clog in the chute with timber, large coal and roof refuse, and a man with a bar will have to start it running again. But after the coal has ceased to run, no effort can safely be made to start it again or to see if it has cleared out the face and pillars. The coal is then marked on the map as extracted, and the breast abandoned. If the unmined coal in the breast does not run and the breast is driven its full length, the coal in the chute is allowed to run out at the gate, or, in mining lingo, the "run is pulled." The breast then stands until the retreat, when the pillar is drilled from top to bottom and shots are fired all at one time, starting the coal running. It is then withdrawn through the gate at the foot of the chute. Later, the stumps are mined and the gangways abandoned.

As stated, the gangways are sectionalized into 800-ft. lengths. When a sec-

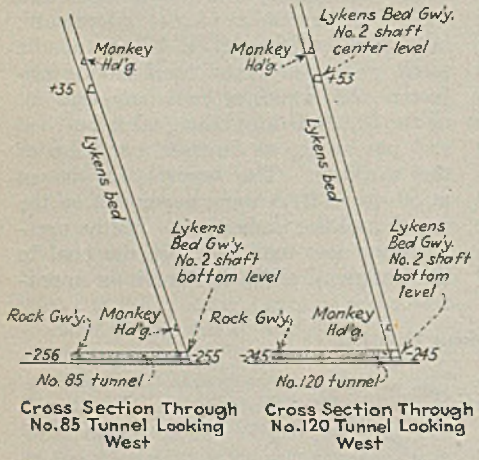
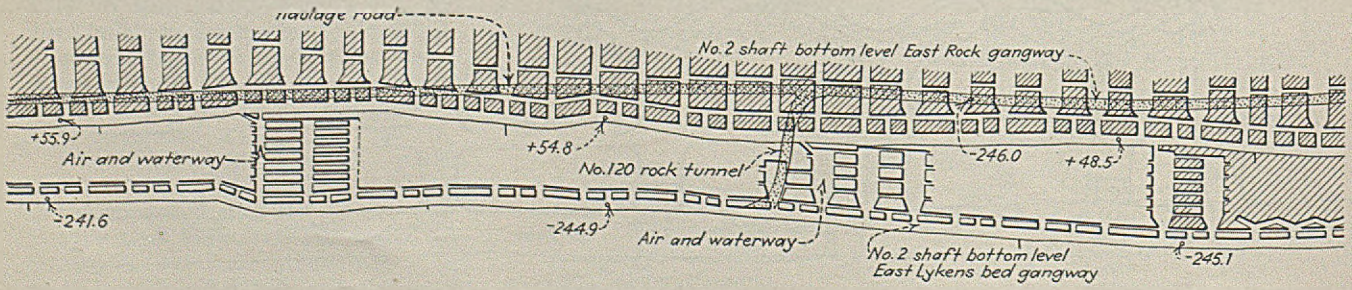


Fig. 3—Three Sections From a Rock Tunnel. One Section Driving Breasts, One Drawing Pillars, One Removing Stumps. Note Method of Tapping Upper Level to Free Water



tion is started, it is customary to drive up three groups of standard breasts in coal that does not run, until a point is reached near the upper level. The men in one of the outer rooms then cautiously drive a slant chute up into the level above, to release any water that may have accumulated in that level.

One group of breasts is driven near the tunnel, one near the middle of the section and one at the far end. Three breasts are driven instead of one, so that the men shooting the end of the slant chute can do so from the most remote of the three breasts and so will escape the flood of water that the shots may release. The rock crosscut from the rock tunnel serves as intake airway and waterway for the section as well as a means of ingress of empties and of egress for loaded cars. Work is so scheduled that one section is driving breasts, another robbing pillars and a third withdrawing stumps. In this way production is kept normal at all times.

Asphyxiations are likely to be caused by coal falling in manways and blocking the airway. To avoid such accidents men are not allowed to shoot the coal from a blind "heading" or from the top "heading," even though holed through. They must go down at least to the next lower "heading" to fire their shots. Every miner carries a Koehler safety lamp as well as an electric lamp.

Thus far, difficulties of mining have not increased with increased depth. The pressure on the bottom of the basin must be prodigious because of its depth and its almost knifelike termination; but, as the wedge is supported without apparent movement at its base, there is little to cause side pressure on the beds being worked.

Short Mountain coal seams run quite freely and they lie as regularly as in Williamstown. As the mines go down, the coal runs more readily in both collieries, which is not a disadvantage. Uncertain running of the coal makes mining and planning difficult. There are two large slip faults, both seeming to be due to a breaking of the measures, caused by the pressure of the basins on the unyielding bottom. One has an overlap of 900 ft. However, it is in the upper measures that the greatest contortion occurs. In a rock tunnel the Primrose, or No. 11, bed, owing to four breaks, is encountered seven times near the bottom of its basin.

As the Short Mountain shaft was sunk near Bear Creek at an elevation of only 897.1 ft. above the sea, it soon reaches an extremely low level. The depth of the shaft to the bottom, or Fifth Level, is 1.590.1 ft., making the elevation at this level —693.0 ft. The bottom of the sump is 50 ft. lower. The Ninth Level in No. 9 slope is 1,291.6 ft. and below sea level and the Ninth Level in No. 12 slope is —1,270 ft. No other workings in the anthracite region go to so low a level, though some may be deeper as measured from the collar of the shaft. Far greater depths than these will be reached later.

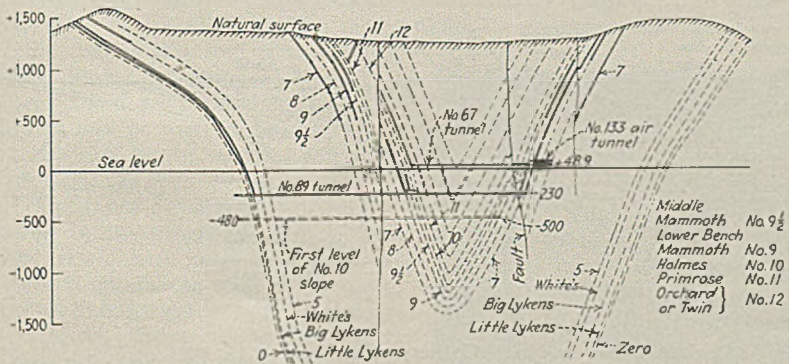


Fig. 4—Cross Section, Lykens Valley Basin at Williamstown

When, in 1836, the Franklin Coal Co. commenced operation, it drove tunnels into the mountain until the coal beds were reached, gangways then being driven in the coal, which frequently "squeezed." Later, slopes from the surface were sunk in the bed and, from these, levels were driven for the removal of the coal. As the gangways extended, an immense quantity of timber had to be used for new construction and replacements. These practices were continued until 1912, when a shaft was sunk, at Short Mountain, in the footwall, with landings at each of the old levels.

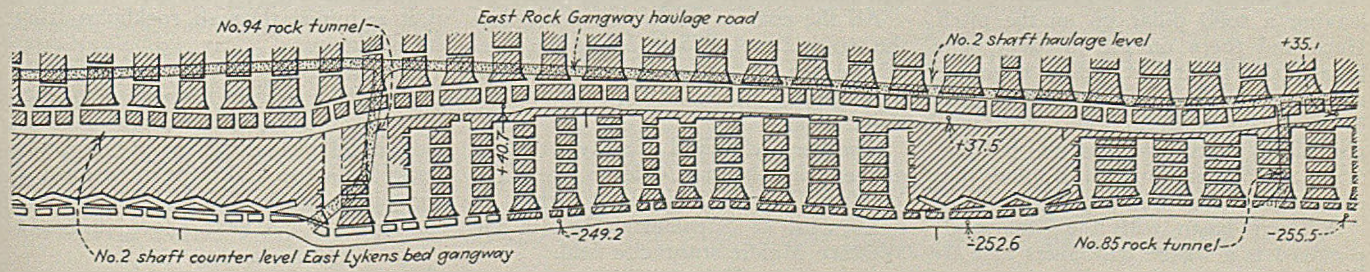
In the development of this shaft, it was noted that the tunnels held up well in the rock strata. As a result, a rock gangway was located about 250 ft. under the Mammoth bed. Cross tunnels were driven at 1,000-ft. intervals to the bed, and the level was thus sectionalized. Because of the presence of slip faults, many falls of rock occurred. Such places were timbered, but the cost of such timbering was found to be neglibile as compared with that where the gangways were driven in the coal. When the gangways had been advanced about 2,000 ft., the same procedure was followed on lower levels. In 1922, similar methods were introduced at Williamstown, a gangway being driven 125 ft. south of the lower bench of the Mammoth.

Whether Short Mountain originated the practice of driving rock gangways is not quite clear. Certain it is that its officials devised the method for themselves as a means of meeting the difficulties confronting them. Today, however, the practice is widespread.

To aid in the work of driving these rock tunnels, four Sullivan scraper mucking machines have been introduced, which drag the rock as a gardener's hoe drags soil. The rock thus dragged is led up a portable inclined gantry, from which it drops into a car. This machine was described in *Coal Age*, April, 1930, pp. 208-209.

Lytle colliery, which, like Williamstown and Short Mountain, is in the Southern field, but 19 miles to the east, being near Minersville, only 6 miles from Pottsville and in the County of Schuylkill, is still within the area where little of the coal is suited to direct mechanical loading and where runs of coal from the unmined seam are to be expected, at least in certain of the beds.

Much of the coal near the tops of the synclines, which would have been suited to mechanical loading and conveying, was mined in earlier years when these more modern methods were, as yet, not dreamed of. Most of what remains is



in steep pitches, where the coal will slide on plates or without them. For this reason there has thus far been no mechanical loading.

Only the softer coals run at Lytle colliery. They may be found in all parts of the measures. Principal among the running seams are the Big Diamond, Primrose, White Ash (Top Split of Mammoth) and Skidmore. Though running is more likely to occur with depth, the Big Diamond, which is nowhere over 1,000 ft. deep, will run at quite shallow depths. Thus, a gangway where the breast pillars were believed to have been completely drawn, was filled up by a rush of coal.

Old maps showed the pillars had been removed, but one cannot rely on these, or indeed on any map, because it was customary to regard coal as having been removed when it had run to such an extent as to close up the openings and make further mining difficult. Even today, just what coal a rush has removed cannot be definitely determined.

In this instance, as it is thought that the running of the coal probably did not extend far up the breasts, a counter will be driven across them and an attempt will be made to remove what coal remains. In this counter, a small buggy will be used that will have a capacity of 25 cu.ft., or about one-fourth of a normal coal car. Because of the runs, curls, rolls and slip faults in the basin, operation of this seam, the Big Diamond, is quite difficult, and it may be necessary to put a rock tunnel below part of it and to sectionalize it so as to reduce maintenance charges.

Leading among running beds is the Primrose, the coal of which is slippy and slithery. The Primrose will run even in the breast. In some cases it will run into the gangways and airways, leaving a solid pillar up on the pitch. Here and there on the lift will be a breast, the pillars of which have not run at all, or have not run much, and by timbering such a breast wall it is possible to reach coal that will not run, drive a counter through it, and thus recover coal that has not run.

A sharp basin with the coal partly removed is a wedge with sides that are in a degree free. The wedge rests on the coal at its point, bringing an immense weight upon it, so that the coal at the bottom of the basin is under such inordinate weight that it cannot be removed, at least by present-day methods. Deep as it is, that depth does not suggest the pressure to which the coal in the bottom of the basin is subjected, for that coal must support not only the rock and coal immediately over it but almost all of the wedge-shaped cross-section that lies teetering above it.

The White Ash, or Top Split of the Mammoth, also tends to run, and here in one place it was realized that pillars could not be mined by driving long skips up the sides of them, nor could they be safely and completely mined by splitting them from end to end at a single operation from the airway up, so a counter has been driven and the pillars are being split up from the level of the counter. That done, the lower end of the pillars will be split from the airway up. By this means it is expected that all the coal will be recovered.

Another bed in the Lytle colliery that runs freely is the Skidmore. This seam in one section was found to be only about 6 in. below the Black Heath. Only a few hundred feet away the interval had been 30 ft. It was quite a surprise when this thinning of the interval was discovered. As the mined seam is so close to the Skidmore, and as the Skidmore is soft, the latter bed will be mined from the Buck Mountain bed below, which it is from 8 to 10 ft. thick, at least on the east end of the property. Rockholes on 35 to 65 deg. to the horizontal will be raised from the Buck Mountain, and from the top of these holes counters will be driven in the Skidmore, laid with 12-lb. rail and furnished with light buggies.

All the coal at Lytle that lies below the Sixth Level, 225 ft. below the level of the sea, yet remains to be mined. This tunnel is 1,259.8 ft. below the shaft collar.

Another Schuylkill County property of the Susquehanna Collieries Co. is the William Penn. This is situated 1½ miles west of Shenandoah and in the Western Middle anthracite field.

At this colliery the Mammoth seam is split into two seams but retains much of the thickness that has made that bed so famous. The Top Split of the Mammoth is 12 ft. 9 in. thick, and the Lower Split on the east of the property is 50 ft. thick and on the west 25 ft. thick. Such a thick bed is difficult to mine, and, as in other properties, it has been subjected to several separate minings.

First it was developed by breasts, then the pillars were removed, but neither the breasts nor the pillars recovered any large proportion of the bed. So in some cases the Mammoth has been mined in four stages: first mining, pillar drawing and two minings by rock chutes from rock gangways in the Skidmore; but even this in places has not exhausted the bed.

The Skidmore here is a sizable bed varying from 24 to 53 in. Consequently the "rock" gangways are sometimes mainly in coal. The rock interval between the Mammoth and the Skidmore is also of favorable thickness, about 20 ft., varying from 12 to 35 ft. Rockholes are driven on a 45-deg. pitch. When the Mammoth bed is reached, counters may or may not be driven. In many cases only a single working place is developed from such a rockhole.

A narrow breast is driven straight up the pitch on the bottom, and then other slants are driven on either side at about 25 deg. pitch, also on the bottom. Back holes are driven from these slants 25 or 50 ft. apart, dependent on the thickness of the coal found in place. These back holes are driven on a gradient that will allow the coal to travel on sheet iron, though the inclination may be made so steep that the coal will travel without the aid of plate chutes. About 50 per cent of the coal at this colliery comes from the Mammoth bed, and all of it is mined through rockholes from the Skidmore.

With levels at certain depth intervals the length of breasts from level to level becomes, in the less steeply pitching beds, excessively long, as in the Little Buck Mountain, with its occasional 2 deg. pitches. One of the planes, from one level to the next above it, has a

(*Turn to page 383*)

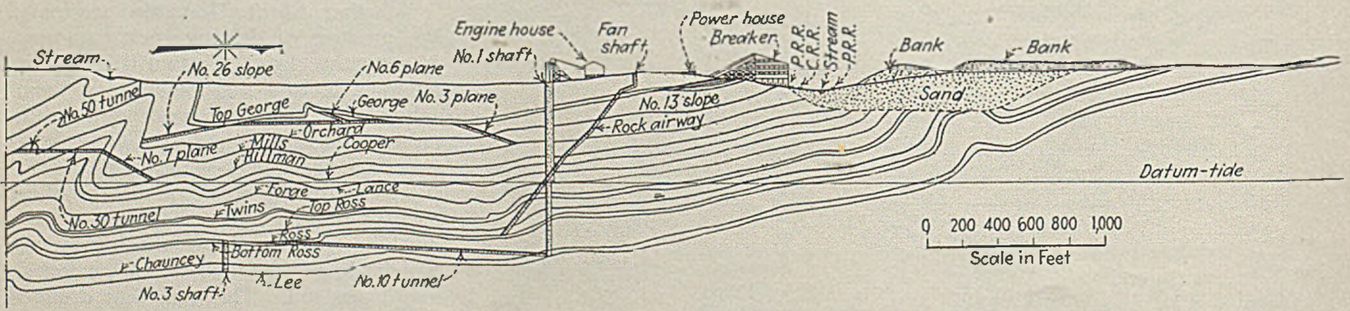


Fig. 5—Cross-Section of Coal Measures at No. 7 Colliery, Nanticoke

MECHANIZED MINING

+At Susquehanna Collieries

MECHANIZATION has lightened some of the most difficult of problems of the Susquehanna Collieries Co. Despite all the disadvantages of pitching beds, they nevertheless have their merits, especially when steep enough that coal can be made to flow out of the breast by gravity. But when seams are thin and pitch but little, the coal has to be pushed or "bucked" down the chute if no mechanical means of moving is provided. This is difficult enough if the coal is thick, and far more so if the coal is thin and if men have to crawl along the chute to push the reluctant coal down the inclination.

Cars cannot be used in breasts, even if, by shooting top or bottom, height is provided, for the gradient may be excessive. The rapid development of mechanization in the anthracite region has resulted from these considerations. It has made it possible to mine thin seams, even those thin seams that are of uncertain thickness. Some seams thin down in places and make any working scheme other than mechanical impossible. In one section the coal thinned in places to 17 in., but the scraper and the scraper hoist made it possible to remove all the coal regardless of this difficulty. It has made the mining of coal on less than a 13-deg. pitch possible, even easy, and the conveyor has rendered it feasible to draw pillars by driving a counter across them on gradients that would be too heavy for cars. Thus entrance is gained to pillars which have been left in place.

Pennsylvania colliery, at Strong, Pa., and Richards colliery, near by, both between Shamokin and Mt. Carmel, Pa., are in the eastern end of the Western Middle field. Here the measures form relatively shallow basins. At both these collieries, some coal has been loaded by scrapers, which prove helpful where the coal is on inclinations too easy for blue annealed iron, on which coal will slide when the inclination is 15 deg., or for galvanized iron, on which coal will slide with an inclination of 13 deg. Where the slope is 25 deg. to 45 deg., the coal will slide on the surface of the bottom rock.

In some cases the gradients are so easy that the breasts become too long for scraping. If the gradient changes so much that coal can be drawn from the lower end of the breast by gravity, a counter may be made near the break in gradient, and the coal above will be removed by scrapers and the coal below by gravity. This shortens the scraper travel and increases its efficiency.

When this combination of scraper and chute is used, the coal is loaded by the scraper into a side-dump buggy, which runs past several breasts on a track laid along the counter. One breast is chosen to receive the coal from each counter, the one chosen being steep enough to run the coal freely and to permit of some storage. Such breasts are kept full, so that the coal will not have far to fall when being dumped. Care must be taken not to allow too much coal to be drawn away or the coal will fall and not slide, and degradation will be excessive.

John A. Clark, Jr., Superintendent, No. 7 Colliery

Sometimes, where the coal is approached by a rockhole, the counter is placed above the rockhole and the scraper is set on that level. The scraper hoist is dismantled before it is sent up the chute, or rockhole, and reassembled at the counter above, being set up on the lower side of that roadway. Buggies at these mines usually hold about 50 cu.ft. Where hoists are located on the counter they usually are air-driven, because of the higher percentage of gas likely to be encountered in such places. Sometimes mules are taken up to the counter by a slant driven on the inclination, but this is expensive unless the seam is thick. As a rule, at Richards and Pennsylvania collieries, counters are driven if the chambers exceed 300 ft. in length.

The Mammoth at Pennsylvania has three splits, 8, 9 and 9½, starting at the lowest, but sometimes there are only two splits and near by as many as six, all of which adds to the difficulty encountered in operation.

With No. 7, or Nanticoke, colliery, Stearns shaft and No. 6, or Glen Lyon, colliery, the western end of the Northern anthracite basin is reached with its somewhat shallower depths, its little synclines and anticlines within the main syncline—so characteristic of the Northern basis—and its Buried Valley.

The measures buckle into what at first were regarded merely as overthrow folds, but in most cases proved to be overthrow, or slip, faults. The strain of overfolding was so great that the rocks parted. Closely mined as these basins are, there are difficulties in correlation of seams, not only between property and property but on a single holding. Thickening of intervals, introductions of rider seams, erosion, splitting, faulting, pinching and folding all make identification difficult and in places impossible until all the seams have been worked to their limits, and perhaps even then.

Here the Buried Valley, an old and wide stream bed filled with coarse gravel, reaches, perhaps, its maximum depth, 325 ft., but as one goes west toward Glen Lyon it gets shallower—only 120 ft. deep—and apparently loses or is losing some of its water content. At Stearns, two miles east of Glen Lyon and three miles west of No. 7 colliery, the Mills bed, the fourth seam in order from the top, has struck gingerly into the Buried Valley and found it there dry as a bone. At the end of the 2x8-ft. opening, the sand, with some pebbles almost as big as one's fist, is standing peacefully for the full 8 ft. of height. Perhaps two buckets of sand in all have fallen onto the floor through the hole in the coal rib. Thus does the fateful Buried Valley appear to be tamed, but eastward, only a little way from this point, drillings proved that there were sands in the old channel as quick and dangerous as ever. In view of the damage the Buried Valley has done in the past, here and in the north, the men it has buried and drowned and the mines it has crushed and flooded, the company views it with all due respect. It has potentialities for mischief, even though at Stearns and Glen Lyon, as has been stated, it seems to be lowering its water level. At some points near Nanticoke also it is relatively shallow—150 ft. deep in the bottom of its channel.

No. 7 mine runs under Nanticoke and No. 6 mine under Glen Lyon. Of all the company's mines, they have to contend with the greatest area of developed and settled surface land. All the other mines now worked are fortunately circumstanced in having no surface development to consider. Perhaps, however, if the two towns were not located over the mines as they are, the procedure of the company would not have been modified by that fact, for the towns are also over the Buried Valley, and care must be taken to protect the mine workings against the weight of sand and the incursion of water.

Because of the lighter gradients over most of the area—the overthrows occupying, of course, only relatively small areas—and because of the thinness of many of the seams, mechanical mining becomes feasible and almost necessary at No. 7 and Stearns. At one place in No. 7 mine, coal which in places is pinched down to 17 in. has been worked with scrapers. At No. 7, the Top George, Orchard, Mills, Hillman, Lance, Top, Middle and Bottom Twin and Top and Bottom Ross have been thus mined. The Top Lee will soon be added to the list and others are likely to follow.

As at most anthracite collieries, the practice at first was to use a 25-hp. hoist for scraping and to pull four places with the hoist, extending them 350 ft. Now only a 7½-hp. hoist with a smaller scraper is used, and two or three places are worked at one time, the ultimate length of which is about 250 ft. When scraper work was first started at No. 7, the 31-in. Orchard bed was chosen for the trials, and something distantly approaching longwall was attempted, but without much success, because the roof was bad and extremely wet. Weakness of the roof indicated that work of this kind would be unsafe, and it was abandoned.

When three breasts are worked with one hoist, one usually is carried ahead of the rest to afford warning of an approach to bad roof. When such weak top is encountered the breasts are narrowed accordingly. Pillars are made only 10 ft. wide where that will suffice and the breasts 40 ft. The pillars practically mine themselves. They may be shot a little, but usually they can be removed merely by pickwork.

If the seam being worked is dry, scrapers gather the coal both up the pitch and down the dip. In six months the percentage of mechanical mining at No. 7 mine has been increased from 4 to 23 per cent and Stearns is already 10 per cent mechanized.

Many advantages have been found in the use of the small 7½-hp. hoist, which, incidentally costs less than half

W. E. Weineck, Superintendent, No. 6 Colliery

as much as the 25-hp. unit. It can readily be mounted on four light timbers at such a height that the ropes can be run straight across the gangway and up the breast, whereas larger hoists must be set down on the gangway floor, making it necessary to install several idler pulleys to carry the ropes over the cars at the loading chutes. The small outfit can be worked in places where it might not be economical to invest in the larger equipment. In general, the tonnage per man is slightly greater with small hoists than with large, although, under certain local conditions, the larger hoist may afford the greater output per man.

A three-man crew can operate a small machine, whereas six or seven men are needed on large scraper installations. Where two faces can be worked together, the tonnage handled by each equipment can be materially increased, as one face can be prepared for firing while coal is being loaded from the other face. Two or more faces can keep the hoist and scraper busy; hence the tonnage per man can be increased even though one or two drillers are added to the crew. Air drills are used to drill holes for blasting when compressed air is available near the working place, but where air piping has not been laid, the electric drill is successfully used.

Careful cost records are kept of each scraper-loader installation, and experience to date shows that this method of mining thin seams in the Susquehanna mines is more economical and more satisfactory than any other method yet used. It is expected that scraper loading can be profitably extended to the mining of thicker seams of coal. In almost all cases, the introduction of scraper methods has been the only means of continuing operations in thin seams and of working others. Without its assistance, some operations would have had to be abandoned. In low working places, the delivery of props at the face is slow and difficult, but with a scraper, props can be dragged in by reversing the scraper or by chaining them to it.

At Stearns shaft workings, much scraper work has been done. At first the breasts were made narrow. Later they were widened to 50 ft. with the hope that at a later date perhaps even modified longwall might be attempted. But with the wide breast came trouble. The faces could not be maintained, and, when the roof broke, there were air blasts. So a return was made to narrower rooms, 30 to 35 ft., with pillars often only 15 ft. wide.

In one section of Stearns, the Orchard bed is being mined by scrapers. Nine places have been or are being scraped by one setting of the hoist, which is only a 7½-hp. electric unit. It must be understood that not all were being driven at one time. Usually only three are in operation together and, of course, only one place is being scraped at any time while the others are being prepared for the scraper. In general, there is one man at the hoist, two men are at the car, two men handle the scraper and two men drill. In all, there are seven men handling three places. In this case, there were in all eight men, an extra man being added because there was much water to handle. The average production is two cars per man, with the arrangement that, if the tonnage is less than that on any date, the quota will be made up on the day following, which can readily be done. Each car contains 100 cu.ft. and yields about 2.6 net tons of clean commercial coal of all sizes. As much as 5,700 tons has been loaded with one setting of the hoist, but if it has to be moved, it is so light that it can speedily be transferred.

Sometimes, at Glen Lyon, when hand-mined breasts go up steeply from the gangway and then flatten off so much that the coal will no longer slide down on plates, the remoter end of the working place is changed from a chute to a buggy breast. The coal is loaded into buggies, pushed to the steeper gradi-

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HAULAGE AND HOISTING

+ At Susquehanna Collieries

STEEPLY PITCHING beds and great working depths at many of the operations of the Susquehanna Collieries Co. subtract from the problem of hauling on level or nearly level roads and make the raising of coal from bed to bed or level to level of relatively greater importance. Consequently, planes (down which loaded cars are lowered), slopes (up which loaded cars are raised) and shafts take a major place in transportation at the company's collieries. Nevertheless, there are in use on inside roads at the various collieries, including spares, 111 cable-reel and trolley locomotives, 10 storage-battery locomotives, 9 compressed air locomotives, and 394 mules. Four of the ten battery locomotives are employed at the No. 6 colliery, Glen Lyon, while at No. 7 colliery, Nanticoke, six battery locomotives and eight compressed-air locomotives, including spares, are employed in very gaseous sections.

At the Pennsylvania, Richards, Short Mountain, Williamstown, William Penn and Lytle collieries, gangways for locomotive and mule haulage are driven on a grade of ½ or 1 per cent in favor of the loads. As is the case in most of the pitching bed mines, these gangways, when driven in coal, follow the contour of the beds to insure an even grade. In certain sections reached by planes or slopes in these colleries, and where consequently physical conditions make the introduction of locomotives difficult, or where gas is present, mules are used.

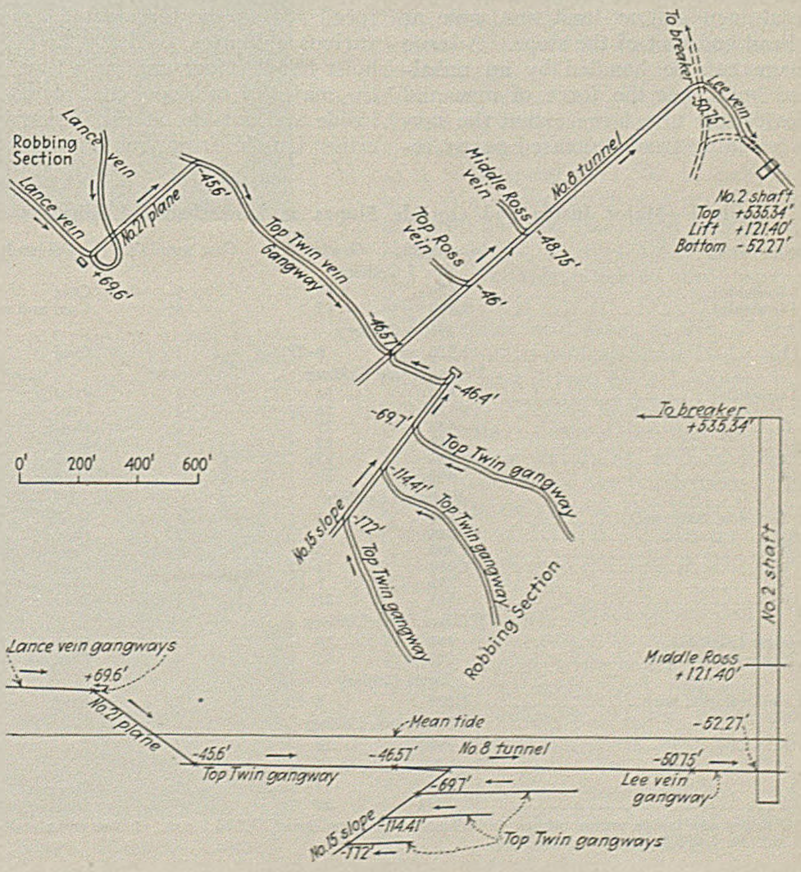
At Nos. 7 and 6 collieries, however, the beds pitch less steeply on the average than those at the southern collieries, thus allowing track to be laid in many of the working places for gathering by locomotives or mules. In laying track on haulage roads and in rooms where the average pitch is comparatively gentle, the contour of the bottom is followed, with the result that grades up to 17 per cent frequently are encountered for short distances. Because of the expense that would be involved in reducing them, these grades are allowed to remain, the size of trips being reduced to permit the locomotives to operate over them without excessive strain on the equipment. Barring the presence of these local conditions, effort is made to keep the grades of haulways on which locomotives or mules operate less than 5 per cent at these two collieries.

In gaseous sections and where physical conditions in both collieries permit it, storage-battery locomotives are used for gathering, supplemented at No. 7 by compressed-air locomotives. Like the other types, the battery locomotives take the grades as they come. Regulation of trip sizes and careful maintenance permit successful operation under these severe service conditions.

Nominal weight of the battery locomotives is 6½ tons and, with the exception of one 80-cell Edison battery, Exide 49-cell batteries have been installed since early in 1925. Number of positive plates is 29. Battery locomotives purchased up to 1923 were equipped with sprocket-and-chain drives. Later types have worm drives. Further details on battery characteristics and life, and on maintenance methods, are given on pp. 378 and 380 of this issue.

The compressed-air locomotives at No. 7, which were installed a number of years ago, now operate in an extremely gaseous section of the workings. Of the eight in use, seven have 6x10-in. cylinders and are used for gathering. The other locomotive, 7x12 in., is used for haulage on the main line. One 6x10 locomotive is kept as a

Fig. 1—Transportation System, No. 2 Shaft, No. 7 Colliery, Showing Planes, Slopes, Rock Tunnels and Coal Gangways



spare. While designed for an air pressure of 1,000 lb. per square inch, tank pressures are now held at approximately 800 lb. per square inch, while the working pressure in the cylinders is 150 lb. per square inch.

As it is necessary in by far the majority of cases to go down to the coal beds at Susquehanna operations, there are few opportunities for hauling to the outside on level or approximately level roads. Consequently, most of the coal and mine rock must be handled through planes, slopes and shafts to its eventual destination on the surface. Fig. 1, a portion of the transportation system at No. 2 shaft, No. 7 colliery, Nanticoke, indicates, without attempting to establish a typical condition, the modes of moving cars from the workings to the breaker.

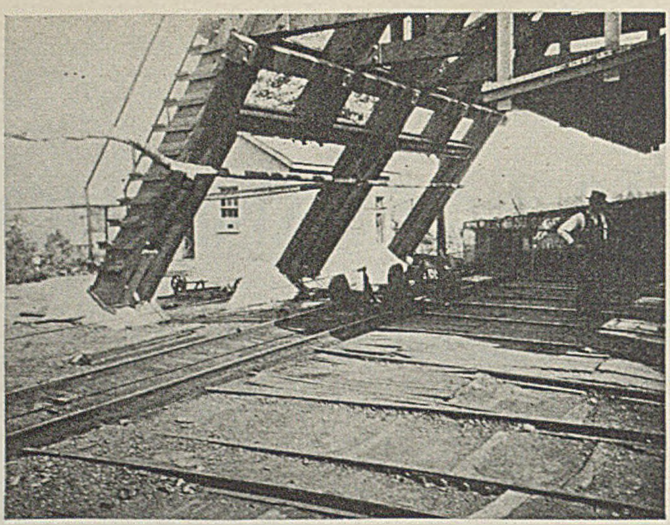


Fig. 2—Transfer Truck for Distributing Empties, Lytle Shaft

With as high as ten or twelve beds lying one over the other, it manifestly is impossible to make shaft landings in each one or drive separate openings from the surface. Therefore, planes frequently are employed, as indicated in Fig. 1, to reach sections in beds overlying those in which shaft or slope landings are established. Conversely, beds below the landings are reached by inside slopes.

As most of the slopes at Susquehanna collieries have only a single track, unbalanced operation is necessarily general, though several balanced slopes are in use. Cars must be coupled and uncoupled at both the top and bottom of the slope with balanced hoisting. Therefore, coupling and uncoupling and the handling of cars require the services of several men and at least one mule at the head and foot of the slope. A large tonnage can be handled by an unbalanced hoist, but the force of men and mules offsets to a large extent the savings accruing from decreased power requirements. With an unbalanced hoist, cars can easily be coupled to the rope at the bottom, and as they are backswitched at the top, the hoist runner, a headman, and a footman can readily handle the work.

Experience has shown that at Susquehanna collieries, as at other anthracite operations, slopes are suitable only for gathering coal from local basins, as the output is limited by the necessary restrictions in maximum speed and in number of cars handled per trip.

As indicated in Table I, the longest slope at any of the Susquehanna operations is at No. 7 colliery. This slope (No. 4) is 3,400 ft. long and is driven on a gradient of 15 deg. No. 4 rope speed also is the highest of any at the various collieries, or 1,800 f.p.m. The hoist handles four cars at a time, while the majority of slopes and planes, both inside and outside, at the various properties handle from one to three cars.

Table I—Major Inside and Outside Slopes at Susquehanna Collieries*

Designation	Length, Ft.	Grade, Deg.	Cars per Trip	Driven In
	No. 7 Colliery			
No. 1 (outside)	1,570	15	1	Coal
No. 4 (outside)	3,400	15	4†	Coal and rock
	No. 6 Colliery			
No. 13	1,320	3–27	1	Coal
	Pennsylvania Colliery			
No. 1 (outside)	839	26	1	Coal
No. 9	1,135	16–23	2	Coal
No. 10	485	25	2	Rock
No. 11	380	25	1	Rock
No. 12	585	23½	2	Rock
No. 14	490	30	1	Rock
	Richards Colliery			
No. 1 (outside, balanced)	840	33	1	Rock
No. 8	925	.....	2	Coal
No. 10	1,400	5½	2	Rock
No. 11	1,060	12–32	2	Coal
No. 12	755	7–19	1	Coal
No. 14	535	21	1	Rock
	William Penn Colliery			
Dirt plane (outside)	900	10	2	Rock
Two inside slopes, each	500	10	1	Coal
	Lytle Colliery			
Four inside slopes, each	1,000	8–10	2	Rock
	Williamstown Colliery			
No. 10	700‡	20	4	Rock
	Short Mountain Colliery			
No. 9	2,100	17	3	Rock
No. 12	700§	20	1	Rock

* All slopes are inside unless otherwise indicated. † Rope speed, 1,800 f.p.m. ‡ Not completed; total length will be 1,400 ft. § Not completed.

Very few outside planes are used, and these only for handling dirt.

The largest electric hoist on any Susquehanna slope has been installed at the No. 10 inside slope, Williamstown colliery. Present length of this slope, driven in rock on a grade of 20 deg. to tap beds below the bottom landing of No. 2 shaft, is 700 ft. When completed, the slope will have a total length of 1,400 ft. Handling four cars per trip at a rope speed of 1,500 f.p.m., No. 10 slope has a capacity of 600 cars per shift of eight hours. Hoisting equipment consists of a 7x4-ft. single drum, driven by an 800-hp. slip-ring motor. Rope size is 1⅜ in.

Except for certain unusual planes and slopes, danger of wrecks dictates the use of rope speeds below 900 f.p.m. As a rule the rope speed is from 500 to 600 f.p.m. Where rope speeds are higher than 900 f.p.m., 60-lb. rails are used, good road beds on an even gradient are built, and the track rails are paralleled on the inside with timbers nailed to the ties to reduce the danger of cars jumping the track.

Storage space, consisting of separate tracks for loaded and empty cars, is provided at the top and bottom of slopes and planes, and at intermediate levels if they exist. A typical arrangement of the storage tracks is shown in Fig. 3, a view of the top landing of No. 10 inside slope, Williamstown colliery. Quite frequently, where conditions permit, one hoist serves both a slope and a plane.

As an indication of the importance of the hoisting problem at Susquehanna collieries, 124 electric hoists aggregating 20,507 motor horsepower are required for the operation of the various mines. In addition, eight large steam hoists are in use. Hoisting speeds are determined at each shaft by the output desired per shift. Steam hoists are not equipped with constant-speed governors; as a result, maximum hoisting speed depends entirely on the tonnage required.

Several of the major hoisting shafts

at Susquehanna collieries are more than 1,000 ft. deep, and in several cases, slopes extend from the bottom landings of these shafts to still lower workings. The two deepest shafts are at the Williamstown and Short Mountain collieries, 1,600 and 1,590 ft., respectively. To secure the proper tonnage from these shafts, high-speed operation is imperative. Two steam-driven hoists, each with double cylindrical clutched drums 12 ft. in diameter, operate in the same shaft at Short Mountain; the rope speed (1¾-in. rope) varies from 3,300 to 4,000 f.p.m., the highest of any Susquehanna hoist. These hoists together handle 600 cars of coal and 60 cars of rock per shift of eight hours. At No. 7 colliery, the shaft hoists also are operated by steam. All hoists handle the coal from several lifts in the various shafts, and those not equipped with clutched drums must travel, during working shifts, at high speed.

All the electrically driven hoists are of modern design. That at No. 6 shaft has a double cylindrical drum with one drum clutched and is operated by a 900-hp. induction motor at a rope speed of 1,650 ft. per minute. The motor control is 8-point full-magnetic reversing with all parts located in the basement of the hoist house, so that the operatives will not be disturbed by the noise of the frequent closing and opening of heavy contactors. Floor grating has been installed in the hoist-room floor directly over the resistor grids in the basement, thus providing for a proper circulation of air over the resistors.

Table II—Major Hoisting Shafts at Susquehanna Collieries*

Designation	Depth, Ft.	Rope Speed, F.P.M.	Equipment
No. 7 Colliery			
No. 1 South (steam)	1,009	....	Cylindrical drum
No. 1 North (steam)	543	....	Double cone drum
No. 2 (steam)	588	....	Double cone drum
No. 8 (steam)	514	....	Cylindrical drum
No. 6 Colliery			
No. 6	732	1,650	Double drum, one clutched
No. 7	395	900	Cylindrical drum
No. 4	634	900	Cylindrical drum
Richards Colliery			
Richards shaft (balanced hoist)	831	800	Cylindrical drum
William Penn Colliery			
Wm. Penn Shaft	880	1,545–2,465	Cylindro-conical drum
Lytle Colliery			
Lytle Shaft, Fifth level	1,335	1,315–2,825	Cylindro-conical drum
Lytle Shaft, Sixth Level	1,264	1,315–2,825	Cylindro-conical drum
Williamstown Colliery			
No. 2	1,600	1,545–2,465	Cylindro-conical drum
No. 1	1,600	1,500	Double drum, one clutched
Short Mountain Colliery			
Short Mtn. Shaft, two steam hoists	1,590	3,300–4,000	Double cylindrical drums

* All hoists electrified, unless otherwise indicated.

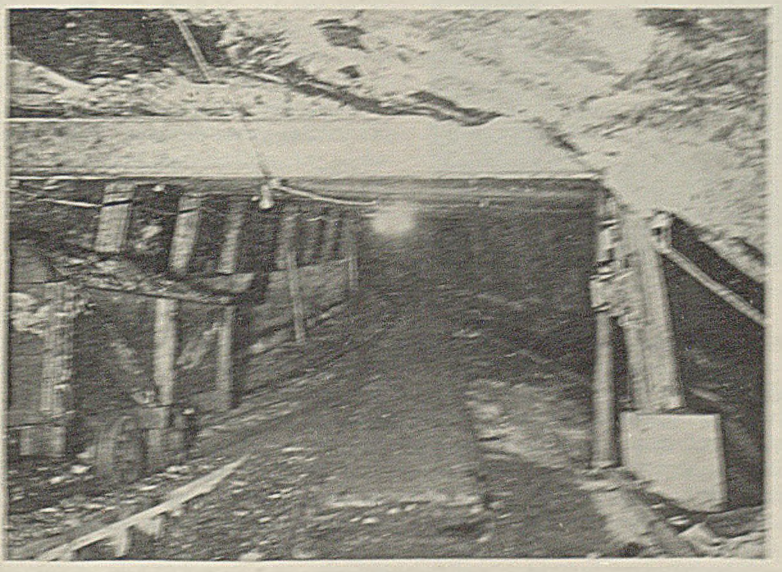


Fig. 3—Loaded and Empty Tracks, Top of No. 10 Slope, Williamstown Colliery

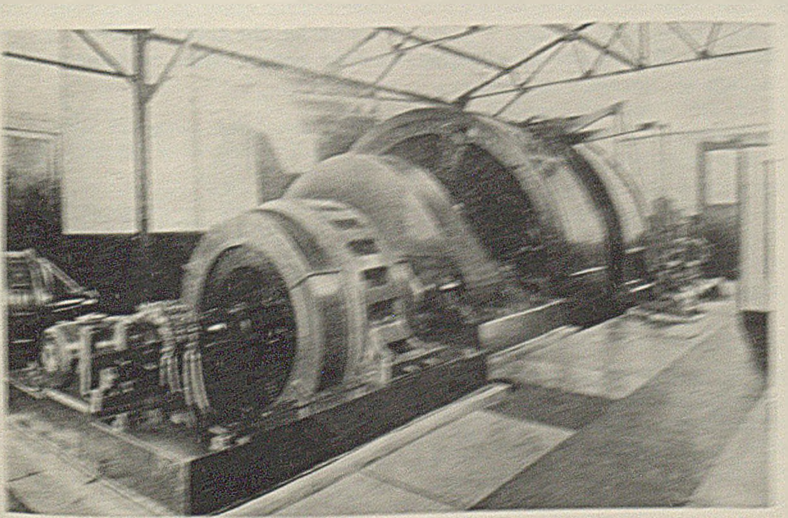


Fig. 4—William Penn Shaft Hoist, 1,300-hp. Motor, Magnetic Control

At William Penn, the coal hoist is equipped with double cylindro-conical drums, one drum clutched, and is driven by a 1,300-hp. induction motor at 1,575- to 2,310 ft.-per-minute rope speed. The control for this hoist is full-magnetic reversing with all contactor magnets operated by 250-volt direct current. Contactors thus operated make much less noise than large a.c. contactors.

At No. 2 shaft, Williamstown colliery, two hoists handle the entire output and another hoist is used for accommodation trips. One electric hoist, the first installed at this opening, has 14-ft. double cylindrical drums, one drum clutched, and a 900-hp. motor drives it at a rope speed of 1,300 ft. per minute. A clutched drum was provided for balanced hoisting from both counter and bottom levels, located 1,246 and 1,556 ft., respectively, below the surface landing.

The other coal hoist at No. 2 shaft has a cylindro-conical drum 10-16 ft. in diameter and driven by a 1,300-hp. motor at a rope speed of 1,575 to 2,300 ft. per minute. Control for this motor is full-magnetic reversing and is located in the basement of the hoist room. This hoist lifts only from the shaft bottom, a distance of 1,556 ft. When no caging delays occur, it completes a trip in 60 seconds.

In converting steam-driven hoists to electric drive, first-motion steam hoists were equipped with a set of herringbone gears, shafts and bearings. A cast-steel coupling on the main gear shaft connects the motor with the drum shaft and displaces the old crank disk.

Second-motion steam and air hoists have been electrified by using suitable

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PREPARATION

+ At Susquehanna Collieries

IN COMMON with all anthracite companies, the Susquehanna Collieries Co. has been forced to meet and overcome the preparation problems growing out of the more exacting market requirements of today. These requirements were responsible for the adoption by the anthracite industry of the present revised standards for sizing and percentage of impurities in the cleaned coal, which, of course, govern preparation at the Susquehanna operations.

Routine preparation at Susquehanna collieries starts with the separation of lump and steamboat sizes on a dump shaker, after which these sizes are passed over a picking table, where the refuse is removed by hand. Lump and steamboat are then crushed before joining the other coal from the dump shakers. Quite frequently, broken also is crushed, in view of the light demand for this size. Coal from the initial separation, plus that broken down in the rolls, is sized on shaker screens. Individual sizes are then cleaned in jigs or other mechanical cleaning equipment. From the washers the coal goes to the loading pockets, and en route from the pockets to the cars is passed over degradation screens to remove breakage.

Wilmot and James jigs are employed on coal. Closer regulation of jig operation to obtain a cleaner product has in late years increased the quantity of commercially salable coal in the reject, and to reclaim this product rock jigs have been installed at all collieries to re-treat refuse from the egg, stove, chestnut and pea jigs. A few Christ jigs are employed in this work. Treatment of the coal end from the rock jigs varies at the different collieries. Depending upon the character of the coal product, it may be returned to the breaker feed without further processing at some of the collieries; at others it is crushed to free interstratified material.

In addition to the jigs, Deister-Overstrom Diagonal - Deck concentrating tables, Hydrotators, and Menzies hydroseparators have been installed for cleaning the three buckwheat sizes. Installations of special cleaning equipment by collieries are given in Table I. The company has found that jigs, when

K. I. Hopwood, General Coal Inspector

closely regulated, can be relied upon to turn out a satisfactory product, even including buckwheat. However, the increasing demand for buckwheat, and the necessary reduction in individual jig capacity to meet the new standards, brought about a pressing problem of space and resulted in the replacement of jigs, by the higher-capacity Hydrotators and hydroseparators at a number of collieries. Production of special low-ash buckwheats also was a major factor in the replacement of buckwheat jigs.

In addition to the usual cleaning, screening and loading problems, the removal of relatively large quantities of flats from the cleaned product is an important activity at all but the Short Mountain and Williamstown collieries. At No. 6 colliery, for example, 120 tons of flats is removed each day from an average production of 3,500 tons. Ordinarily, special slotted plates are installed on the ends of the sizing screens to remove flats. One type of slotted plate, used at No. 6 colliery, is shown in Fig. 1. The slots are so arranged that the direction of flow is changed between groups of slots, while a row of backward-slanting openings in the center assists in removal of flats on the backward stroke. Slotted plates used at the Richards, Pennsylvania, William Penn and Lytle collieries differ from those at No. 6 in that the slots are parallel in a direction at right angles to the flow of coal.

At No. 7 colliery, Nanticoke, the equipment for the removal of flats consists of a number of angles mounted in the chutes from the screens. The assembly is shown in Fig. 2. Position of the angles is such that the flat pieces, in passing over the assembly, are turned up on one edge so that they will fall through the slots more readily. Slots between angles are wider at the discharge end to decrease any tendency for individual pieces to stick. As a further safeguard against blinding of the assembly, the discharge end is mounted in such a manner (Fig. 2) that the flats have a clear space to fall through before they strike the cross member.

As a general rule, no attempt is made

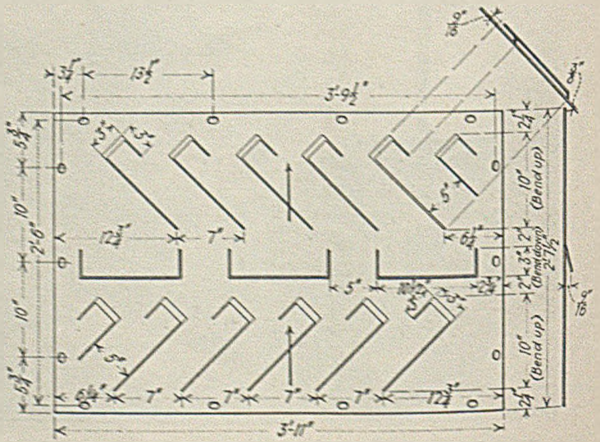


Fig. 1—Slotted Plate Used at No. 6 Colliery to Remove Flats From Stove

Table I—Special Cleaning Equipment at Susquehanna Collieries

Equipment	Number of Units	Size Treated
No. 6 Colliery		
Tables*	4	No. 1 buckwheat
Tables*	3	No. 2 buckwheat
Tables*	3	No. 3 buckwheat
Hydrotators	1	No. 3 buckwheat
Richards Colliery		
Hydroseparators†	1	No. 3 buckwheat
William Penn Colliery		
Hydrotators	1	No. 3 buckwheat
Williamstown Colliery		
Hydroseparators	3	No. 1 buckwheat
Hydroseparators	2	No. 2 buckwheat
Hydroseparators	2	No. 3 buckwheat
Short Mountain Colliery		
Hydroseparators	2	No. 1 buckwheat
Hydroseparators‡	2	No. 2 buckwheat
Hydroseparators‡	2	No. 3 buckwheat

* Deister-Overstrom "Diagonal-Deck" concentrating tables.
† Three-compartment type.
‡ Two-compartment type.

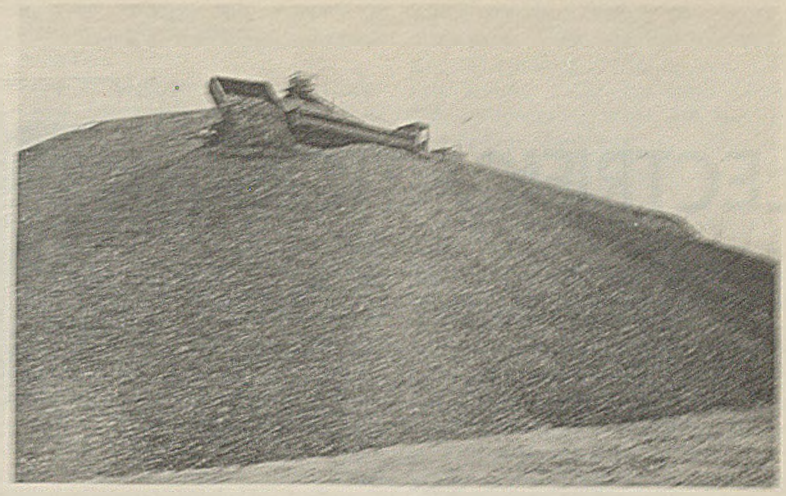


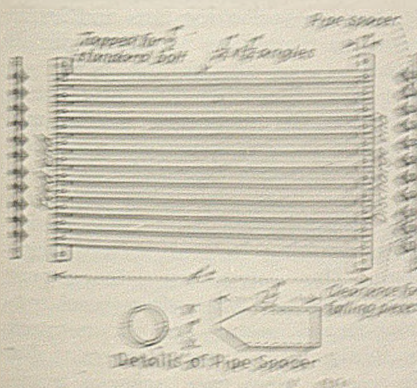
Fig. 3—Stocking Coal at No. 7 Colliery. Trailer in Dumping Position

to remove flats from sizes smaller than chestnut. All flat material is discarded at the Pennsylvania, Richards, William Penn and Lytle collieries, largely because the quantity of coal contained in them does not warrant the installation of recovery equipment. At No. 7 and No. 6 collieries, however, the coal content of the flats runs as high as 50 per cent, and they consequently are run to jigs for re-treatment. The coal end from these jigs is returned to the breaker feed after—at No. 7 only—crushing.

Inspection of coal before shipment is in charge of a separate department under the head of a chief coal inspector, who reports directly to the general manager. Two or more coal inspectors, depending upon the tonnage shipped, are stationed at each colliery. Each car of broken, egg, stove, chestnut and pea is sampled at six points, the total weight of the samples being approximately 100 lb. for broken and egg, and 50 lb. for the other three sizes. These samples are screened through a hand screen to determine undersize and oversize, and then are hand-picked to determine the percentages of slate and bone. Cars which fail to come up to standard are condemned and the coal is returned to the breaker feed.

Acceptance or condemnation of buckwheat cars is based on an ash determination in addition to the sizing tests. Nine samples are taken from each car by use of a 2-in. tube, which is inserted into the coal to a depth of 18 in.

Fig. 2—Bar Assembly Employed at No. 7 Colliery to Remove Flats



An unusual departure from general anthracite practice is the storing of raw coal at No. 7 and Pennsylvania collieries. Raw coal also was stored at Lytle colliery in 1931, but the equipment has since been transferred to No. 7. At the Pennsylvania colliery, the coal to be stored is dumped from the mine cars in the usual manner, and is run to the picking table, where the large pieces of rock are removed. Big pieces of coal are sent to the rolls for reduction to steamboat. The storage coal then goes to a pocket, from which it is hauled to the storage pile in electric-driven Differential two-way side-dump cars. Two side-dump cars are used, each with a capacity of 20 cu.yd. Ten-yard three-way-dump trailers are attached to the 20-yd. side-dump cars, and may be used for sidewise dumping or for extending the stockpile endwise. Coal is reclaimed at Pennsylvania colliery by an electric shovel and the two 20-yd. side-dump cars without trailers.

Stocking of raw coal was begun at No. 7 colliery this year. At this colliery, after removal of the rock on the picking table, the coal is crushed to egg size before storing. As at Pennsylvania, two 20-yd. Differential cars with 10-yd. trailers are used for stocking purposes, and the coal will be reclaimed with an electric shovel and the side-dump cars.

In former years, sizes that were seasonally slow were shipped to the company's McClellan storage yard, on the Susquehanna River near Millersburg. Here, also, reserve stocks were built up in anticipation of rush seasons. Considerable degradation was the inevitable result of the handling and rehandling at the yard, while storage by sizes resulted in increased rusting, frequently requiring further treatment in jigs. Raw storage was resorted to in an attempt to reduce the degradation and rusting growing out of the handling and storage of the prepared sizes. The company's experience has shown that there is no difference between the stored mine-run and fresh-mined coal, as a large portion of the coal is sent through the rolls after reclamation, presenting fresh surfaces before shipment. Degradation is reduced and rusting is eliminated due to the presence of the fines in the stored mine-run and the reserves are instantly available by double-shifting the breaker.

Refuse - disposal equipment and methods at Susquehanna collieries are based on the dumping of nearly 200,000 mine cars of breaker refuse and an approximately equal quantity of mine rock per year. The percentage of refuse handled on the surface per ton of coal varies from around 20 per cent up to as high as 42 per cent. In addition, a considerable quantity of mine rock is gobbed underground where conditions permit. Larries and motor-operated side-dump cars are the principal types of equipment employed on the surface, though at some collieries both mine rock and breaker refuse are dumped from mine cars or home-made side-dump cars pulled by a locomotive.

At No. 7, No. 6, and Pennsylvania collieries, Connellsville turntable type larries are employed as the final step in disposal of refuse on the bank. No. 7 refuse, both breaker and mine rock, is hauled in mine cars to a loading pocket at the foot of an incline. The two 12-cu.yd. larries are loaded from this pocket and are then hauled to the top of the incline, whence they proceed under their own power to the dumping point. Mine rock and breaker refuse at No. 6 colliery also is hauled to the top of an incline from a collecting pocket in the valley, in this case in gunboats (skips). The skips dump into pockets at the top of the incline, from

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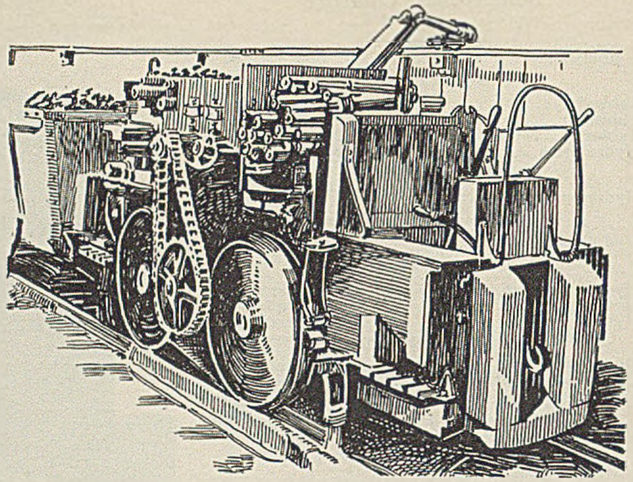
ELECTRIFICATION

+ At Susquehanna Collieries



First American Mine Locomotive, Installed at Short Mountain Colliery in 1887

AMERICAN coal mines date their electric development from the momentous day when an electric mine locomotive, built in 1887, was put in service at the mines of the Lykens Valley Coal Co., now known as Short Mountain colliery of the Susquehanna Collieries Co. A second locomotive was purchased later, and both locomotives were in service until 1926, when they were replaced by modern units.

In 1888, William Sullivan Schlessinger built a 500-volt series-wound direct-current generator for operating the first locomotive, and the coal breaker was lighted at night by forty or fifty 10-amp. lamps wired in series. In later years, the Susquehanna Coal Co. extended the use of electricity and installed several engine generator sets to supply 250-volt direct current for operating locomotives, slope hoists, fans and pumps, but, as mine workings extended and distances became too great for the economical transmission of direct current, alternating equipment had to be introduced.

Eleven 2,300-volt, 3-phase, 60-cycle alternating-current generators, totaling in capacity 4,300 kw., were installed at the collieries at which power was most needed. The most noteworthy of these installations were: Two 500-kw. (625-kva.) engine-generators purchased April 10, 1916, and installed at Scott colliery, a Susquehanna Coal Co. mine near Shamokin, Pa. The engines operated at 125 lb. gage pressure, non-condensing, using the exhaust for heating feed water in the boiler plant of the colliery. On Nov. 1, 1917, a 750-kw. turbo-generator was purchased for use at No. 7 colliery. This machine operated also at 125 lb. gage pressure, non-condensing, the exhaust steam being used to heat boiler-feed water.

During 1917, a 1,000-kw. (1,250-kva.) mixed-pressure turbo-generator was installed at Short Mountain colliery which operated condensing and derived its power from exhaust steam, at 16 lb. absolute pressure, supplied by two air compressors. A high-pressure valve gear admitted steam at 125 lb. gage pressure whenever the quantity of low-pressure steam was unable to handle the load on the generator. At times, the turbine operated entirely as a high-pressure unit.

When the collieries were acquired by the management of the M. A. Hanna Co. in 1917, the main boiler plants at all the collieries needed extensive repairs, and boiler inspectors were reducing each year the pressures at which the boilers were permitted to run. It was estimated that central boiler plants with electric generating stations at each division would save 400,000 tons of marketable coal each year. This saving in fuel alone warranted the erection of new plants.

New central boiler plants would still leave most of the steam-driven installations in proximity to the boilers. Consideration was given to the purchase of electrical energy, but the schedules of the local power companies at that time were prohibitory because of the penalty they imposed for abnormal demands such as flood-water pumping entailed, so generating stations were erected in the Shamokin, Lykens and Wyoming divisions and at Lytle colliery of the Lytle Coal Co.

For the three larger plants turbo-generators of 3,000 kw. capacity were allocated by the War Industries Board, but they were somewhat smaller than were desirable for a plant increase with duplicate units. As switching equipment of ample rupturing capacity was available for 2,300-volt units of this capacity, and because 2,300-volt power was needed for local distribution, this voltage was adopted for generation. The generators were arranged with an ungrounded neutral, so that the power would not be interrupted should outside lines become grounded.

Control equipment consisted of a main-station switchboard with cell-mounted circuit breakers, buses and auxiliaries, a substation board for local distribution of 2,300-volt power and a third switchboard for 2,300- and 460-volt station auxiliaries. The substation and station auxiliary boards were equipped with oil circuit breakers of low rupturing capacity with each bus connected to the main station bus through cell-mounted breakers and reactors, the reactors being designed for short-circuit protection of the small breakers. Outside the stations, 2,300-22,000 volt transformers, 22-kv. buses and switching auxiliaries were installed for control of the higher voltage transmitted to distant collieries.

At the receiving ends of the lines, one or two banks each of three single-phase transformers stepped down the 22-kv. transmission to 2,300 volts for use at the colliery. The outdoor portion of the colliery substation consisted of a 9x9-ft. square-steel tower, 22 ft. high, with 3-pole disconnecting switch, horn-type fuses, suspension choke coils and lightning arrester. The 2,300-volt sides of the transformer banks are controlled by incoming-line and outgoing-feeder panels.

Oil circuit breakers were selected that would rupture safely any short-circuit currents on the 2,300-volt side of the transformers. Each outgoing feeder line was equipped with low-cost lightning arresters, and a station-type arrester was connected to the substation bus. Where possible, independent circuits were provided for fans and inside pumps, so that these would remain in operation even though the power in other feeder lines should be interrupted.

Between the generating station and the motor drive is interposed an inductive load from two banks of transformers, 22-kv. lines and 2,300-volt overhead transmission lines and feeder cables, resulting in poor voltage regulation. The system has a low power factor, especially when slow-speed low-power-factor motors are in operation on lightly loaded transformers. For this reason, when two banks of transformers serve a substation, one bank is disconnected during light loads and, when possible, some of the step-up transformers at the power plants are taken out of service.

Mine pumps are driven by high-speed motors which inherently are high-power-factor machines. Synchronous motors have been successfully applied to driving centrifugal pumps so that the power factor on the system is materially raised during heavy-load flood-water periods. Air compressors afford a fairly constant and heavy load during the 8-hour shift in which the colliery operates, and when driven by synchronous motors, correct power factor. Though compressed-air requirements decrease about a half during the sixteen hours in which the colliery is idle, their synchronous motors nevertheless help to counteract the power factor, for fewer motor drives are then in operation. Synchronous motor-generators seldom operate continuously at full load, but as they work when others are working they effect a material improvement in power factor.

In accord with plans made when the M. A. Hanna Co. took control, the Shamokin power plant with boiler room was built and two 3,000-kw. turbo-generators and several boilers were installed, but, due to the termination of the War, the installation of the rest of the plant was delayed.

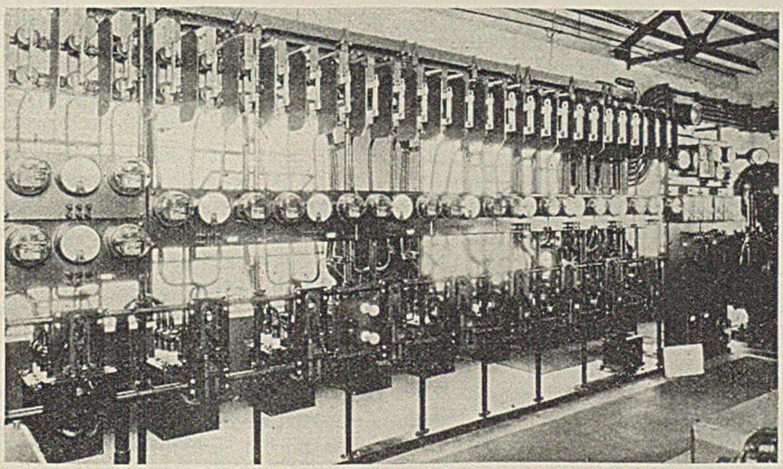
In 1927, the power company bought the uncompleted Shamokin plant and the collieries company agreed to purchase sufficient electrical energy to operate five collieries in that division. The power company undertook to complete the Shamokin plant and to purchase coal for its operation.

Power is delivered at the station busbars at 2,300 volts, 3 phase, 60-cycles, and distributed to Pennsylvania colliery and Richards tunnel at this voltage. For distant transmission to Richards, Cameron and Luke Fidler collieries, the voltage was stepped up to 22 kv. through 4,000-kva., 3-phase transformers.

Because of high-mining costs, Luke Fidler and Scott collieries were abandoned in 1929. Scott colliery was never electrified, because of the rapid depletion of its coal reserves. It was necessary, however, to install an automatic pumping station 538 ft. below the surface in the Scott Short shaft to prevent water from entering active working of Pennsylvania colliery.

With two of the original five collieries abandoned, the power contract was modified to include William Penn colliery, near Shenandoah, and Lytle colliery, near Minersville. These two collieries were, therefore, completely electrified and now operate on a combined power contract with Cameron, Richards and Pennsylvania collieries.

At William Penn and Lytle, the power company provided the necessary transformers for 2,300-volt, 3-phase, 60-cycle power, though the collieries company owns and maintains the 2,300-volt substation switching equipment and distribution lines. A new substation distribution switchboard was installed at William Penn, and the old generating station switchboard at Lytle was rebuilt to handle the incoming and outgoing power.



Substation Switchboard, William Penn Colliery. Two Incoming Line Panels and Nine Outgoing 2,300-Volt Feeders

The average demand of the five collieries is about 12,000 kw., although, during high-water pumping, the demand has reached 13,500 kw. and the yearly consumption of electrical energy varies from 38,000,000 to 48,000,000 kw.-hr., depending upon the colliery working time. The Lykens power plant is described on page 371 and will not be discussed here.

Power is transmitted from the Lykens plant to Williamstown colliery, a distance of 5 miles, over two 22-kv., 3-phase lines supported on double-circuit steel towers terminating with nine 833-kva. single-phase transformers for 2,300-volt distribution at No. 2 shaft substation. The load at this station in general consists of 900-hp. and 1,300-hp. coal hoists, a 250-hp. man hoist, two air compressors, two 300-kw. motor-generators, fans and an inside load of 7,050 hp., of which 6,150 hp. is used to drive mine pumps.

Four 400,000-circ.mil cables feed down No. 2 shaft to the top pump station, also three 300,000-circ.mil cables between the top and counter stations and two 300,000-circ.mil cables from the counter to the bottom. These cables are protected by oil circuit breakers and induction-type relays on the power-input ends and oil circuit breakers with reverse-power relays on the incoming-power ends. These automatically cut out a damaged cable without interfering with transmittal of power over the remaining cables.

The largest electric-driven slope hoist on the properties is that at No. 10 slope at the bottom of No. 2 shaft, 1,600 ft. below the surface. The single drum of this hoist has a diameter of 7 ft. and a 4-ft. face. It is geared for an average rope speed of 1,500 ft. per minute and is driven by an 800-hp. 2,200-volt motor.

As the local power company at Lykens transmitted at 22 kv., this voltage was selected for transmission lines. This decision proved to be a happy one, for a tie between the lines of the power company and the 22-kv. bus at the power plant was later provided, so that, in case of emergency, energy could be interchanged, a provision of which both companies have availed themselves.

Nanticoke power plant supplies electrical energy to No. 6 colliery, at Glen Lyon, which is completely electrified; also steam and electricity for operating No. 7 colliery. The generating plant consists of two 3,200-kw. (4,000-kva.) turbo-generators and necessary station auxiliaries. Power is distributed around No. 7 colliery through eight feeder circuits by 2,300-volt, 3-phase, 60-cycle current direct from the station buses. For transmission of power to No. 6 colliery at 22 kv., six 2,300-22,000 volt transformers are provided outside the station with necessary buses and switching equipment.

Two air compressors, located in the basement of the turbine room, supply air at 100-lb. gage pressure to No. 7 colliery and two 1,000-lb. air compressors provide high-pressure air for locomotives in South shaft. Equipment at No. 8 shaft, No. 7 colliery, is completely electrified, with the exception of the shaft hoist, which is steam-operated. Electric power was formerly transmitted at 2,300 volts from the power plant, but now three 333-kva. transformers serve this load. Substation transformers at No. 6 colliery comprise six 400-kva. units at Stearns, three 625-kva. at No. 7 shaft, and six 833-kva. at No. 6 shaft.

Nanticoke boiler plant comprises twenty 150-hp. water-tube boilers arranged in ten batteries, each of 500 hp. Slush and No. 3 buckwheat are fed over traveling-grate stokers, the percentage of No. 3 buckwheat used depending on the load. This boiler plant generates an average of 2,075,000,000 lb. of steam per year, of which 665,000,000 lb. passes through the turbines and station auxiliaries. In all, 30,500,000 kw.-hr. is generated each year.

The Nanticoke power plant is interconnected with the local power company through a 4,500-kva., 3-phase transformer bank, and an agreement with the power company permits an interchange of power when needed by either party.

During 1929, the Lytle colliery, which had operated its own power plant, was completely electrified so as to afford the savings which would result from combining Lytle, William Penn, Richards, Pennsylvania and Cameron collieries on one power contract. Power for Lytle was included with the other collieries on May 1, 1929, and by December of 1929 a normal demand was established and Lytle colliery ceased to operate on steam.

HAULAGE AND HOISTING

At Susquehanna Collieries

(Concluded from page 365)

gearing, shafts and bearings for motor drive. These are used on slopes and planes, as the duty is usually light.

Motors for inside slope hoists operate on 230-volt direct current, unless 440- or 2,200-volt alternating current is available. When purchasing new equipment, the direct-current motor control is so arranged that dynamic braking is afforded for descending cars and all alternating-current motors operate with regenerative braking when cars are lowered.

Control for 2,200-volt motors of 50, 75 and 100 hp. consists of a primary reversing contactor, drum controller for secondary-speed control, resistor, low-voltage contactor, and switchboard panel equipped with disconnecting switches, oil circuit breaker, overload relays and ammeter. Motors 150 hp. and larger are controlled by full-magnetic reversing control.

As most of the cages are of the platform type, lack of space for empty tracks on the one side of several of the shafts has forced the use of transfer trucks, one of which, used at Lytle colliery, is shown in Fig. 2. Empty cars are run onto the truck by gravity, and are held in place by a dog. The truck is moved from track to track for receiving and discharging empties by means of an endless rope which passes around a motor-driven sheave. By a system of levers and toggles beneath the platform, the truck operative, from his quarters at the side of the platform, can stop the truck opposite any desired shaft track. When the truck stops, the dog is released to allow the car to run onto the cage by gravity. At Lytle, six hundred cars are handled by one transfer hoist in eight hours.

By reason of the fact that the various collieries were at one time operated by independent companies, track gage and construction vary from colliery to colliery. In general, main-line track is laid with 60-lb. rail, with 40-lb. rail on secondary haulage routes and 25-lb. rail in such working places as can be reached with track. At a few collieries, however, 40-lb. rail is used throughout. Wood ties are standard for all classes of track. Main and secondary haulage roads are ditched as a rule, as they also serve as drainageways for the working sections.

Surface transportation of coal and mine rock from the openings to the breaker or dump is done with electric locomotives at all except No. 7, No. 6, Pennsylvania and Short Mountain collieries. No equipment is used on the surface at Pennsylvania for hauling coal and mine rock, and steam locomotives are employed at No. 7, No. 6, and Short Mountain collieries. In all, there are 30 steam locomotives in use, as follows: No. 7 colliery, 6; No. 6, 20; and Short Mountain, 4. Steam locomotive sizes vary from 12 to 25 tons. At Williamstown colliery, four 13-ton trolley locomotives are employed in hauling coal through Williamstown tunnel from the landing at No. 2 shaft to the breaker.

PREPARATION

At Susquehanna Collieries

(Concluded from page 367)

which the two larries, similar to those at No. 7 colliery, carry the refuse to the dumping point.

At the Pennsylvania colliery, as at No. 7 and No. 6, two Connellsville larries handle the breaker refuse from the breaker rock pockets to the bank. The latter is at approximately the same elevation as the surface works and therefore can be reached without the use of hoisting machinery. A separate bank is provided for the mine rock, which is dumped directly from the mine cars.

Until this year, separate handling of mine rock prevailed at Short Mountain colliery. At this colliery, refuse constitutes 42 per cent of the total material handled on the surface. Breaker rock formerly was dumped into pockets in the breaker, loaded into dump cars, hoisted up a plane 1,050 ft. long, and finally hauled 800 ft. to the dumping point by a mule. Mine rock was separately loaded into cars at the shaft, hauled 3,600 ft. to a pocket, again dumped into cars, and, as a final step, was hauled by locomotive 1,200 ft. to the dumping point. To eliminate this multiplicity of equipment and handlings, cars of mine rock are now dumped with the coal cars in the breaker. The rock is diverted by means of a fly gate to the refuse pocket, where it is joined with the breaker refuse. From the refuse pocket, the combined mine and breaker rock is hauled to the dump in a Differential 10-yd. motor-operated two-way-dump car equipped with a 10-yd. three-way-dump trailer.

Two Differential cars are used at the Richards colliery. One is identical with that in use at Short Mountain, while the other has a capacity of 28 cu.yd., in addition to the 10-yd. trailer. Both mine refuse and breaker refuse go into a common pocket, from which it is hauled 5,000 ft. to the dump by the larries. At William Penn colliery, home-made side-dump cars are used. At Lytle and Williamstown collieries, the entire disposal problem is solved by the use of mine cars, which are discharged over horn dumps.

Maximum distances to dumping points vary from 2,500 to 5,000 ft. at the various collieries, and the grades over which larries and cars travel vary from zero to 6 or 7 per cent. Except where special conditions prevail, bank sites are selected which will allow the disposal equipment to travel direct to the dumping point without the use of hoisting or lowering equipment.

POWER GENERATION

+ At Short Mountain Colliery

ERECTED in 1920 and 1921, to supply steam and electricity for the operation of Short Mountain and Williamstown collieries, the Lykens power plant was the second commercial installation to use anthracite silt in powdered form; the first, a smaller installation, having been built by the Lytle Coal Co. at Lytle colliery.

When Lykens plant was put in operation, the steam for operating Short Mountain colliery was being supplied by three boiler plants consisting in all of nine water-tube boilers, each with 5,000 sq.ft. of heating surface, and three locomotive-type boilers, each with a heating surface of 1,000 sq.ft. At Williamstown colliery, five boiler plants were in operation containing between them fourteen water-tube boilers, each with 5,000 sq.ft. of heating surface, and three locomotive-type boilers, each with a heating surface of 750 sq.ft. The combined operating forces of these eight plants, including firemen, water tenders, ashmen, coal passers, boiler cleaners, etc., totaled 154 men and the coal consumption for the year 1917 was 203,631 gross tons, the average boiler efficiency in these plants being between 35 and 40 per cent. All the fuel burned was commercial coal, about 90 per cent of which was No. 3 buckwheat and the remainder No. 2.

In the latter half of 1917, an exhaustive study was made to determine the best means of reducing power cost at these two collieries. The local power companies not being in a position to provide sufficient energy for colliery operation, the company had to erect a new boiler plant and generating station. The Short Mountain colliery remained on steam except where new installations could be more economically operated by electricity.

To operate the existing steam equipment at Short Mountain colliery, six 600-hp. boilers were installed. Two 3,200-kw. turbo-generators were selected to supply electrical energy for both Short Mountain and Williamstown collieries, and plans were made for a future third machine of at least 7,500 kw., for it was estimated that a generating capacity of 10,000 kw. would suffice. For operating the turbines, six 500-hp. boilers were installed, which provide sufficient steam for operating 9,000-kw. and one of the 3,200-kw. machines.

High-pressure superheated steam is necessary for low turbine-water rates, whereas the water rate on slide-valve reciprocating engines operating non-condensing is not materially improved by superheating the steam. The existing machines were not built for operating at high pressures, so it was decided to generate steam at both 190- and 145-lb. pressures.

The boiler and turbine plants being selected, much thought was given to the grade of coal that would give greatest economy. Naturally, the first proposal was traveling-grate stokers burning No. 3 buckwheat, but, as this size of coal has a good market, the use of silt was proposed. Experience with fine coals on chain-grate stokers had shown that some commercial coal would have to be burned with the silt if such stokers were used, especially when operating the boilers at high ratings. Mountains of slush, an accumulation of years, were available. These had no great commercial value, but when pulverized and burned in suspension would replace an enormous quantity of marketable coal.

An experimental plant was installed in 1918, and research continued until late in 1920. The pilot plant consisted of a 2,500-sq.ft. water-tube boiler, a 42-in. screen-type pulverizing mill and a rotary dryer. The economical operation of the Lykens plant during the past ten years proves that anthracite slush can be burned successfully in powdered form. The operation of the plant has surpassed the expectations of its most optimistic advocates.

A mixture of about 25 per cent coal and 75 per cent water is pumped against a head of 400 ft., either from the breaker washery or slush pile, to a storage site on the side of the mountain, a distance of 2,500 to 3,500 ft.

Here the coal is discharged into two concrete dewatering tanks with four slow-moving drag scrapers for removing the slush. These scrapers discharge directly to two coal stackers, each consisting of a 90-ft. boom carrying a drag scraper. The lower side of the scraper trough is fitted with a number of sliding gates, from which the coal can be discharged at any point along the boom. As the boom swings through an angle of 180 deg., the two stacker units provide storage for at least 100,000 tons. The coal as it leaves the stackers contains about 30 per cent of moisture, but after standing in the storage pile 48 hours the moisture decreases to about 10 per cent.

Coal is reclaimed from the storage pile by a drag scraper operated by a motor-driven double-drum hoist. Suitable anchor posts for attaching the head-rope sheave are arranged around the pile. The hoist is mounted on a turntable provided with a central discharge, which feature permits swinging the hoist drums in line with the pull of the drag scraper. Dewatering, stacking and reclaiming coal require, in all, the services of only two men.

From the discharge hopper of the drag scraper the coal is conveyed by a scraper conveyor to a distributing conveyor which carries it over the raw-coal bunkers in the pulverizing house. From the bunkers the coal is passed to two 25-ton-per-hour double shell dryers where the moisture content is reduced to about 1 per cent. The coal is then elevated into a concrete bin located over the pulverizing room. This bin is arranged with suitable discharges to eight 42-in. screen mills.

As fed to the mills, about 70 per cent of the silt will pass through a $\frac{3}{64}$-in. screen, and of the finished material leaving the mill, about 82 per cent passes through a 200-mesh screen. Such fine grinding is necessary with anthracite, or all the coal will not ignite, the volatile content of the fuel being only 8 per cent, as compared with the 30 or 40 per cent of bituminous coals.

Coal from the mills is discharged into screw conveyors, which in turn feed into duplicate systems of bucket elevators lifting the coal to a point above the boiler bunker level, whence screw conveyors in duplicate transfer it to the fuel bins above the boiler aisle. The total capacity of the fuel bins is 250 tons, a supply sufficient for the 24-hour full load on the station.

The boilers are arranged in two rows, six being on each side of the operating aisle. Six 5,000-sq.ft. horizontal water-tube boilers, equipped with superheaters and operated at 190 lb. pressure, are provided, and six 6,000-sq.ft. boilers of the same type, operating at 145 lb. pressure, but without superheaters. All are designed for 200 lb. working pressure.

The higher-pressure boilers supply steam to the turbines, and the lower-pressure boilers provide steam for distribution to the hoists, air compressors, and pumps of Short Mountain colliery. The steam header consists of two connected loops with sectionalizing valves between each pair of boilers, so that any of the boilers can be used on either high- or low-pressure service.

To afford a good burner setting, the front of the combustion chamber of each boiler is extended, the floor rising from the front of the combustion chamber to the bridge wall. The furnace volume of the 5,000-sq.ft. boilers is nearly 1,600 cu.ft., giving 3.5 sq.ft. of heating surface per cubic foot of furnace volume. The 6,000-sq.ft. boilers have 4 sq.ft. of heating surface per cubic foot of furnace volume. Ashes are sluiced from the pit with mine water.

Each boiler is fired by a single burner located in the arch which forms the top of the combustion-chamber extension. The opening of each burner is 2½ in. wide and 5 ft. 2 in. long. The burners discharge directly against a hinged deflector, the position of which is controlled by a chain wheel and screw operated from the floor. The flame travel can therefore be directed to suit the load. Secondary air is admitted into the cast-iron housing surrounding the burner, being regulated by a damper fitted to the top of the housing and operated from the floor. The feeders, two for each burner, are mounted directly below the pulverized-fuel bins with the controls conveniently located on the boiler fronts.

Primary air is supplied by two motor-driven fans discharging midway into the primary air header which extends the length of the boiler room directly above the operating aisle. Two radial brick stacks of 12 ft. inside diameter at the top and rising 175 ft. above the base have been erected, each serving six boilers and having two breechings, each connected to three boilers.

The present installed generating capacity consists of two 3,200-kw. (4,000-kva.), 2,300-volt, 3-phase 60-cycle, and one 9,000-kw. (11,250-kva.), 13,200-volt, 3-phase, 60-cycle turbo-generators. The third machine was put in service in 1929.

Condensers are all low-head jet-mounted units and are located directly below the turbine exhaust. They are equipped with Rado-jet air pumps. Removal pumps for the two smaller turbines are turbine-driven, and that of the large machine is motor-driven. A spray pond is used for cooling injection water, which requires three 4,500-g.p.m. motor-driven centrifugal pumps. Hot- and cold-water tunnels extend from the spray-pond basin to the basement of the turbine room.

Boiler feed water is supplied by four centrifugal pumps, two motor- and two turbine-driven, located in the basement of the turbine room directly below the feed-water heater. Heat for feed water is supplied by the removal pumps of the condensers which serve the smaller turbines and from the following sources: discharge from Rado-jet air pumps, turbine-driven boiler-feed pumps (when operating), colliery air compressors and shaft hoists. The available exhaust steam for feeding boiler-feed water maintains a fairly constant heat balance over 24 hours.

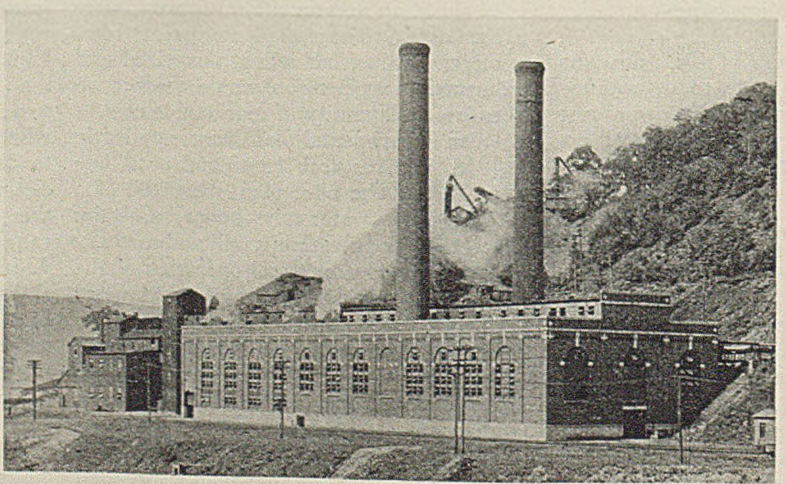
The 3,200-kw. generators are cooled by air washers, and the 9,000-kw. generator has a closed system of cooling using fresh water through a fin-type cooler. Piping is so arranged that the warm water from the 9,000-kw. generator cooler either can be used in the feed-water heater or emptied into the hot-water tunnel for spray-pond make-up.

The 9,000-kw., 13,200-volt generator is connected solidly to the secondary of a 11,250-kva., 13,200-22,000 volt, 3-phase auto-transformer by single-conductor lead-sheath cables. An oil circuit breaker connects the auto-transformer to the 22-kva. outdoor bus so that the generator and transformer form a 9,000-kw., 22,000-volt generating unit.

All oil circuit breakers are opened and closed by a station control battery installed in a separate room. A 7.5-kw. motor-generator is provided for charging this battery. A 50-kva., 3-phase, 2,300-460-volt transformer provides power for the motors of the air-washer pump, oil purifiers and other small motors used in the power plant and boiler room. When the 9,000-kw. turbo-generator was installed, a motor-driven centrifugal-type oil purifier with motor-driven oil pump was put in service.

Both 2,200- and 440-volt power are required in the operation of the pulverizing plant, which is transmitted at 2,200 volts by cable from the generating station. Three 150-kva. transformers located at the pulverizing plant provide 440-volt power. The 440-volt control apparatus is located in a separate room, and all motor drives are interlocked to insure proper sequence when starting or stopping conveyors.

The boiler plant generates an average of 1,700,000,000 lb. of steam each year, of which 650,000,000 lb. is used in the turbine plant. The remaining 1,050,000,000 lb. of steam is required for operating steam equipment at Short Mountain colliery. During a year of normal coal production an average of 40,000,000 kw.-hr. is required in the operation of the collieries and power plant.



Lykens Power Plant, Short Mountain Colliery

COMPRESSED AIR

+ At Susquehanna Collieries

AT the Susquehanna collieries, compressed air has been found a necessity for mining operations. Wherever made available, opportunities for using it as a convenience and a labor saver constantly have presented themselves. Not only is compressed air used extensively at these mines in the preparation of working faces for blasting, but also in the operation of all hoists and pumps which are installed in places where gas is present or is to be feared. Moreover, in the South Shaft of No. 7 colliery, eight compressed-air locomotives are still in successful operation and doubtless will continue to be used, estimates on substituting permissible storage batteries having shown that the expense of new equipment, including the high cost for power to widely separated charging stations, would not warrant a change, the existing compressors, air lines and locomotives being in good working condition.

In mines with difficult gradients, where locomotives often never come to the shaft or to the surface except for repair and where the bringing of them to the shaft or to daylight involves hauling them up planes, it is difficult to arrange for any concentration of charging stations. These South Shaft locomotives are supplied with air at 1,000-lb. pressure by two steam-driven air compressors, each of 500-cu.ft. per minute capacity.

At the Susquehanna collieries, scraper hoists are frequently operated by compressed air, especially in gassy places or where electric power lines have not been installed, and an air-driven shaker chute has recently been put in operation in No. 7 mine. Such air-driven equipment can be reversed merely by operation of the valves. Thus material or men can be taken to the face as readily as coal can be transported to the car if the gradients are not too unfavorable. The jerk of the air-propelled chute is more pronounced than that of the electrically propelled unit, though the economy in power is not so great. Several Little Tugger hoists also have been installed for spotting cars under loading chutes, thus dispensing with the more costly and less convenient mine mule.

Centrifugal mine pumps also are sometimes primed at the Susquehanna collieries by compressed-air ejectors, and hoist brakes and clutches are operated by compressed air from the colliery air-supply lines. Each hoist usually is provided with a separate compressor, the colliery air supply being used only when the small compressor is temporarily out of service.

When a mine has been converted, as have most of the Susquehanna collieries, from steam to electric operation, compressed air must be used to operate the car dumps at the breaker tip, and air whistles also are often provided. However, the Susquehanna company uses more electric sirens than air whistles, because electric power always is ready for use, whereas compressed air may not be available when the colliery is idle. In many of the mines, compressed air is being used also for signaling on slopes, where, owing to the presence of gas, the use of electric signals has been deemed unsafe. On the other hand, at shafts, electric signals are replacing those formerly operated by compressed air. Larries and steam locomotives are provided with small air compressors for dumping loads and operating brakes.

In the shops of the Susquehanna company, compressed air is used for sharpening drill steel, and where steam is no longer available it is also employed for the actuation of hydraulic presses and of riveting and forging hammers.

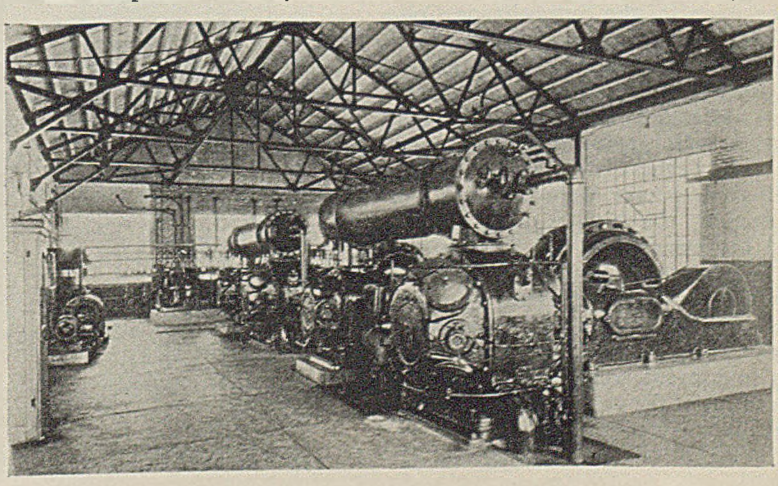
Utility air hoists have proved to be labor savers in the shops, and air-operated hand drills have reduced the time expended in the making of repairs. Windings of electrical machines are cleaned periodically with compressed air, and insulating varnish is blown on them by the same means, which also is used in the heating torches by which worn locomotive tires are annealed prior to being turned down.

When installing new equipment in place of old, the use of air-driven concrete breakers has been found to save much time where foundations have to be removed, and, when time comes for refurbishment, air-spray painting saves time and labor, the sandblast removing the scale from steel buildings and from power transmission towers prior to their being sprayed with paint.

At each colliery air compressors deliver compressed air through suitable pipe lines to the inside workings, but wherever, because of inadequate pipeline or compressor capacity, the pressure at the face drops below 60 lb., a receiver is connected with the pipe lines, and a small electrically driven compressor is arranged to feed into this air receiver. A check valve in the colliery air line permits colliery air to flow into the

(Turn to page 376)

Air Compressor With Synchronous Motors at Williamstown Colliery



PUMPING

+ At Susquehanna Collieries

WATER problems are no respecters of markets. They must be met whether the mines run regularly or irregularly. With an aggregate of 12.34 tons of water pumped per ton of coal, or 46,000,000 tons in 1931, the disposal of mine water constitutes one of the largest problems of the Susquehanna collieries, as at all the deeper anthracite mines, a load that is particularly burdensome at times of slow operation and still more when the mines are not producing.

Cameron mine operated on extremely short time in 1931, and its ratio of tons of water to tons of coal was 153.22 to 1. Two mines, Richards and Williamstown, pumped in that year a quantity relatively small as compared with Cameron: namely, 5.08 and 5.80 tons of water per ton of coal, respectively, but enough to add appreciably to mining costs.

When new pumping stations are constructed, they usually are excavated in the rock and are so arranged that they can be entirely surrounded by water—in other words, "submerged"—without closing off the passageway by which the pumproom is approached. This prevents the loss of the pumps in case of a prolonged power failure, failure of column line, excessive water inflow or similar disaster. Where a station cannot be arranged for permanent submergence, dams or bulkhead doors are provided for use in emergencies.

When the use of electrically driven centrifugal pumps was first considered for the mines of the Susquehanna Collieries Co., as for other anthracite properties, it was not thought desirable to build them for high heads. The early pumps were designed for slow-speed operation with pressures per stage of about 35 lb. (equivalent to an 80-ft. lift). As 10-stage pumps were the limit in construction, the highest head pumps would lift water only 800 ft. Speeds were later increased to 1,200 r.p.m., and today many pumps revolving at 1,800 r.p.m. are in successful operation. Pumps were equipped with diffusion vanes to prevent wear and subsequent replacement of the casings, but the more modern pumps are of volute type, operating at 200 ft. or more per stage.

The first large centrifugal pumps installed by the Susquehanna Collieries Co. were placed in the Top and Counter stations of the Williamstown colliery, where they are still operating. They are Allis-Chalmers, 8- and 10-stage, 640- and 800-ft. head, 80-ft.-per-stage, 1,800-g.p.m. and 880-r.p.m. These pumps have operated for over ten years with the lowest maintenance cost of any pump on the properties.

Four pumps were originally installed in each station with space in which a fifth pump could be installed when needed. This fifth pump has since been installed in each station, but the one at the Counter station, by reason of its equipment with Francis impellers, has a capacity of 2,200 g.p.m. and yet does not overload the 600-hp. synchronous motor by which it is driven. By equipping the original pumps with Francis impellers an increase in capacity of about 400 g.p.m. can later be obtained without much expense.

Metal used in centrifugal mine pumps in the anthracite mines and at the Susquehanna collieries has usually been 75 per cent copper, 10 per cent tin, and 15 per cent lead, although some variation in this bronze frequently occurs. Chrome iron has been used for impellers and shaft sleeves.

At No. 2 shaft bottom, No. 7 colliery, three 2,500-g.p.m. double-acting duplex steam-driven plunger pumps discharge water to the surface. Eleven steam-driven plunger pumps having a rated capacity of 16,500 g.p.m. handle all water up Short Mountain shaft in three lifts, a total static head of 1,771 ft. In all, 115 centrifugal pumps and 79 plunger and piston pumps are in service at the Susquehanna collieries, having a total capacity of approximately 226,580 g.p.m. and requiring 27,932 motor horsepower.

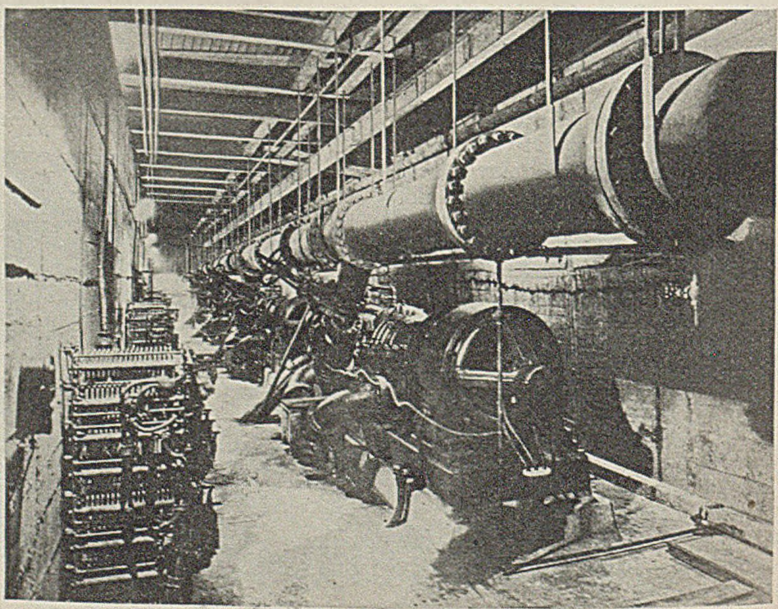
Because of the corrosive action of sulphuric acid, all metal in contact with the mine water is of acid-resisting bronze, though sometimes, as in the case of column pipe, wood lining is used.

Column lines are given sufficient area so that the frictional loss will not be excessive even when all the pumps in a station are in operation. Diameters of discharge lines are chosen with full recognition of the fact that the head at which the pumps operate will vary with ths number of pumps discharging into the column.

At these mines, suction lines usually are made one or even two pipe sizes larger than the suction opening of the

(Turn to page 376)

Underground Pump Station at Williamstown; Five 2,000-G.P.M., 880-R.P.M. Centrifugal Pumps Driven by 500-Hp. Slip-Ring Motors



SAFETY

+ At Susquehanna Collieries

ELIMINATION of open lights and substitution therefor of Edison and Wheat electric cap lamps, together with Koehler flame safety lamps, an increased use of permissible explosives and electric-battery firing, the almost exclusive use of the M.S.A. Skullgard safety hat, the guarding of machinery and the proper installation and maintenance of electrical equipment have been factors in a vigorous campaign for safety which the Susquehanna Collieries Co. and the Lytle Coal Co. for many years have been waging. About one year ago, this safety work was reorganized and the safety and compensation departments were combined under the common head of a supervisor of safety and compensation who reports directly to the general manager.

A meeting of all general foremen was called, and, in several days' conference, safety standards were adopted. All items were approved unanimously before they were included in the "standard." Thus, every foreman took his definite part in the formulation of the rules by which the property directly under his supervision was thereafter to be inspected and judged.

The personnel of the safety department consists of the supervisor of safety and compensation and four inspectors, one for each inspection district. Every day, without previous notification, the safety inspector appears at some mine as the shift is about to start and, selecting a fireboss or section foreman, informs that official that he will accompany him on the inspection he is about to make. The fireboss then covers his regular district with the safety inspector.

At the end of his inspection, any criticisms or recommendations that occur to him are noted on the left half of a report sheet. These comments he discusses with the mine foreman, who, on the right side of the report, indicates the action he has taken to comply with them. This report is then typed, and copies are sent to the colliery superintendent, the supervisor of safety and compensation, the mine foreman and the safety inspector.

When the inspector again visits this district, he notes, on his report, the date when his former recommendations were put into effect and whether the unsafe conditions he then noted have been corrected. If not, an investigation is made to find the reason.

Clyde G. Brehm, Supervisor of Safety and Compensation

Records are kept of each fireboss' district, showing date, number and character of the safety inspector's criticisms, as well as the nature and cause of, and disability resulting from, any accidents in the district.

Monthly safety meetings, for which the colliery superintendent is responsible, are conducted at all collieries. Each month a statement, with blueprints of location, of all serious and fatal accidents is prepared and sent to all division superintendents and safety inspectors. These are discussed at the division safety meetings.

First-aid teams are maintained at each colliery and all first-aid training is conducted by the corps of company surgeons. At every colliery, emergency hospitals are maintained on the surface and on each underground level. Thirty-eight such emergency hospitals are maintained underground.

Regular teams, certificated in mine-rescue work by the U. S. Bureau of Mines, are maintained at each colliery, and others are at all times in training under the direction of the supervisor of safety. Rescue equipment ready for instant use is as follows: 23 McCaa apparatus of 2-hour type, 61 Burrell All-Service gas masks, 5 H.H. Inhalators, 15 M.S.A. carbon-monoxide detectors.

In each division, a certified and trained man is in charge of apparatus and training. He makes a monthly report on training, condition of apparatus, quantity and location of supplies, and certifies that every machine in his charge is ready for instant use. The division safety inspector also inspects the rescue stations and equipment and makes a monthly report to the supervisor of safety. When needed, all the equipment and supplies could be assembled at any one point within the company property in less than two hours.

A few safety rules in force follow: Roof must be tested with a steel bar. Timber sets must be carefully held in place where necessary by a "sprag" or horizontal strut extending from the timber being set back to the previous set. Where posts of such sets are lashed together by horizontal planks running from one to the other, they must be of adequate strength and held in place by two spikes at each end. Axes must not have handles longer than 22 in. lest the man using the ax with one hand should touch the ground or a prop with the end of the handle and thus make a

DAILY INSPECTION REPORT

Report Covering Safety Inspection of Working Under the Supervision of ______________ Mine Foreman: ______________ Assistant Mine Foreman: ______________ Fireboss ______________ Colliery: ______________ District.

______________ 1932

Criticisms	*Comments by Foreman.*
Miner No. X attached detonator to powder by wrong method. Proper method was explained to him.	Miner No. X will be watched to see that he prepares explosives properly.
Bad top on No. Y miner's road.	Company men were sent to take down bad top at once.
Miner No. Z — Timber lying too close to track.	Timber was moved, and miner will be warned to maintain proper clearance.

misdirected blow that might cut a hand or sever a finger.

Every man carries a safety lamp as well as an electric cap lamp. When the man to whom the lamp is confided is at his working place, the lamp must be kept at the high point of the face, and must always be lighted. All accessible places must be examined at least weekly, whether used or idle.

Every main door is required to be in duplicate, so that if one fails, the other can be substituted for it. Faces of old chambers are never left blind but connected up to the gangway above. On all exhaust ventilating fans are posted notices reading "Safety Lamps Only," because the return air may possibly reach the explosive limit, though all care is taken to see that such a quantity of gas is never even approximated.

At the Susquehanna collieries over 3,000 Skullgard hats are in use, the underground employees in three collieries being entirely thus equipped. The introduction of this safety equipment has been gradual and its value as protection against head injuries is shown by the following table:

Year	Tons Mined per Head Injury
1928	55,130
1929	65,604
1930	71,233
1931	92,911
8 months, 1932	182.723

▼

COMPRESSED AIR

At Susquehanna Collieries

(Concluded from page 373)

receiver, but prevents the small compressor from delivering air back to the colliery lines beyond it. These small compressors therefore enable a suitable working pressure to be maintained even at points some distance from the main colliery compressor plant.

At points beyond the reach of the main colliery air lines, portable air compressors electrically driven are installed. Such compressors usually are driven through a reduction gear, but recent experience has shown that a Texrope or a Cog-Belt drive will prevent compressor vibrations from being transmitted to the driving motors. Special heavy-duty magnetic starters and unloading devices also have reduced the cost of electrical maintenance.

At collieries operating entirely on electric power, the main air compressors are driven by direct-connected synchronous motors. Automatic operation of large electrically driven compressors has often been considered, but, as these machines are located in substations where an attendant is always on duty, full automatic operation would not be an economy.

Large installations inside the mines would reduce air-transmission losses and result in higher pressure at the working places, but the excessive cost of cooling the necessary circulating water has discouraged inside installations, for fresh water must be circulated through their cylinder jackets and intercoolers. At surface installations, cooling water is circulated by a motor-driven centrifugal pump through spray nozzles which discharge into a storage tank.

After-coolers have been given much consideration, as cool dry air can be transmitted more economically than heated air and used to better advantage in air tools, but it is difficult to show that they would make any saving in dollars.

In compressing air from atmospheric pressure to 100 lb. gage, much heat is lost, so tests were made on two machines to determine how much heat was present in the discharge water. If sufficient heat could be obtained from this source, and the cost of utilization would not be too great, the water, it was thought, after leaving the compressor could be used in the wash houses during the summer months, thus saving the expense of operating hot-water boilers. Test data on the following compressors showed that half the power furnished the compressors was lost in heat.

Compressor	22—13 x 14 in.	28—17¼ x 21 in
Displacement	3,168 cu.ft.	2,690 cu.ft.
Rev. per min.	257	180
Horsepower	500	438
Receiver pressure	90 lb.	55 lb.
Inlet water	55 deg.F.	74 deg.F.
Outlet water	110 deg.F.	91 deg.F.
Temperature rise	55 deg.F.	17 deg.F.
Water circulated	26.8 g.p.m.	74.7 g.p.m.
B.t.u. per hour	737,000	633,000
Heat loss	289 hp.	248 hp.

Though compressed air is needed for economical mining, it is an expensive form of power, as most compressors operate at full capacity during the colliery working day and usually run at half-load during the other 16 hours. The steady load over many hours results in high steam and kilowatt-hour consumption.

▼

PUMPING

At Susquehanna Collieries

(Concluded from Page 374)

pump, depending upon pump capacity and length of suction pipe. If the suction line is too small, the pumps may not operate successfully, especially if one pump is operating alone, because, under such conditions, the lower frictional head would increase its capacity. Suction strainers with removable chip baskets also are made of area as ample as that of the suction pipes.

Gate and check valves also usually are made of larger dimensions than the discharge opening of the pump, in order to reduce the velocity of the water flowing through them, because thereby longer life will be assured. Gate and check valves generally are built of bronze, but, when cast-iron check valves are used, they are always selected oversize to reduce water velocity.

Automatic control of centrifugal pumps has been developed to such a degree of perfection that more reliable operation is obtained with equipment than with hand control, for the automatic features embodied in the control will act more quickly in an emergency than is possible with manual supervision.

Most of the plunger pumps at these mines are self-priming, but, where the valve chamber area is large in comparison with the area displaced by the plunger, the pump may not readily prime itself. Automatic priming control has been developed for use with plunger pumps, so that many plunger pumps operating but a few hours each day can operate when required without the cost of attendance at each pump. One attendant can therefore supervise the operation of several pumps located at various places around the mine.

Squirrel-cage motors usually are provided for driving centrifugal pumps, although motors above 300 hp. are often of slip-ring type. Several synchronous motors with direct-connected exciters have been placed in service, and their operation is entirely successful except where the voltage drop is below normal. For general application on centrifugal-pump drives, synchronous motors are required to have 110 to 120 per cent pull-out torque and not less than 125 per cent pull-in torque. Gathering pumps usually are of piston type and driven by direct-current motors from haulage circuits in the mines.

VENTILATION

+ At Susquehanna Collieries

UNDER the anthracite laws of the Commonwealth of Pennsylvania, 200 cu.ft. of air per minute must be furnished for every person employed in any mine and as much more as circumstances may require. Because of the mining methods adopted and the large number of coal beds worked, anthracite mines rarely can be ventilated satisfactorily by a single fan.

With the continuous changes in mine development which extensions of the workings involve, with the variations in the thickness of coal seams and with the faults encountered in operation, the duties demanded from the various fans installed at a mine frequently vary greatly. At all mines the fans are tested periodically to ascertain whether each is delivering sufficient air to afford safe working conditions. As mining conditions change, the operating characteristics of the fans must be modified to provide safe ventilation.

At the Susquehanna collieries, fans located near the main boiler plants usually are steam-driven, although some new installations have been equipped with electric drive. When steam was replaced by electricity, many old steam fans also were changed to electric-motor drive. Where there was space between the engine and fan casing, a silent chain or belt was easily installed between fan and motor. Frequently, however, it was necessary to cut off the fan shaft and install a stub shaft with coupling and outboard bearing to accommodate the speed reducer.

It usually has been desirable to arrange the drive in this manner because it permitted a three-bearing motor to be used, for standard two-bearing motors do not always have bearings suitable for chain drive. Where the fan shaft was extended, the building formerly used to house the steam-engine drive usually had to be enlarged. Three types of drive have been used on both old and new fans, namely: belt, silent-chain and Texrope or Cog-Belt.

Motors driving mine fans vary in size from 25 to 150 hp. and are operated at constant speed. As the load during the 8-hour shift determines the power demand, no saving is effected by operating the fans at reduced speed during the 16-hour idle period. Moreover, normal ventilation must be maintained 24 hours each day, as the firebosses make their rounds early in the morning before the miners go inside. All mine-fan motors are of slip-ring type except those direct-connected to the fan rotor, which are of squirrel-cage construction.

Formerly, many squirrel-cage motors were used on the main fans, but these have been changed to motors of the wound-rotor type, for the sudden torque which the former applied when starting damaged the silent-chain drives. Starters usually are made automatic, so that after an interruption, the fan will start again when power returns. New starters are arranged for definite time acceleration, as this provides more even starting than the old current-limit relays, on which reliance could not always be placed.

In addition to the motor starter, each installation is provided with a panel equipped with a suitable oil-circuit breaker having overload trip, ammeter, disconnecting switches and lightning arresters. To each fan, 2,200-volt, 3-phase, 60-cycle power is delivered, all motors operating at this voltage.

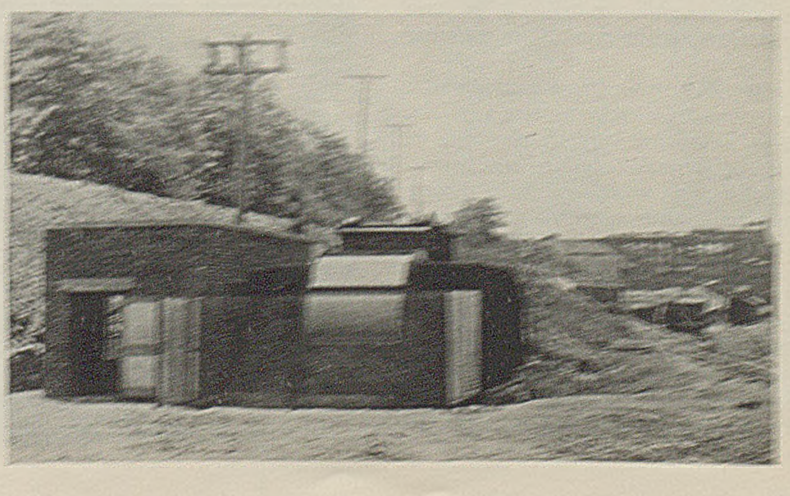
Where possible, a separate feeder circuit has been provided for mine-fan operation. This permits the installation of suitable signal systems in the substation to indicate whether the fan is operating. A signal system may consist either of a contact-making ammeter or of an air vane in the fan discharge. Either system requires a signal bell and lamps operated from the 115-volt substation lighting circuit.

In the past, whenever an opening was abandoned, the fan was moved to a new development. It has been found, however, that the cost of moving old fans having large-diameter rotors was more expensive than the purchase of new-design higher-speed fans. Moreover, modern fans operate at higher efficiency, thus reducing the consumption of electrical energy.

In practically all mines, small blowers with Ventubes are used to ventilate blind crosscuts properly and clear the working faces until the ventilating crosscut openings are completed. Ventubes of from 8- to 20-in. diameter are used, depending upon the volume of air needed and the distance of transmission. The use of a larger blower and one of higher pressure may often be more economical than using larger tubing, especially where the installation is more or less temporary.

In all, 37 main ventilating fans are in service at the Susquehanna properties delivering a normal volume of 3,274,000 cu.ft., or 128 tons, of air per minute.

Old Heavy Rotor Fan Gives Place to Modern Ventilator. An 8½-ft. Fan, 150,000 Cu.Ft. per Minute, Capacity 2.7 In. Water Gage, at Pennsylvania Colliery.



MAINTENANCE

+ At Susquehanna Collieries

FULL and efficient service from every piece of equipment installed is the basis of the Susquehanna maintenance program. The company attempts, with due regard to the safety factor, to keep equipment capacity in close relation to the job it is expected to perform, and thereafter bends its energies toward keeping it operating efficiently over the full period of normal life. Losses of time and money due to breakdowns and shortened life are a comparatively minor item at Susquehanna collieries.

In general, each colliery has its own maintenance department, and the electrical and mechanical foremen in charge report to the superintendent. Because of the nature of the work, however, provision is made for consulting assistance from the electrical and mechanical engineers in the main office. Each colliery has its own electrical repair and machine shops. Equipment too heavy for colliery facilities is forwarded to larger shops at No. 7, Pennsylvania and Short Mountain collieries for repair.

Organization of colliery electrical departments is based upon the appointment of one electrician, one helper and one bonder at each opening, in addition to the shop staff. To assist the colliery staff, particularly in ordering replacements, the company insists on a detailed list of major equipment and parts for each installation. A copy of this list goes to the main office for use in checking requisitions. No installation is considered to be complete until this list has been made up, either by the colliery staff or a member of the general engineering staff.

Every piece of electrical equipment is inspected at least twice a month by the colliery electrician, and in the case of fan, pumps, and similar equipment, where stoppage would result in closing down parts of the mine, a daily inspection is made. Once a month, all bonding is inspected by a member of the colliery electrical staff, who also notes the condition of trolley and feeder wires.

Electric locomotives, by reason of the harder service they encounter, receive special attention. In addition to twice-yearly inspections covering all electrical and mechanical equipment from the tires to the trolley wheel, the locomotive runner must inspect his machine at the end of each shift. His findings are entered on the form shown in Fig. 1, which goes to the mine foreman and the colliery electrician. The locomotive runner also is expected to take care of the trailing cable, including inspection and repairs.

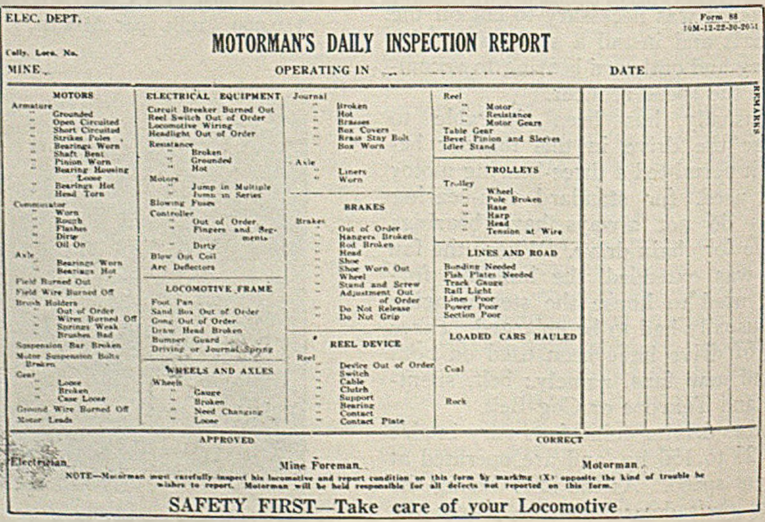
In the case of battery locomotives, the report of the locomotive runner is supplemented by a daily battery report. This report contains space for daily charging details and also for information on the results of the weekly equalizing charge. One battery report sheet is complete when the month-end readings on the specific gravity of the solution in each cell is obtained. These readings are taken immediately after the regular equalizing charge. Every three months, each battery receives a thorough inspection at the hands of a maintenance engineer from the general engineering staff, assisted by the manufacturer's service man.

Batteries are charged from specific-gravity charts, which are made up to show the ampere-hours required for a full charge at each specific-gravity range, from 1.27-1.28 down to 1.13-1.14. The charging attendant secures the specific gravity of the discharged battery from a pilot cell, and sets his ampere-hour meter at the required figure. Pilot cells are changed once each month. This method of determining discharge condition was adopted in place of ampere-hour meters on the locomotive; the jarring and shocks received by these meters while the locomotive was in service rendered them inaccurate and increased their maintenance cost.

All storage-battery locomotives are located at No. 7 and No. 6 collieries, where operating conditions include short stretches of roadway on grades as high as 17 per cent. In spite of these severe conditions of service, the improved battery maintenance methods have enabled the company to request—and receive—increased life guarantees from battery manufacturers. Life history of batteries back to 1919 are given in Table I, together with other locomotive and battery details. With the exception of one Edison battery, all battery installations since early in 1925 have been Exide lead cells.

Out of the 113 mine locomotives used by the Susquehanna Collieries Co., 62, including ten battery types, are located at No. 7 and No. 6 collieries. Uneven track and high grades are prevalent, throwing heavy strains on locomotive frames, with the result that axle and shaft failures, spring breakage, and wear were costly items. To eliminate excessive breakage and wear of axles, crankpins, motor armature shafts, bolts, and similar parts, the company now em-

Fig. 1—Motorman's Daily Report on Locomotive Conditions


ELEC. DEPT.
Form 88
10M-12-22-30-2051
MOTORMAN'S DAILY INSPECTION REPORT
Colly. Loco. No.
MINE
OPERATING IN
DATE

MOTORS
Armature — Grounded, Open Circuited, Short Circuited, Strikes Poles, Bearings Worn, Shaft Bent, Pinion Worn, Bearing Housing Loose, Bearings Hot, Head Torn
Commutator — Worn, Rough, Flashes, Dirty, Oil On
Axle — Bearings Worn, Bearings Hot
Field Burned Out
Field Wire Burned Off
Brush Holders — Out of Order, Wires Burned Off, Springs Weak, Brushes Bad
Suspension Bar Broken
Motor Suspension Bolts Broken
Gear — Loose, Broken, Case Loose
Ground Wire Burned Off
Motor Leads

ELECTRICAL EQUIPMENT
Circuit Breaker Burned Out
Reel Switch Out of Order
Locomotive Wiring
Headlight Out of Order
Resistance — Broken, Grounded, Hot
Motors — Jump in Multiple, Jump in Series
Blowing Fuses
Controller — Out of Order, Fingers and Segments, Dirty
Blow Out Coil
Arc Deflectors

LOCOMOTIVE FRAME
Foot Pan
Sand Box Out of Order
Gong Out of Order
Draw Head Broken
Bumper Guard
Driving or Journal Spring

WHEELS AND AXLES
Wheels — Gauge, Broken, Need Changing, Loose

Journal — Broken, Hot, Brasses, Box Covers, Brass Stay Bolt, Box Worn
Axle — Liners, Worn

BRAKES
Brakes — Out of Order, Hangers Broken, Rod Broken, Head, Shoe, Shoe Worn Out, Wheel, Stand and Screw, Adjustment Out of Order, Do Not Release, Do Not Grip

REEL DEVICE
Reel — Device Out of Order, Switch, Cable, Clutch, Support, Bearing, Contact, Contact Plate

Reel — Motor, Resistance, Motor Gears
Table Gear
Bevel Pinion and Sleeves
Idler Stand

TROLLEYS
Trolley — Wheel, Pole Broken, Base, Harp, Head, Tension at Wire

LINES AND ROAD
Bonding Needed
Fish Plates Needed
Track Gauge
Rail Light
Lines Poor
Power Poor
Section Poor

LOADED CARS HAULED
Coal
Rock

REMARKS

APPROVED
CORRECT
Electrician
Mine Foreman
Motorman
NOTE—Motorman must carefully inspect his locomotive and report condition on this form by marking (X) opposite the kind of trouble he wishes to report. Motorman will be held responsible for all defects not reported on this form.
SAFETY FIRST—Take care of your Locomotive

ploys heat-treated chrome-vanadium steel ("Elastuff"), supplied by Horace T. Potts & Co., Philadelphia, Pa. Sizes up to 1⅝ in. round and 2 in. hexagonal contain 0.25-0.35 per cent carbon; for all other sizes, carbon content is 0.45-0.55 per cent. Physical characteristics are given in the following table:

	Diameter, Round Sizes, Inches		
	1¾ to 3	3½ to 6½	6½ to 8
Tensile strength, lb. per sq.in.	140,000–150,000	145,000–160,000	130,000–150,000
Tensile strength, yield point, lb. per sq.in.	120,000–135,000	120,000–135,000	105,000–125,000
Per cent elongation in 2 in.	16–20	15–20	15–20
Per cent reduction in area	52–60	42–52	42–52
Brinell	302–340	302–340	255–322

Replacement of the older types of axles began three years ago, and none has been broken since the use of the chrome-vanadium alloy was begun.

All of the older locomotives were equipped with coil springs, which allowed but little axle flexibility, with the result that considerable breakage ensued. These springs have been replaced by a type made up of steel with the following characteristics: carbon, 0.90-1.10 per cent; manganese, 0.50 per cent, maximum; phosphorus and sulphur, each 0.05 per cent, maximum; working strength, 60,000 lb. per square inch. Research on the best type of bearing metal for brasses and axle bearings resulted in standardization on the following analysis: copper, 80 per cent; lead and tin, 10 per cent each.

Electric locomotives originally were arranged to take side thrust on the journal-box faces. Excessive wear resulted, and to avoid undue replacement of journal boxes, end-thrust plates are now installed, supplemented by replaceable wearing strips welded to the journal. Studies on motor bearings resulted in the adoption of a rigid roller bearing on the pinion end for strength where the load occurs, and a self-aligning ball bearing on the commutator end to provide for alignment after wear takes place.

In view of the hard service which mine locomotives receive, rigid armature specifications have been adopted by the company, as follows: best grade of magnet wire, salamander white enamel finish, "delbeston" insulation; each coil separated in the cell portion by mica insulation of sufficient thickness and size to fit the cell; coils dipped and baked after forming and before insulation, hot-pressed after insulation; piece of high-grade mica placed between lower leads and coil to prevent fracturing when leads are bent; leads sleeved with asbestos sleeving, taped over sleeving with half-lapped mica tape, half-lapped asbestos tape applied over mica tape; coils firmly tied to corners to prevent leads working against the coils and also to prevent breakage of cell insulation when leads are bent; mica strip is laid across the top side of coil under the asbestos tape after cell insulation has been applied as an additional protection and insulation under the bands; high-grade demineralized asbestos used in tapes and sleeving.

Reconditioning of mine-locomotive motors is not carried on indefinitely at Susquehanna collieries. Maintenance costs for each of the older types of motors are closely watched, and when an appreciable rise is noted, the motor is replaced with the latest type. As the new motors have a considerably higher rating with approximately the same physical dimensions, the change not only cuts down the cost of maintenance but also adds materially to the power of the locomotive. Obsolete motors are either scrapped or applied on small slope hoists where the duty is light.

Routine repairs to mine locomotives are made underground, as are the daily and half-yearly inspections. No definite system of periodic overhauling has been established, due to the varying character of service the locomotives receive. The company follows the rule that electric locomotives must receive a general overhauling, both electrical and mechanical, when major repairs are necessary. All electrical equipment is taken out, inspected, and repaired, mechanical parts are replaced if necessary, and the frame receives new bolts and rivets and is strenghtened at points where weakness appears. To complete the job, each locomotive receives a coat of "Hanna Green" machinery paint. This color has been established as the standard for all overhauled machinery, including electric locomotives.

Wear on locomotive tires is a major item of expense which the Susquehanna Collieries Co. is reducing through tire filling with the electric welder. The company has not installed equipment of its own for this purpose, but sends its tires to the Westinghouse Electric & Mfg. Co.'s service shop in the region. Experience has shown that it is possible to fill the tires about four times. Steam locomotive tires are an exception to this rule, as building them up by electric welding is not considered sufficiently valuable to warrant the necessary expense. These tires are turned down when worn until too thin for further service. For some time, the company has experimented with cutting tools which would permit tires to be turned without preliminary annealing or re-

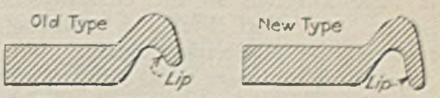


Fig. 2—Old and New Construction, Locomotive Brake Shoes

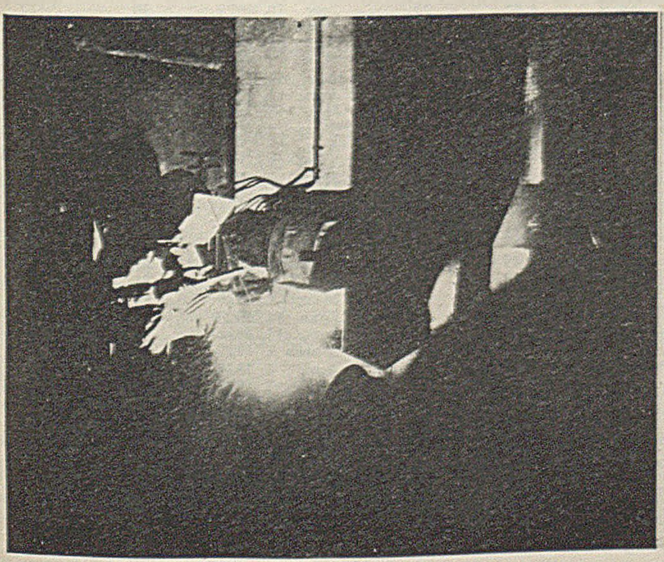


Fig. 3—Building Up Mine Car Wheels by Electric Welding, No. 7 Shop

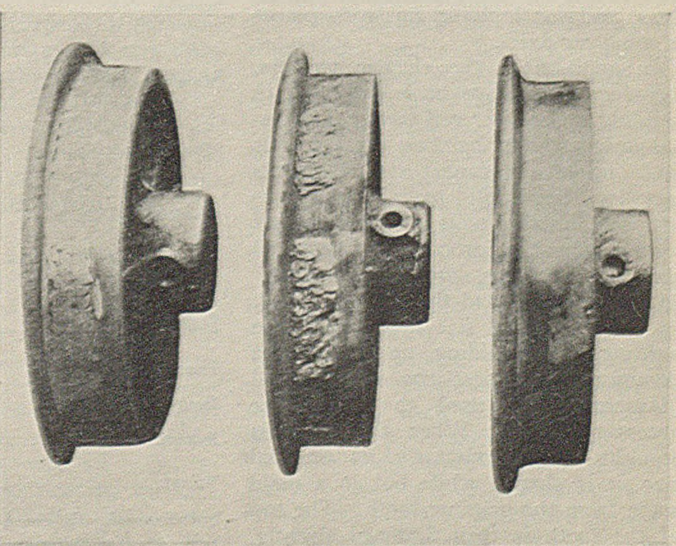


Fig. 4—Worn Wheel and the Two Steps in Rebuilding for Further Service

moval from the spider. As a result of this investigation, the Crucible Steel Co.'s cutting steel, Rex "AAA" cobalt high-speed steel, has been adopted.

Special cast-iron brake shoes with Ferallun and crucible steel inserts are used on mine locomotives. With the shape of shoe originally employed, considerable trouble was encountered from shoes working out of position on the tread. To prevent this action, the lip which rides on the tire flange has been lengthened, as shown in Fig. 2, until it extends down the full depth of the shoe. Better braking results, as the shoe is held in the proper position on the tread, and difficulties from shoes working loose from the tire have been eliminated.

Susquehanna has extended the use of the electric welder to the filling of worn places in mine-car wheels. Cast-iron chilled-tread wheels with seven spokes are used on mine cars, and spragging therefore results in the formation of seven flat spots on the wheel tread. At other places, the thickness of the tread is little affected, so the company is adding to wheel life and reducing replacements by electric welding.

In filling the worn spots (Fig. 3) a high-carbon steel electrode is used. When sufficient metal is deposited to bring the worn places up to their original shape, the wheel is ground to a fair circle, after which it is ready for service. A worn wheel before and after rebuilding is shown in Fig. 4. Ordinarily, worn spots can be built up three times, after which the character of the surface is such that metal from the electrode will not adhere sufficiently for grinding and subsequent use. Wheel rebuilding for all the company's operations is done at No. 7 colliery, using a 300-amp., one-man welder.

A similar welder was purchased for making repairs to bronze mine-pump casings at Pennsylvania and Richards collieries, and its cost was saved in three months on this duty alone. Later, it was applied to the construction of special pipe fittings, in making repairs to pipe lines, and for building up worn places in mine-car axles.

In addition to the electric welders, oxyacetylene equipment is employed in building up breaker roll teeth. Susquehanna has standardized on breaker rolls made up of manganese steel segments carrying "hawk-bill" teeth. As a general rule, breaker rolls are taken out of service when the percentage of prepared sizes (broken, egg, stove, and chestnut) drops below 90, and the teeth are built up to the original size by oxyacetylene welding. In building up a tooth, a chromium-manganese-iron welding rod (Hascrome) is used to supply the necessary metal. When the tooth is brought to approximately its original size, it is shaped while hot in a mold made from the original tooth. The top of the tooth is then flattened slightly,

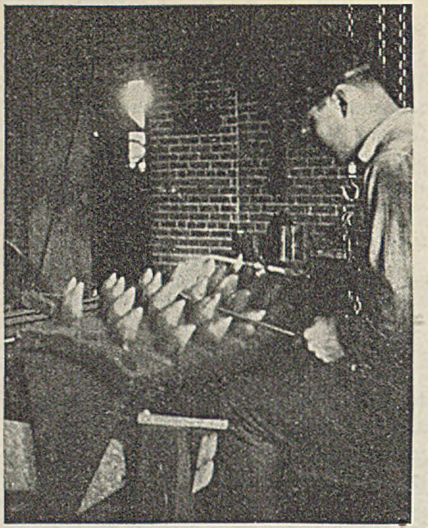


Fig. 5—Building Up Roll Teeth in Preparation for Hard-Surfacing

and Stellite is applied to the wearing surface. At some collieries, Stellite is used for building up the tooth, as well as for the final hard-surfacing application. The new teeth outwear the originals. Three rebuildings are possible before the segment must be discarded.

Neutralization of acid in breaker water supply has been adopted at two Susquehanna collieries to reduce destruction of steel parts. Breaker water usually is obtained from the mines, and at No. 6 and Richards the acidity at times runs as high as 23 grains to the gallon. Hydrated lime is the neutralizing agent used at these two plants, and is added to the breaker supply by a Gauntt variable-speed "lime feeder," manufactured by the W. J. Savage Co., Knoxville, Tenn. Just enough lime is added to almost exactly neutralize the acid, leaving approximately 1.5 grains per gallon in the breaker supply. Exact neutralization is not desirable, as slight reductions in acid content would result in an excess of lime in the breaker water, which would eventually appear as a white stain on the prepared coal. The 1.5 grains of acidity has little effect on metal. Through the use of neutralizing plants, breaker costs at these two operations have been reduced slightly more than 1c. per ton.

The supply system at Susquehanna collieries is based upon individual supply houses and yards at each operation for repair parts, mine supplies, tools, timber, and all other items in demand for routine operation. Requisitions for colliery repairs or other supplies originate with the mine foreman or storekeeper, and from them go to the colliery superintendent, who prepares the requisitions. The superintendent sends the requisitions to the main office at Nanticoke, where they receive the attention of the general manager, the purchasing agent, and the electrical and mechanical engineers. The latter, if the requisition includes electrical or mechanical equipment of any kind, check the items against the installation record mentioned at the beginning of this article, to insure their correctness, and also decide, with the assistance of their records, whether it is possible to obtain idle equipment from another colliery.

The general manager and purchasing agent further check the requisitions for quantities, with the object of determining whether or not the colliery already has sufficient material or whether the requisitions show excessive use of any items. Superintendents are expected to carry as small stocks of material, supplies, and parts as possible, and to order minimum quantities consistent with operating demands.

Table I—Life of Storage Batteries at Nos. 7 and 6 Collieries

Make of Locomotive	Colliery	No. Cells per Battery	No. Plates per Cell	Date Installed	Guarantee Months	Actual Life, Months
Mancha	No. 7	48	33	June 2, 1919	30	25
		48	33	July 1, 1921	30	24
		48	33	July 10, 1923	30	12
		48	33	Aug. 21, 1924	30	*
		80†	..	Oct. 31, 1928	10 years	..
Mancha	No. 7	48	33	May 1, 1919	30	28
		48	33	Aug. 31, 1921	30	31
		49	29	April 1, 1924	36	63
		49	29	Jan. 15, 1930	40	..
Mancha	No. 7	48	33	May 1, 1919	30	28
		48	33	Aug. 31, 1921	30	31
		49	29	April 1, 1924	36	65
		49	29	Sept. 7, 1929	40	..
Mancha	No. 6	49	29	May 16, 1923	36	26
		49	29	July 1, 1925	36	36
		49	29	July 1, 1928	40	40
		49	29	Nov. 1, 1931	40	..
Mancha	No. 6	49	29	June 4, 1923	36	33
		49	29	March 1, 1926	36	36
		49	29	March 4, 1929	40	..
Ironton	No. 7	49	29	June 11, 1923	36	39
		49	29	Sept. 11, 1926	36	30
		49	29	March 1, 1929	40	..
Ironton	No. 7	49	29	April 1, 1924	36	40
		49	29	Aug. 2, 1927	36	..
Ironton	No. 6	49	29	April 9, 1924	36	61
		49	29	May 23, 1929	40	..
Ironton	No. 7	49	29	April 1, 1924	36	36
		49	29	April 14, 1927	36	..
Vulcan	No. 6	49	23	Oct. 1, 1924	30	4‡
		48	33	Feb. 1, 1925	30	4‡
		49	29	Dec. 4, 1928	40	..

*No record. †Edison A-12 cells. ‡Destroyed in accident.

MERCHANDISING

+ Susquehanna Coals

How Hanna Advertises Susquehanna Collieries

RESPONSIBILITY for the sale and distribution of the output of the Susquehanna Collieries Co. and its affiliate, the Lytle Coal Co., rests with the parent organization of the group, the M. A. Hanna Co., of Cleveland, Ohio. When the Hanna interests purchased the anthracite properties of the Pennsylvania Railroad Co., fifteen years ago, these properties were being operated under the direction of the Susquehanna Coal Co. The last-named company also functioned as general sales agent for the various mines in the Pennsylvania group. With the formation of the Susquehanna Collieries Co., the Susquehanna Coal Co. passed out of the picture as an active corporation, but the sales organization and personnel which it had built up was absorbed by the Hanna company and further expanded to give a wider, directly controlled distribution of the tonnage.

Because the greatest concentration of anthracite consumption is in the Middle Atlantic and New England states, the new Ohio management naturally found it desirable to continue to maintain the general sales headquarters for the anthracite division of its activities at Philadelphia. Existing district sales offices at Philadelphia, New York, Baltimore, Chicago and Erie, Pa., also were continued, but the local sales office at Williamsport, Pa., a survival of the formative stages of the old Susquehanna sales organization, was abandoned.

Buffalo and Cleveland were added to the list of district offices. The position of Susquehanna tonnage in the lake trade was further strengthened through the direct affiliation with the dock facilities at the Head of the Lakes controlled by the M. A. Hanna Coal & Dock Co., of Minneapolis. By the purchase of the wholesale business of Andrew D. Bailie at Montreal and its merger into Susquehanna Collieries, Ltd., a wholly owned sales subsidiary was set up to handle business in Quebec and the Maritime Provinces of Canada. In addition, direct sales connections also were established with independent wholesale companies at certain other strategic points in anthracite consuming territory.

Today the sales set-up for handling Susquehanna tonnage includes eight district offices of the M. A. Hanna Co. in the United States, the Montreal subsidiary, the affiliation with the Hanna Coal & Dock Co., and four direct outlets through non-affiliated selling companies. New England tonnage moves through the Atlantic Coal Co. of New England, which also is associated with the Berwind-White bituminous interests. The Canadian Northwest is reached through the Murphy Coal Co., of Fort William, Ont. Lower west-bank Lake Michigan territory not covered by the Hanna office at Chicago is served by the Fellenz Coal & Dock Co., of Milwaukee, Wis., and the M. H. Hussey Corporation at Waukegan, Ill.

The territory covered by the New York district sales office includes the greater metropolitan area south to New Brunswick, N. J., and north and west to Elmira, N. Y., and the Canadian border. Philadelphia handles the area south of New Brunswick to Wilmington, Del., and, of course, the State of Pennsylvania with the exception of Erie and a small area directly tributary to that city. Maintenance of a district sales office at Erie is a sentimental tribute to a tradition which has its roots in the earlier history of the merchandising of tonnage from the Susquehanna mines, when the bulk of the distribution was made through independent or semi-independent wholesalers. At one time, the Erie office was the western outpost in the market set-up and, when a Chicago office was later established, that office was under the jurisdiction of the Erie agency. Baltimore sales territory runs south of Wilmington, Del., to Charleston, S. C.

Markets in Ohio and Indiana not directly tributary to lake ports and in Michigan are served by the Cleveland district office. All-rail Middle Western business moves through the Chicago office. Purely local trade in the mining region proper is handled by the Susquehanna Collieries Co. as agent for the parent organization, with all sales reports on the tonnage clearing through Philadelphia headquarters. Some occasional business also is handled by the Hanna Coal Co. at points where the M. A. Hanna Co. is without direct sales representation.

The M. A. Hanna Co. also acts as general sales agent for the distribution of Ambricoal, a briquet manufactured at Lykens, Pa., by the American Briquet Co., of Philadelphia. These briquets, pillow-shaped and weighing approximately 2¼ oz., are made from Short Mountain colliery culm. The culm is washed before processing to eliminate extraneous material and is briquetted with a patent binder consisting of a mechanical emulsion of cornstarch, water and asphaltum. Distribution of Ambricoal is confined largely to the Middle Atlantic and New England states. Some of the product is used for ordinary house-heating purposes, but most of the sales effort is directed toward building up specialty markets such as cooking and in fireplaces where a quick, hot, clean fire is demanded.

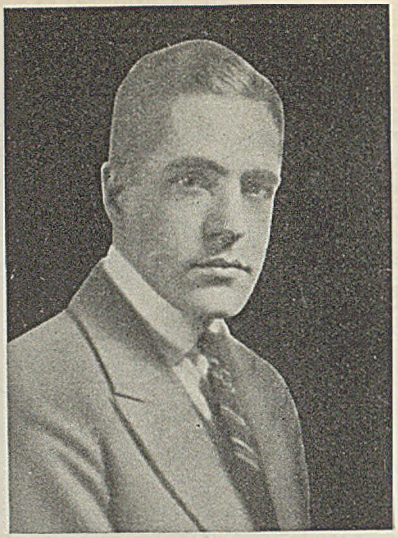
At the present time, 34 road salesmen work out of the district offices. This total is exclusive of district managers, clerical forces and the personnel of the outside agencies such as Susquehanna Collieries, Ltd.; Atlantic Coal Co. of New England and the M. A. Hanna Coal & Dock Co. Most of the traveling is done by automobiles, all of which are the property of the M. A. Hanna Co. The company has standardized on Chevrolet coupés for this service. Experience has shown that, from the standpoint of cost and efficiency, it is advisable to turn in a used car for a new one as soon as the speedometer registers approximately 30,000 miles. Operating costs average 2½c. per mile. Salesmen call upon their customers at least once in every seven days.

Sales budgets for the year, forecasting monthly movement both by sizes and by territories, are made up in April. The tonnage estimates of the sales department are correlated with production schedules for each mine or division of the operating companies. Basic data for these budgets are derived from detailed records of past business showing annual and monthly purchases by sizes of retail dealers and industrial consumers. These data are so collated that it is possible to launch quick drives on selected customers to move sizes which may be lagging behind their seasonal marks. Market survey data also include information on competitive consumption in the areas covered by the Hanna sales force. The annual sales budget, of course, is revised currently to keep it in line with actual developments and trends.

A bonus system gives salesmen an incentive and the opportunity to increase their earnings above the minimum salary paid. While this bonus system rewards volume, it is also so devised that the energetic worker in a territory where the opportunity to expand total volume may be more limited by circumstances and conditions beyond the control of the individual salesman than may be the case in a richer field can cash in by special merchandising efforts in other directions. For example, bonus points may be won by adding desirable new accounts to the books, by sales missionary work and cooperative endeavors with other salesmen and offices in closing accounts, and by success in pushing the sale of slow-moving sizes.

The M. A. Hanna Co. employs three service engineers, two working out of Philadelphia headquarters and one out of the New York district office. These engineers are primarily concerned with cooperating with the sales staff in servicing both industrial and domestic consumers. Cultivation of the industrial market in the limited area open to power-plant sales of smaller sizes of anthracite has been so successful from a tonnage standpoint that the Hanna organization has not been active in promoting the domestic stoker as a means of enlarging retail outlets for buckwheat and rice coal.

Unlike some of its competitors, the M. A. Hanna Co. has no set promotional plan for merchandising the product to and through the retail coal merchants. Neither has it any elaborate portfolios of dealer helps, such as mailing pieces and advertising copy to be run by the retailer over his own signature in his local newspapers. Sales officials of the company believe that better results for both the producer and the retail distributor can be secured by building up special, individual promotional campaigns based on local conditions confronting the individual retail coal man in his particular market area. When a retail distributor desires such merchandising counsel and assistance, the sales department makes a special study and then has individual copy prepared for the retail dealer for insertion in local media in that particular retail coal merchant's community. The copy or, if need be, the entire plan of campaign is worked up without expense to the retailer, who bears only the cost of insertion of the advertisements in his local media.



C. W. Stone, General Sales Agent

So far, the virtues of Susquehanna anthracite have not been broadcast over the radio, except by certain of its dealers in their own communities. Billboards showing the Hanna trademark advertise the location of each Susquehanna colliery in the region.

During recent months, sales headquarters at Philadelphia has been doing its bit to lift the clouds of depression with a semi-humorous approach through a monthly direct mail campaign using a four-page $5\frac{1}{4}$x$7\frac{1}{2}$-in. mailing piece. The cover of each piece is a reproduction of one of the Lawson Wood series of monkey pictures with an appropriate caption; the caption theme is picked up in the inside pages in a letter in rhymed prose contrasting the Boom Era of 1929 with present-day conditions and how to get out of them. The letter ends with a brief postscript exhorting the recipient to stock up on Susquehanna anthracite *now*.

Except in the case of the premium coal from Lykens Valley, no attempt is made to identify directly the product of the mines as a whole or of individual collieries. The coal from Lykens Valley, being the only genuine Franklin coal mined today, is trademarked with thousands of small red triangles scattered through each car of the domestic sizes as it is being loaded at the breakers. Each red triangle bears the copyrighted "Hanna" insignia on one side and the phrase "The Only Genuine Franklin Coal of Lykens Valley" on the reverse side.

▼

MANAGEMENT

At Susquehanna Collieries

(Continued from page 355)

and a yield report is made weekly from information supplied by the colliery superintendents. These figures are tabulated at the Nanticoke office and delivered to the president and general manager.

An estimate of working time is made on the first of every month for each colliery operation, and each superintendent makes an estimate of his tonnage and cost based on that working opportunity. The secretary of the company consolidates this information and adds the estimated realization, and it is then sent back, via the general manager, to the superintendents for their confidential information.

In his monthly written report to the general manager, each superintendent adds essential items of actual performance and describes all accidents to employees. The general manager in turn sends a copy to the president.

Budgeting of larger expenses is made at the Susquehanna collieries in November, ready for the following year. The budgets originate with the individual colliery, being prepared for the colliery superintendent by the mining engineer and submitted to the general manager for his favorable or unfavorable action and suggestions, as may be

So important are these and other charges, and so variant are the prospects and conditions due to changes in market, that with the mere approval of such items on the budget, work cannot be commenced by the colliery superintendent on his own initiative but must await the filing of an "authority for expenditure," or A.F.E., which must bear the signatures of the mining engineer, the colliery superintendent, the general manager, and the president.

Nevertheless, in no case are ends subordinated to means. In the management structure a little leeway always is provided. The framework is simple in smaller matters, but each individual is the more rigorously required to exercise discretion, knowing that if the power of discretion lodged with him is not properly exercised someone else who will use it more carefully, more industriously and more wisely will have the reins turned over to him.

It has been found that this simple operating structure has reduced overhead and effected results; has, in short, saved money and, without any dogmatism as to what might be best for less scattered and less diverse properties, or as to the relative theoretic advantages of staff and line organizations, the Susquehanna adheres, and probably will always adhere, to the latter as the best suited to its own conditions and to the type of men it has selected to fill its positions of authority. It has sought as its colliery superintendents and mining engineers men of initiative and responsibility and built its structure on such men, and it does not hesitate to give them some degree of freedom in the conduct of the affairs which have been placed in their hands.

MECHANIZED MINING

At Susquehanna Collieries

(Concluded from page 362)

ent and discharged through an endgate onto the plate chute below. Only rarely, however, is this done. Counters are never used here or in No. 7. In No. 7, buggies are used also to avoid taking up rock. Such buggies are 28 in. high and of all lengths and widths, but mechanical mining is making them unnecessary.

At No. 7 mine, the Hillman bed has a clay roof which, after exposure, swells and turns almost to mud. Above this is a reasonably strong sandrock. It was first mined to the four corners of the property, usually by rooms driven sideling on the pitch, so that the gradient was from 3 to 4 deg. Empties were brought into the rooms by mules and were run out by hand, the speed being controlled by spragging the wheels.

As the coal over much of the area was 7 ft. thick, it was possible to leave 18 in. of coal as roof, supplementing this support by timbers. The rooms were allowed to stand, and eventually the timbers rotted, and the coal and clay fell, filling the rooms with the débris. The clay became wet and expanded, making second mining almost impossible under present conditions, for the clay had almost filled the openings. As the quantity of coal these pillars would render is computed at about 4½ million tons, however, it seemed that something should be done to make it available. For years no attempt was made to extract the pillars, but now the company is working on a mechanical robbing system.

The present plan is to take the coal out by splitting the pillars, which will be reached by cutting a counter across them wide enough that the clay that has fallen across the path of the proposed counter can be stowed on either side. Probably only one pillar in each counter will be split at a time. When a pillar is to be split, the clay which is in the way will be rehandled and placed in that part of the roadway that has been abandoned, due to removal of the pillar coal for which it was constructed. The coal will be brought to the counter in buggies, discharged on a shaking chute in the counter and delivered thence to cars on a gangway.

In all, No. 7 mine has 32 scraper units with 374 hp. in aggregate; No. 6 has four units with 73 hp., and Richards has five units with 120 hp. Summarizing these, the Susquehanna Collieries Co. has 41 units with 567 aggregate horsepower, also one shaker chute at No. 7, with a 15-hp. drive unit. Some of these are of Sullivan and some of Vulcan manufacture. Of the former, 88 per cent are of 7½ hp.; 12 per cent of 25 hp. It may be added that 83 per cent of these are electric and 17 per cent are air-driven. The electrical units are powered by Westinghouse motors running at 2,500 r.p.m. The reels hold 300 ft. of ⅜-in. rope and 600 ft. of 5/16-in. rope.

In addition to its underground mines the Susquehanna Collieries Co. has five strippings, two at Glen Lyon, one at Pennsylvania, one at Richards and one at Nanticoke colliery. These are uncovering the synclinals of some of the upper beds. These folds are all quite sharp. There are no broad-shouldered anticlines, nor long flanks of synclines to favor extensive stripping, so most of the work covers a limited area.

Of these strippings, the largest is that at Richards colliery, with an ultimate output of 200,000 tons. A 900 P. & H. dragline excavator with 100-ft. boom and 2-yd. bucket removes the overburden and a 490 Marion electric shovel with 2¼-yd. bucket handles the coal and dividing rock. Western Wheel 4-cu.yd. cars transport the coal; they are brought up a plane by an electric hoist and then handled by a Vulcan locomotive. The coal is dumped into a counter chute near the stripping and passes to the Water Level Tunnel, where it is loaded into mine cars and conveyed on the surface with other cars of coal to the breaker by two 13-ton General Electric locomotives, a distance of about a mile. This stripping is operated under contract by the Rhoads Contracting Co.

Next largest is the No. 1 stripping, at No. 7 (Nanticoke) colliery, where a 125 Marion 2,300-volt electric shovel with an aluminum boom and a 2½-yd. drag bucket is used to remove overburden and a No. 7 Marion 440-volt electric shovel with 1¼-yd. dipper is used to remove the coal. This coal is handled by a number of mine locomotives and hoists and a steam locomotive which bring it to the tipple, these units also serving other coal. This stripping is operated under contract by C. R. Cummins, Inc. Other strippings contain respectively 95,000 tons, 61,000 tons and 26,600 tons, the shovels in one stripping using a diesel motor and the coal in yet another being loaded into Mack trucks.

MINING METHODS

At Susquehanna Collieries

(Concluded from page 360)

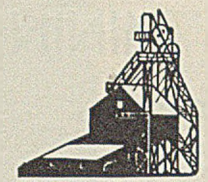
length of 700 ft., another of 600 ft. Empty cars are hauled up the plane above a counter—located at a point where the pitch of the bed has become 6 deg. or less—and then dropped into the counter by means of a switch. The counters have a gradient of 1 per cent in favor of the load, and they cut the breasts into two or more lifts.

Buggies, varying in capacity from 38 to 79 cu.ft., depending on conditions, are used in the rooms. The room tracks are laid on the bottom, and the counter is sunk in the rock. Consequently, when the buggies have been lowered to the counter by small hoists, they can be emptied into the full-size cars by opening the endgate. The cars are pushed to the plane, pulled by the rope of the plane hoist above the switch, and lowered down the plane. On heavy pitches, it may be added, side-dumping buggies are occasionally used, as will be described in detailing operations at the Pennsylvania colliery, p. 361.

All the roads in this mine are in the Skidmore, thus lowering maintenance costs. No man-catchers are used at this colliery, the steepest pitch now worked being 45 deg.

In this mine, no shaking chutes or scrapers have been introduced. The pitches nearly everywhere are so heavy that mechanical aids are not needed. Only in the Skidmore is the seam thin enough to make scrapers desirable, and much of the Skidmore is so steep that application is likely to be limited.

OPERATING IDEAS



From Production, Electrical and Mechanical Men

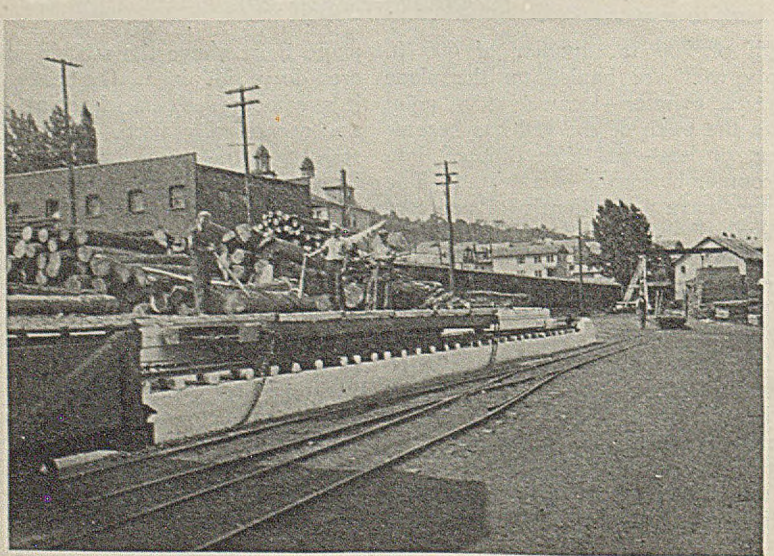
Movable Truck Aids in Filling Timber Orders

Handling of heavy, bulky supplies, particularly timbers and ties, is a job of considerable importance at the operations of the Susquehanna Collieries Co. and the Lytle Coal Co. Perhaps the smallest consumer is the Lytle colliery of the Lytle Coal Co., which requires 600 tons of timbers and lumber, 4 tons of rails, and 600 ties for a month's operation in normal times. At No. 6 colliery, however, the quantities used per month run up to the following: timbers and lumber, 1,400 tons; rails, 30 tons; ties, 5,000.

To store and issue these quantities of supplies, the company maintains extensive storage yards and timber docks at the majority of its collieries, of which the most important is at No. 6. Here a separate narrow-gage track extends through the yard to serve the lumber stacks and timber dock, and also to receive heavy machinery and parts unloaded from railroad cars. For handling heavy equipment from the cars, a chain hoist running on a trolley is used. This hoist and its supporting structure, shown in the background of the accompanying illustration, extend across the narrow-gage supply track.

Mine timbers are discharged from railroad cars or trucks into the timber dock, part of which is shown in the figure. The supply track runs along the foot of this dock. To facilitate loading of timbers, an intermediate truck is installed between the dock proper and the supply track. This truck is propelled by an endless rope, and by running it back and forth, timbers of various sizes may be assembled to load a mine car. Chains also are attached to the truck for the purpose of shifting mine cars, whether singly or in trips. Originally, the dock was so arranged that the timbers loaded on the truck could be taken to a cut-off saw for reducing them to the desired length, but the company now purchases timbers cut to standard lengths, thus eliminating supplementary sawing.

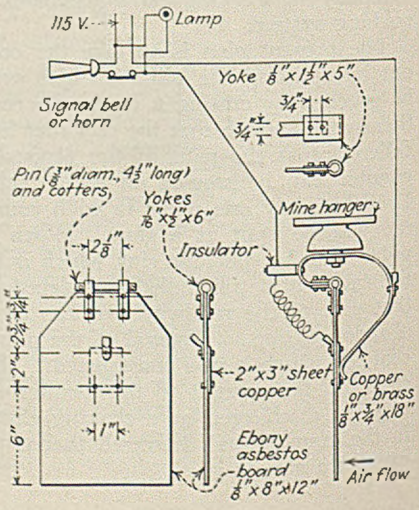
Supply Yard, No. 6 Colliery, Showing Timber Dock and Assembling Track



Air Vane Used to Indicate Ventilation Stoppages

A simple type of air vane has been installed in the airways at several operations of the Susquehanna Collieries Co. for signaling interruptions in ventilation by sounding a horn or lighting a signal lamp. These vanes, shown in the accompanying illustration, were designed by C. H. Matthews, electrical engineer, and operate on the 115-volt lighting circuit. During normal flow, the vane is held open by air pressure, but when the pressure drops, due to interruption in fan operation or for other causes, the vane drops back to the vertical position, closing the circuit to the signal equipment. Attachment by an ordinary mine hanger is one of the features of the equipment.

Construction Details, Air Vane



Operating Ideas from PRODUCTION, ELECTRICAL *and* MECHANICAL MEN

Signal System Gives Warning Where Men Cross Tracks

For warning men of the approach of locomotives or larries at surface crossings where the view is interrupted by construction or the lay of the land, a signal system has been installed at several plants of the Susquehanna Collieries Co. This system, including the trolley switch, was designed by C. H. Matthews, electrical engineer. Fig. 1 gives the necessary wiring diagrams for the switches, relays and lamps; details

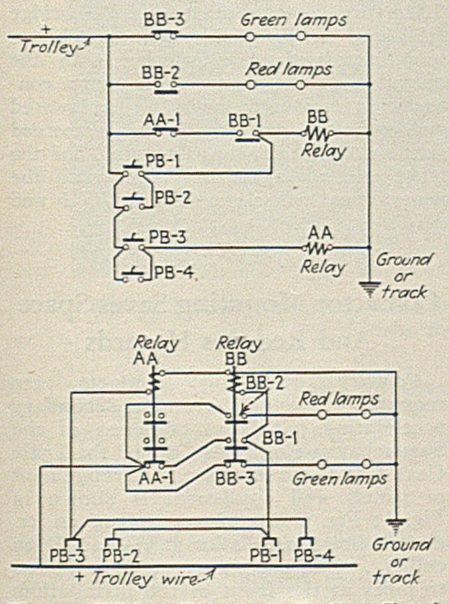


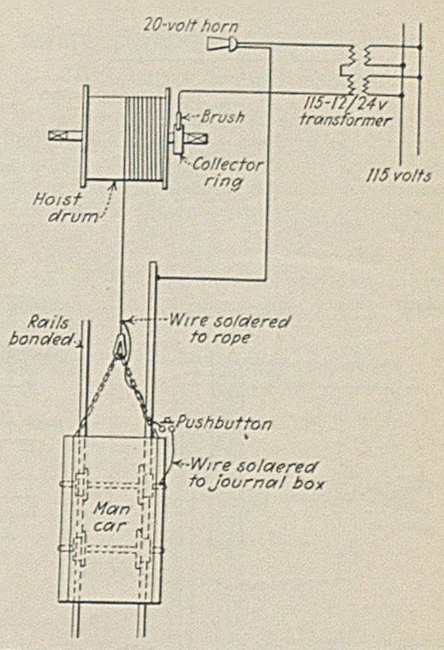
Fig. 1—Wiring Diagrams, Trolley Signal System

of the construction of the trolley switches are given in Fig. 2.

Aside from the four trolley switches (*PB-1*, *PB-2*, *PB-3* and *PB-4*), equipment consists of two 250-volt multi-finger d.c. relays, one (*AA*) with one contact (*AA-1*) normally closed and one (*BB*) with two contacts (*BB-1* and *BB-2*) normally closed. Switches *PB-1* and *PB-2* are located along the trolley wire at suitable distances for the desired signal area, while switches *PB-3* and *PB-4* are located 2 ft. from *PB-2* and *PB-1*, respectively. Switches *PB-1* and *PB-2* are closed by the trolley wheel to light the red signal lamps or ring a gong to indicate that the locomotive is approaching the crossing, while *PB-3* and *PB-4* are closed by the trolley wheel to control the green lamps which show that the crossing is clear.

Use Hoisting Rope for Circuit In Operating Man Car

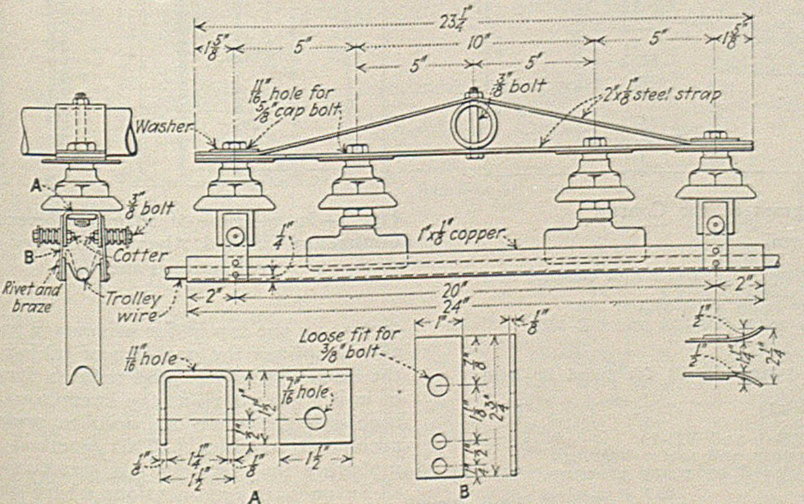
Control of the operation of the man car at the Accommodation slope, Pennsylvania colliery, Susquehanna Collieries Co., is placed in the hands of a man riding in the car by using the hoisting rope and rails as circuits in a signal system. As shown in the accompanying illustration, signals are made with a pushbutton on the end of the car and are transmitted to the horn on the surface through the hoisting rope and an insulated collector ring on the drum shaft. The return circuit is through the rails and car wheels to the pushbutton. Use of bonded rails on wood ties, wooden rollers for carrying the hoisting rope, and a wood-lagged hoist drum makes the signal system possible. Operating current is supplied by a 110-12/24-volt transformer.



Electric Safety Signal System for Controlling Man-Car Operation

> ## No Limit
>
> There are no limitations on the types of operating problems which have been met and solved by production, electrical, mechanical and safety men at the operations of the Susquehanna Collieries Co. Concrete evidence of the scope of their efforts in meeting and overcoming every-day operating problems lies in the variety of items included in these pages. Similarly, there is no limitation on practical kinks presented from month to month in the Operating Ideas section of *Coal Age*. If you have a solution for any production, electrical, mechanical or safety problem, send it in. A sketch or photograph may make it clearer. *Coal Age* pays for acceptable ideas at the rate of $5 or more each.

Fig. 2—Construction Details, Trolley Contact Switch

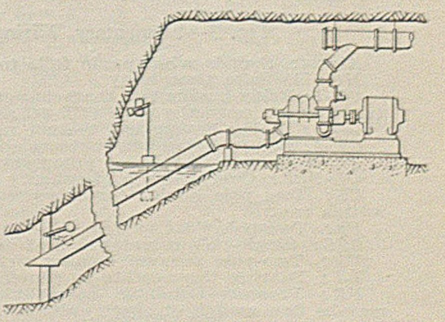


Automatic Pump Control At a Slope Sump

Automatic control of centrifugal mine pumps may be so designed that one scheme of control can be applied to all pumping stations regardless of the size of pumps or type of drive motors. But occasionally some special application of control is required to meet local conditions, as, for example, a float-switch control at a sump sunk on a slope in the coal seam, where the usual type of float switch is not suitable because it operates vertically.

How this special condition can be met

Fig. 1—General Arrangement of Slope-Sump Pump Station



Operating Ideas from Production, Electrical *and* Mechanical Men

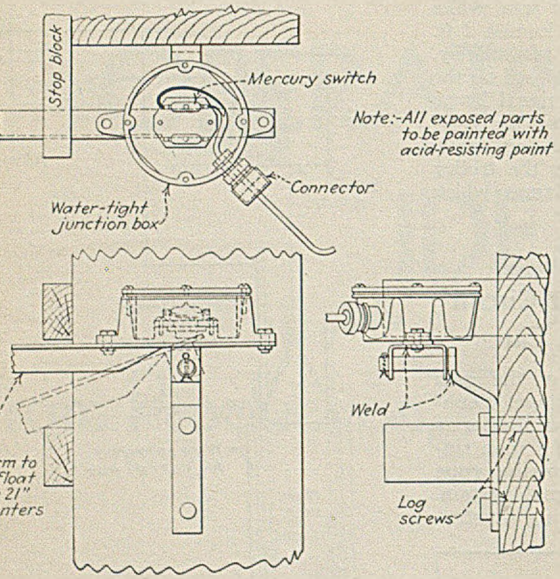


Fig. 2—Details of Submerged Float Switch

is demonstrated by an installation made by C. H. Matthews, electrical engineer of the Susquehanna Collieries Co., at No. 7 colliery, Nanticoke, Pa. Fig. 1 indicates the general arrangement of this installation, with a submerged float switch at the low-water level in the slope sump to stop the pump when the water recedes to this stage. It was found feasible, of course, to rely upon the opening of a flow switch on the check valve or a pressure switch on the pump casing to protect the pump by locking out the station until trouble is located and corrected, should the pump lose water.

The design of the float switch (see Fig. 2) embodies a 6-in. copper float attached to a Benjamin watertight junction inclosing a mercury switch which is connected through a Crouse-Hinds connector to the control panel in the pump room. This connection is made by a No. 12 (B&S) rubber insulated cable, and the control is the standard Barrett-Haentjens automatic system with the addition only of a relay with two normally open contacts.

The function of the submerged float is seen in Fig. 3, which also shows the relay *CR-3* added to the control equipment. Assuming the sump to be filled with water, the contacts of the submerged float switch would be closed. The two-pole float switch (*FS-1* and *FS-2*) closes when the water in the sump rises to high-water level. As soon as relay coil *CR-1* closes, the pump is primed and put in operation. Relay coil *CR-3* closes with relay *CR-1* and closes its contacts *CR-3A* and *CR-3B*. These two contacts of relay *CR-3* bridge *FS-1* and *FS-2*, so this float switch can now open without interfering with the operation of the pump. The pump continues to run until the water is lowered and opens the contacts of the submerged float switch which stops the pump, and the pump will not again be started until the water rises and closes switch *FS-1* and *FS-2*.

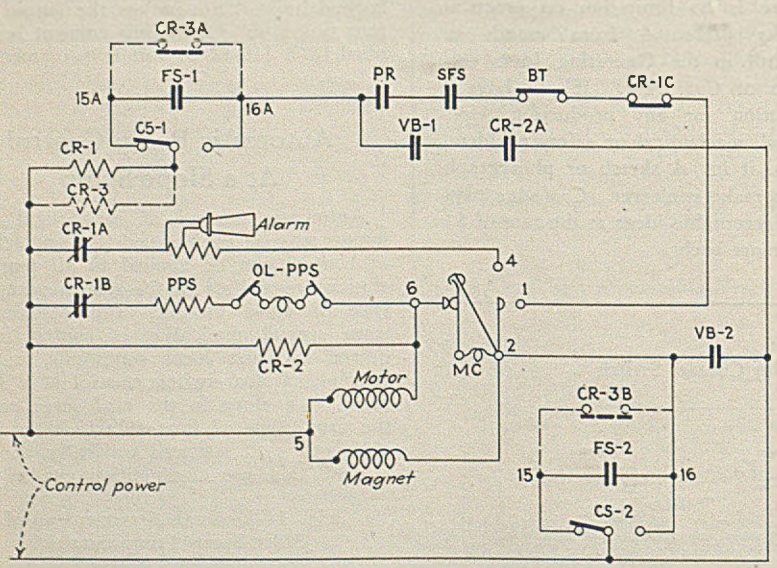


Fig. 3—Elementary Wiring Diagram of the Control

Alarm: Sounds when pump fails to perform
MC: Definite time relay
CR-1: Relay having two contacts normally closed (*CR-1A* and *CR-1B*) and two contacts normally open (*CR-1C* and *CR-1D*)
CR-2: Relay having one contact normally open (CR-2A)
CR-3: Relay having two contacts normally open (*CR-3A* and *CR-3B*)
PPS: Magnet of priming pump starter
OL-PPS: Overload trip of primary pump starter
CS: Two pole double throw switch (CS-1 and CS-2) for hand or float switch control
FS: Two-pole float switch (FS-1 and FS-2)
SFS: Single-pole submerged float switch
VB: Two-pole vacuum breaker switch (VB-1 and VB-2)
BT: Bearing thermostats on centrifugal pump and motor bearings
PR: Pressure regulator, normally open, closed by pump pressure. This may be flow switch or check valve or both.

Contactor Mounting Saves Space And Reduces Hazards

Primary reversing contacts are mounted on and above the secondary accelerating panels at collieries of the Susquehanna Collieries Co. and the Lytle Coal Co. to save space. Arrangement of panels and equipment is shown in Fig. 1; Fig. 2 is a photograph of an a.c. electric hoist installation at William Penn colliery. The secondary panel is bolted to pipes at the front of the installation. Running across the tops of these pipes is a plate ⅜ in. thick and 2½ in. wide which supports the fronts of the reversing contactors; the backs are attached directly to pipes at the rear of the installation.

Mounting the primary reversing con-

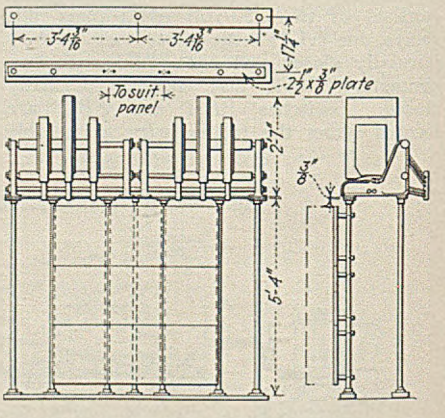


Fig. 1—Installation of Primary Reversing Contractors on and Above Secondary Accelerating Panel

tactors on the top of the secondary panel also simplifies the problem of taking off the leads at the back, and reduces danger of injury, inasmuch as the contactors are high enough above the floor to prevent accidental contact. This method of mounting the contactors is standard for all Susquehanna applications where space

Operating Ideas from PRODUCTION, ELECTRICAL and MECHANICAL MEN

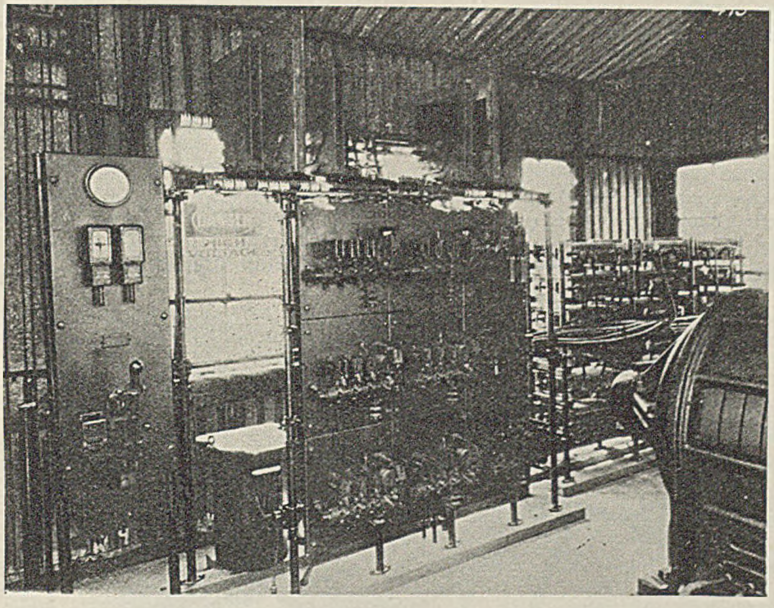
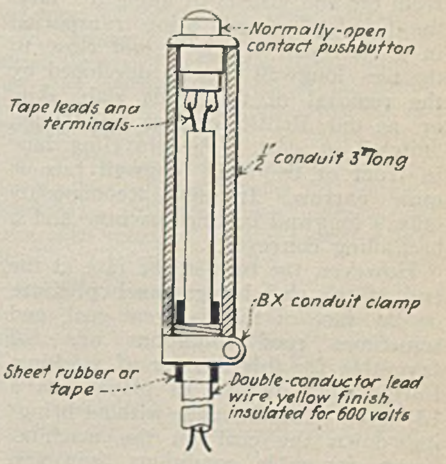


Fig. 2—Primary Reversing Contactor Installation for Dirt-Plane Hoist, William Penn Colliery

Safety Pushbutton Cuts Hazards In Scraper Signal System

To eliminate the possibility of connecting signal wires for controlling the operation of scraper hoists to leads for firing shots, the Susquehanna Collieries Co. uses a safety pushbutton developed by the engineering department. This pushbutton is attached to the end of a double-conductor rubber-insulated cable with a distinctive yellow finish, thus



Construction Details, Safety Pushbutton for Scraper Signaling

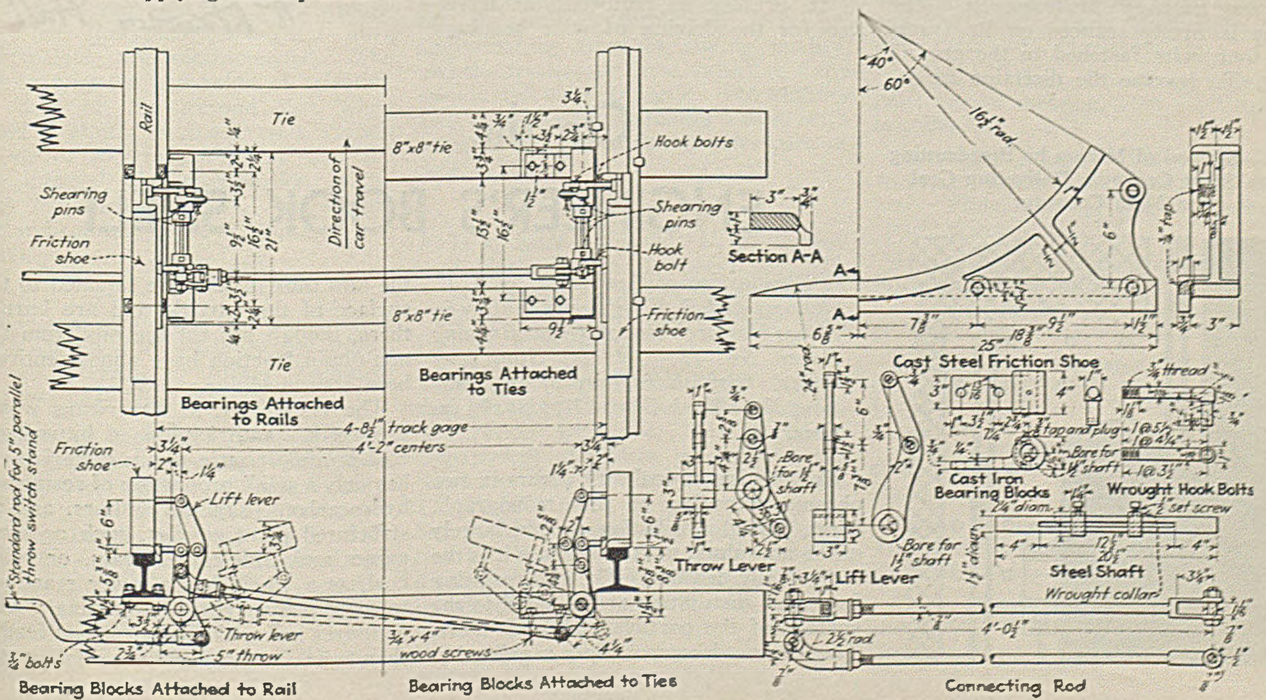
eliminating any possibility of the scraper crew attaching it to shooting leads by mistake. The button, as shown in the illustration, is made of ½-in. conduit with an Edwards & Co. normally open contact pushbutton inserted in one end. Without tearing the button assembly apart, it is impossible for the ends of the conductors to come in contact with lead wires.

is at a premium, and facilitates installation by reason of the fact that the necessary supplies, once standardized, are easily kept in stock or secured as needed.

Safety Stop Halts Runaway Cars At Breaker Loading Points

Danger of injury from railroad cars running away on the breaker tracks led the safety department of the Susquehanna Collieries Co. to develop the removable car stop shown in the accompanying illustration. If the car is under control, the friction shoes shown in the figure are dropped from the rail and the car passes through to the loading point. If the car is out of control, the shoes are raised to position on the rails. The front wheels of the car run up on the shoes, and slide them out of the lever arms by shearing off the light cotterpins inserted in the hook bolts. The car continues down the track until the friction of the shoes on the rails brings it to a stop. When the shoes are freed from the car, they are again attached to the levers by cotterpins ready for the next application.

Removable Stop for Preventing Runaways. Details Shown at Right. Methods of Applying the Stop Either to the Rails or to the Ties Shown at Left



NOTES

. . . from Across the Sea

AN INTERESTING modification of longwall mining in Germany, though one withal of limited application, is "broad cutting," or *breitschrämen.* For the full length of a longwall face, a cut is made of unusual depth—13 to 15 ft.—by a longwall cutter, and the coal is attacked by pickhammers from the end instead of along the face, the dislodged mineral being transported in a conveyor, which is laid close to the new longwall face as developed by the removal of this wide slab, skip, or, as our British cousins might say, "flitch," of coal. The traveling lane in front of the main longwall face is quite narrow. It need accommodate only a longwall cutting machine and a backfilling conveyor.

However, the turn in the face at the end of the slab brings much pressure on the face of the undercut coal, and sometimes roof conditions are not favorable for this manner of working. Furthermore, not in all places can a 13- or 15-ft. cut be made without bringing down the coal on the machine. Given favorable conditions, however, the broadcutting method has considerable advantages.

A small conveyor, which has been dubbed *kurzrutsche,* has been developed for this and like purposes. It can be set so as to deliver the coal at a slight angle to the perpendicular into the main conveyor. It consists essentially of a small double-acting compressed-air shaker-conveyor engine and an ordinary conveyor pan, arranged longitudinally together on a common ground plate and coupled up direct, says the *Eickhoff Mitteilungen.* The engine is firmly secured on its frame with four bolts fastened to the ground plate. To reverse the direction of delivery the engine can be turned through 180 deg. Beside it on the other half of the base plate are installed two ball frames as roller paths for the shaker-conveyor trough, in which the latter rests in the usual manner on two T attachments fitted underneath. Two props between the roof and the ground plate hold the conveyor in position.

But this same conveyor has other applications. It can be used in room-and-pillar workings to bring the coal to the road in the room, either, with one conveyor, from one side only or, with two conveyors, from the right and the left. If the conveyor is too short, it can be lengthened by the use of additional pans, either at one end or at both ends, so as to increase its length to 98 ft. or less, as required. It serves also for the driving of wide headings where bottom is lifted, and the rock thus afforded is stowed on the side of the road.

If desired, the pan can be constructed with a trough side away from the coal and a ramp side against the face, so that the coal when it is brought down, probably by pickhammers, will fall into the conveyor. In fact, the conveyor can be fitted with adjusting ratchets, by which it can be caused to advance under the fallen coal, up to the face or under the kerf itself. This short conveyor is inexpensive and convenient and, being readily movable, it is transferred from one place to another without difficulty.

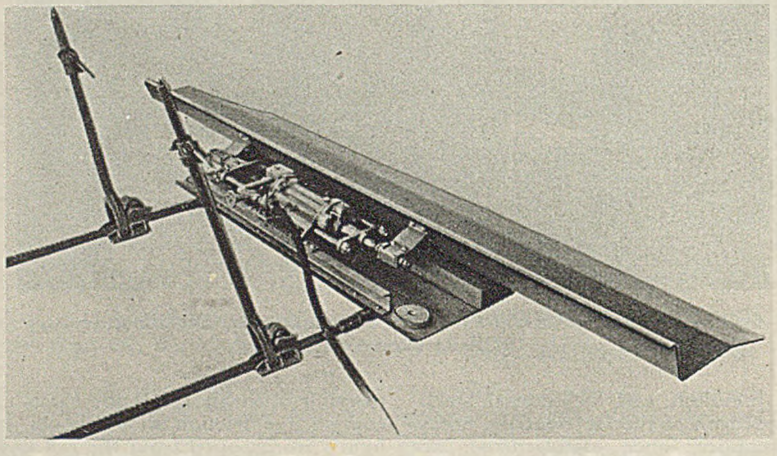
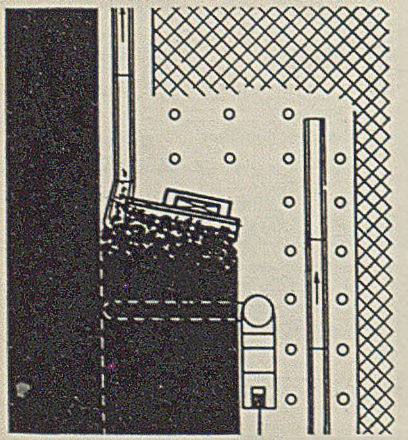


Fig. 2—Short Conveyor With Ramped Trough and Adjusting Ratchets

In America it probably would be found available not only for room-and-pillar work and in driving gob headings but also on the open ends of pillars or again in the crosscutting of pillars, either when driving up rooms or when extracting ribs. It is probable that a duckbill would be used with this short conveyor whenever it was applied in the driving of crosscuts.

R. Dawson Hall

Fig. 1—Method of Mining by Broadcutting With Short Conveyor Delivering Coal to Main Conveyor



On the ENGINEER'S BOOK SHELF

The Combustion of Coal Dust, by A. L. Godbert and R. V. Wheeler, Safety in Mines Research Board, Great Britain; Paper No. 73. H. M. Stationery Office. British Library of Information, New York City; 21 pp., 6x9¾ in. Price, 25c.

Combustion of coal dust occurs in two phases, according to this monograph. First, partial distillation occurs, largely of the non-ulmin matter, because it is the more easily distilled. The oils resulting from this distillation are liquated to the surface of the particle and burn there. The ulmins decompose less rapidly, but the tars thus formed are liquated to the surface of the particle and are burned there, though not till the oils from the non-ulmin fraction have almost entirely been consumed.

The vitrain, or, as Americans would express it, anthraxylon, of bituminous coal is almost pure ulmin material. It has only a small proportion of resins and hydrocarbons, say the authors, and no structured plant entities, such as spore exines and cuticles. Durain, or splint coal, as a whole has a lower reactivity to oxygen than vitrain at ordinary temperatures and probably burns less readily than vitrain, but quite evidently the spore exines and cuticles in durain are often so numerous and always so generative of readily burning oils that they more than compensate for the low reactivity of its ulmins.

Speed of combustion in the second phase depends on the character of the char. If the coal cokes in distillation and tends to form cenospheres, or polygonal balloons, then rapid combustion occurs, especially if the walls or windows of the balloon are thin. They may burn through, leaving a polygonal framework, which may itself also burn. But if the coal has not coked and the nub left is, therefore, somewhat dense, combustion will be slow.

* * *

Tests of Rock Dust Barriers in the Experimental Mine; Bulletin 353, U. S. Bureau of Mines. Price, 10c.

This bulletin, by G. S. Rice, H. P. Greenwald and H. C. Howarth, sets forth experiments and conclusions relative to the rock-dust barrier. The authors declare that the barrier should retain one-fourth to one-third of its dust when operated by a sudden blast of air, so that the dust remaining can cope with a delayed flame, and that the barrier must be placed close to the roof. It must operate to stop an explosion regardless of the direction from which it approaches.

Statement is made that sections which cannot be ventilated and inspected should be sealed by strong stoppings of concrete and masonry and not protected merely by a rock-dust barrier. Sixty pounds of rock dust per square foot of the entry cross-section is recommended, but the authors declare that it will not stop explosions of pure coal dust or a gas explosion. Rock dusting 100 ft. on either side of the barrier will add greatly to its effectiveness.

Diatomite laid on a barrier is more readily spread by an explosion than other dusts and does not gather moisture, but limestone and shale dust, nevertheless, are recommended. The authors question the value of selecting any dust on the ground that when heated it emits, or might emit, carbon dioxide or moisture, arguing that the time interval of the explosion is too short for such emission, and stating that indications of such emission are absent.

* * *

Carbonizing Properties and Constitution of Coal, by A. C. Fieldner and others. U. S. Bureau of Mines Technical Papers 511, 519 and 524.

Results of experimental work on the carbonizing properties and constitution of Davis bed coal from Garrett County, Maryland, and mixtures of Davis coal with Pittsburgh bed coal (T. P. 511; price, 10c.), washed and unwashed coal from the Mary Lee bed, Flat Top, Ala. (T. P. 519; price, 10c.), and Pittsburgh bed coal, Edenborn mine, Fayette County, Pennsylvania (T. P. 525; price, 10c.) are given in these publications. These results cover: physical examination of columnar sections, microscopic examination of thin sections, extraction of components by solvents and rational analysis, plastic and miscellaneous properties, low- and high-temperature assay distillation tests, and carbonizing tests in experimental equipment. These studies are a part of a series undertaken by the Bureau of Mines in cooperation with the American Gas Association and other agencies. Included in the discussion of results of carbonizing tests are: coke yield, analysis and physical properties; yield and physical and chemical properties of gas, tar, tar-distillates, light oils and ammonia. In the case of the Davis coal, results of carbonization tests are given for both the coal alone and for mixtures with Pittsburgh bed coal. Results are given for both washed and unwashed Mary Lee coal.

* * *

Friability, Slacking Characteristics, Low-Temperature Carbonization Assay and Agglutinating Value of Washington and Other Coals, by H. F. Yancey, K. A. Johnson and W. A. Selvig. U. S. Bureau of Mines Technical Paper 512; price, 25c.

This report presents the results of work done under a cooperative agreement between the Bureau of Mines and the University of Washington, covering coals from Washington and coal-mining districts in other states. Washington coals, in particular, cover a wide range in rank, and for that reason were selected for the major part of the work. Results cover: relation of friability to rank, bed moisture, heating value, and fixed carbon; relation of slacking indexes to bed moisture, rank and friability; physical characteristics and analyses of low-temperature cokes from the various coals studied; thermal stability of the coals and composition of the gases; yields of low-temperature oils, tar and water; results of tests for agglutinating value or coking quality, and the relation of these values to fixed carbon and coke strength. The authors also correlate agglutinating values with some of the chemical characteristics of coal.

* * *

Falls of Roof and Coal; U. S. Bureau of Mines Technical Papers 520, 522, and 534, by J. W. Paul and J. N. Geyer; Report of Investigations 3188, by H. Tomlinson.

The first three publications present the results of studies, undertaken in cooperation with the West Virginia Department of Mines, of falls in the Sewickley bed in Monongalia County (T. P. 520; price, 5c.), the Pittsburgh bed in Marion and Monongalia Counties (T. P. 522) and in the Panhandle district (T. P. 534; price, 5c.); the fourth (R. I. 3188) deals with investigations in mines in Lincoln County, Wyoming. Physical conditions and mining methods in the mines studied are presented as a background for the determination of the influence of protective measures on frequency and severity of accidents in this classification. Accidents caused by falls are tabulated according to the places of occurrence, frequency and severity, and cost of compensation. Data are given on size and quantity of timber used, cost of timbering, supervision and roof-testing methods. The authors close with recommendations designed to reduce the number of accidents due to falls of roof and coal.

Industrial Notes

Louis E. Underwood, managing engineer, stationary motor engineering department, General Electric Co., Lynn, Mass., has been appointed manager of the Pittsfield works of the company, vice E. A. Wagner, retired.

G. E. Tenney, formerly sales manager for the Moore Drop Forging Co., Springfield, Mass., has been made Chicago district sales manager for the Lincoln Electric Co., Cleveland, Ohio.

SKF Industries, Inc., New York City, supervising the Skayef Ball Bearing Co., Hartford, Conn., and the Hess-Bright Mfg. Co., Atlas Ball Co., and SKF Research Laboratory, Philadelphia, Pa., announce the consolidation of the manufacturing activities of the Skayef and Hess-Bright companies.

Harvey Lefevre, formerly sales manager for the H. K. Porter Co., Pittsburgh, Pa., has joined the staff of the Heisler Locomotive Works, Erie, Pa.

Jeffrey Mfg. Co., Columbus, Ohio, has removed its Southwestern branch office from Houston to Dallas, Texas.

Coming Meetings

American Institute of Mining and Metallurgical Engineers, Coal Division, and the Pennsylvania Anthracite Section; Oct. 14-15, Hazleton, Pa.

Kanawha Coal Operators' Association; annual meeting, Oct. 20, Charleston, W. Va.

Anthracite - Lehigh Valley Section, American Society of Mechanical Engineers; Friday evening, Oct. 21, Redington Hotel, Wilkes-Barre, Pa.

Mining and Metallurgical Advisory Boards, Carnegie Institute of Technology; annual meeting, Oct. 28, Carnegie Institute of Technology, Pittsburgh, Pa.

Indiana Coal Operators' Association; annual meeting, Nov. 15, Terre Haute, Ind.

Harlan County Coal Operators' Association; annual meeting, Nov. 16, Harlan, Ky.

Southern Appalachian Coal Operators' Association; annual meeting, Nov. 18, Knoxville, Tenn.

Tenth National Exposition of Power and Mechanical Engineering, Dec. 5-10, Grand Central Palace, New York City.

WORD from the FIELD

Automatic Heat Service Offered

To meet the needs of interested dealers for specific information on the mechanical and merchandising aspects of the use of stokers in burning anthracite, the Hudson Coal Co. has established a new service, "Automatic Heat With Anthracite." Dealers are invited to send their salesmen and representatives to the company's research department laboratories at Scranton for a special two-week course in combustion service or automatic heat, and the department also will consult with dealers on automatic heat problems. The company's advertising department has prepared an automatic heat advertising campaign for the use of dealers. Special dealer merchandising plans also are available.

Start St. Nicholas Breaker

Full commercial operation of the new 12,500-ton-per-day St. Nicholas central breaker of the Philadelphia & Reading Coal & Iron Co. began on Oct. 3. This breaker, equipped with Chance cones, will prepare the coal from all of the company's mines in the Mahanoy district east of Locust Summit, Pa., the site of the first of the Reading company's central breakers.

First-Aid Meets Held

A team of the Carbon Fuel Co., Notomine, W. Va., won first place in the first-aid contests featuring the Fourth Annual Safety Meet of the Kanawha Valley Mining Institute, at Montgomery, W. Va., Sept. 17. First place in the colored division also went to a Carbon Fuel team.

Four thousand people attended the Seventh Annual Safety Meet of the Coal River Mining Institute, Sept. 5, at Madison, W. Va. First place in the first-aid competition for white teams was won by a team from the Dorothy (W. Va.) mine of the Chesapeake & Ohio Ry. fuel department. First place for colored teams went to the Red Parrot Coal Co., Prenter.

Birmingham Fetes Ramsay

In spite of his decision to forego his annual party on the top of Red Mountain as not in keeping with the times, Birmingham refused to let Sept. 24, the 68th birthday of Erskine Ramsay, chairman of the board, Alabama By-Products Corporation, pass unnoticed. The first of a series of events in Mr. Ramsay's honor was a luncheon by the Kiwanis Club of Birmingham, which was followed by a Rotary Club party. As a climax to the appreciative functions, Mr. Ramsay was the guest of honor at a party given by the 1,000 students of the Ramsay Technical High School.

May Build Power Lines

Alabama mining and industrial enterprises were granted the right to condemn rights-of-way and construct transmission systems for supplying power to industrial and domestic consumers, according to the provisions of a law passed by the state legislature in September.

C.F.&I. Installs New Equipment

Installation of a new Ottumwa scraper line box-car loader for lump coal and a portable scraper for nut coal is being pushed at the Rockvale mine of the Colorado Fuel & Iron Co., Rockvale, Colo. The Rockvale improvements are the latest project in a program which included the recent installation of screening facilities at the Salida (Colo.) tipple and a new hoist at the Kebler (Colo.) mine to replace old steam equipment.

Stonega Wins Safety Awards

Stonega Coke & Coal Co. mines won all four places among mining operations participating in the accident-prevention campaign put on by the Virginia Manufacturers' Association during April, May and June. Derby mine took first place with a total of 225,329 man-hours per lost-time accident; Imboden followed with 76,455 man-hours per accident; Exeter, 69,913 man-hours; Stonega, 64,111 man-hours.

Coal Production Rises

Bituminous coal production, in response to increased seasonal demand, rose to 26,266,000 net tons in September, according to preliminary estimates by the U. S. Bureau of Mines. Output in August was 22,489,000 tons, while in September, 1931, production totaled 31,919,000 tons. Anthracite production rose to 4,108,000 net tons in September, against 3,465,000 tons is August, and 4,362,-000 tons in September, 1931.

Total production of bituminous coal in the first nine months of 1932 was 211,200,000 tons, a decrease of 25.1 per cent from the output of 282,040,000 tons in the same period in 1931. Anthracite production in the first nine months of 1932 was 34,756,000 tons, a decline of 21.5 per cent from the corresponding 1931 figure of 44,257,000 tons.

Ohio Coal Rates Reduced

Intrastate coal freight rates from the Cambridge and Hocking fields to lake ports and intermediate points on the Baltimore & Ohio, Pennsylvania, New York Central and Wheeling & Lake Erie railroads were reduced 23 to 29c. per ton by the Ohio Public Utilities Commission, Sept. 29. These reductions grew out of cuts made several weeks ago by the Wheeling & Lake Erie on coal from eastern Ohio to the same destinations, which were followed on Sept. 2 by orders reducing rates approximately 25c. per ton from originating points on the Baltimore & Ohio, Pennsylvania, New York Central and Pittsburgh & Lake Erie lines in eastern Ohio. The Commission has ordered the Chesapeake & Ohio and the New York Central lines to show cause why rates from the Pomeroy Bend district should not also be reduced.

After protests from western Pennsylvania, the Interstate Commerce Commission, on Oct. 4, revoked its order suspending reduced interstate rates filed by the Pittsburgh & West Virginia Ry. for coal from western Pennsylvania to the destinations dealt with in the Ohio orders. Proposed Pittsburgh & West Virginia reductions varied from 15c. to 25c. per ton. The Commission postponed until Nov. 9 a hearing on the justification for the reductions.

Wyoming Collieries Starts Up

Wyoming Valley Collieries Co., lately organized, started operations at the Harry E. and Forty Fort collieries, near Wilkes-Barre, Pa., Sept. 1, giving employment to approximately 800 men. These operations were leased from the Lehigh Valley Coal Co. R. H. Buchanan, president, Northumberland Mining Co., heads the new company. James H. Pierce, vice-president, Stuart, James & Cooke, Inc., is vice-president and treasurer. H. D. Kynor, general manager, Northumberland Mining Co., has been appointed to a like position in the new company. Wyoming Valley Collieries Co., according to reports, will install a Chance plant to prepare the expected output of 500,000 tons per year.

"Blue Coal" on Air Again

Delaware, Lackawanna & Western Coal Co., New York City, resumed its "blue coal" radio broadcasts over eleven Columbia stations Oct. 2 and added eleven National Broadcasting Co. stations in the Eastern anthracite consuming territory Oct. 5. Short talks on caring for the furnace, improvement in heating conditions, and economy in the fuel use are given on both programs by John Barclay, "blue coal" heating engineer.

Anthracite Wage Question Goes to Board; Sign Pacts in Indiana and Southwest

WITH the miners steadfastly refusing to accede to a wage reduction, the joint conference of representatives of the anthracite operators and miners, called in New York City, Sept. 6, at the request of the operators, came to an end Oct. 4. The operators' request, in accordance with the terms of the present wage agreement, will go to a board of two members, one to be selected by the operators and the other by the miners. This board, the agreement provides, "shall be obligated, within 90 days after appointment, to arrive at a decision on all issues in controversy, and to that end shall formulate their own rules and methods of procedure and may enlarge the board to an odd number, in which case a majority vote will be binding." The miners, however, indicated that they would oppose enlargement.

During the discussions last month between the anthracite executives and the union officials, operators contended that a wage reduction would make it possible to lower prices sufficiently to halt the shrinkage in sales due to decreased consumer purchasing power and the inroads of competitive fuels. The reduction, it was pointed out, would be in line with the action taken in the union bituminous districts in the last few years. With commodity prices down, operators argued, the miners' standards of living would not be jeopardized and the workers' position would be benefited by the stabilization of the industry.

Union officials renewed their contention of other years that reductions in production costs could be effected through greater economies in operation, sales and distribution. They again offered to cooperate with the producers in a campaign for lower freight rates and for decreased taxes. Commodity prices, they said, have started upward again, making a wage reduction inopportune. Moreover, they took the position that anthracite wages had always lagged behind bituminous union scales and that the reductions in the soft-coal fields, therefore, should not be an argument for similar action on anthracite wages now.

As stated in the preceding issue (*Coal Age*, Vol. 37, p. 345), union representatives made a point that "the 10 per cent increase in war-time wage rates" still left the workers with inadequate earnings. This 10 per cent figure, of course, referred to the Pinchot award in the fall of 1923. As a matter of fact, beginning in May, 1916, successive increases culminating in the award of the Anthracite Coal Commission in 1920, brought the daily wages for all anthracite workers 162 per cent over the 1913 base. The Pinchot award increased all rates then in effect 10 per cent.

An agreement between the Indiana Coal Operators' Association and District 11, United Mine Workers, providing for a wage reduction of 25 per cent, was signed in Terre Haute, Sept. 10, bringing to an end a stoppage that began with the expiration of the old agreement, on March 31. The new contract, which expires March 31, 1935, carries provisions for division of work to loaders displaced by the installation of conveyors, except where this equipment is used for driving room necks and entries, and for reductions in the price of house coal, and, if possible, powder. Wage scales at strip mines were automatically reduced in conformity with the cut in deep-shaft rates.

Approximately 70 per cent of the operators in Arkansas and Oklahoma, at a meeting in Chicago early in October, agreed to resume contractual relations with District 21 of the United Mine Workers. The new agreement provides for a basic scale of $3.75 for eight hours and 80c. per ton for loading. Prior to its adoption, reports indicate, scales as low as $2.06 per day prevailed. Among those who refused to deal with the union were a number of producers in the Pittsburg and McAlester-Hartshorne districts, who had earlier announced their opposition to the closed shop. Considerable picketing took place in the Pittsburg district, but little trouble was encountered. A large number of miners also returned to work in the open-shop mines in the McAlester district.

The request of operators in the McAlester-Hartshorne district for a permanent injunction against union interference with open-shop operation was granted by Judge Hal Johnson in September. Judge Johnson also granted a temporary restraining order against District 21 and continued other temporary injunctions until Oct. 3, although union attorneys contended that "District 21" was extinct.

Old and New Indiana Wage Scales

	New Scale	Old Scale
Machine mining, per ton	$0.560*	$0.790
Pick mining, per ton	0.680	0.910
Chain Machines:		
Runner and helper, each	5.060	6.737
Narrow yardage, loaders	1.130	1.507
Narrow yardage, runner and helper, each	0.078†	0.104
Wide yardage, loaders	0.710	0.948
Wide yardage, runner and helper, each	0.047†	0.062
Room Turning, Machine Mines:		
Narrow	3.264	4.352
Wide	2.040	2.720
Pick Mines:		
Narrow yardage	1.800	2.400
Wide yardage	1.130	1.507
Narrow room turning	4.350	5.800
Wide room turning	2.720	3.625
Brushing:		
Per yard	0.425	0.566
Per added inch per yard	0.050	0.067
In rooms, per yard	0.346	0.461
Per added inch per yard	0.036	0.048
Without shooting, entries, per yard	0.038	0.051
In rooms, per yard	0.029	0.038
Rolls:		
Chain machine, per cubic foot	0.034	0.045
Pick mining, per cubic foot	0.041	0.054
Shotfirers:		
Pick mines, per shift	7.500	10.000
Machine mines, per shift	6.150	8.200
Mechanical Loading, Per Day, 8 Hours:		
Men loading on conveyors	6.750	9.000
Men drilling, snubbing and shooting	6.150	8.200
Cutting and shearing machine runners and helpers, mechanical loading machine runners and helpers	6.750	9.000
Inside Day Labor:		
Day labor	4.575	6.100
Spike team driver	4.820	6.425
Motormen	5.140	6.850
Trip riders	4.690	6.250
Trappers	2.610	3.475
Outside Day Labor:		
Day men	4.200	5.600
Blacksmith, 9 hours	5.000	6.670
Engineers, first, per month	146.570	195.420
Second	138.230	184.310
Third	134.060	178.750
Firemen, per day, 10 hours	4.590	6.110
Per month	131.250	175.000
Per night, 12 hours	4.500	6.000
Per month, night shift	129.950	173.260

*Cutting, 8.5c.; loading, 47.5c. †Operators have the privilege of working a night shift for cutting coal with machines. All men so employed shall be paid 39c. extra for each eight hours work in addition to the scale price per ton. The old bonus was 52c. per eight hours.

Ending a seven-month strike precipitated by a wage reduction on Feb. 1, miners in the Hocking Valley, Pomeroy and Crooksville fields of Ohio, at a convention in Murray City, Sept. 18, accepted a settlement based on a ten-point program proposed by Governor White last May. This program, later modified to provide for the discharge of miners from outside fields, included: $3.28 for day labor, 38c. per ton for loading, and 6c. per ton for cutting; reemployment of miners without discrimination against union members or strike participants; wage payments in currency; permission for employees to trade where they please; no abridgment of right to elect checkweighmen; and no further wage reductions without 30 days' notice to the governor. Approximately 6,000 men, of whom 1,000 already were at work, were affected by the settlement.

Ohio Collieries Co. held out at first for the original program, which provided that miners working in May should continue to work. Following sniping and picketing at its No. 267 mine, which resulted in the death of a high-school boy and the wounding of a mine guard in clashes on Sept. 23 and 26, the company accepted the modified plan. Miners and operators in the Tuscarawas field of Ohio decided last month to carry on temporarily under the terms of a wage scale negotiated a few months ago, thus preventing a walkout of 1,000 men. The present scale calls for 40c. per ton for loading and $3.50 for day work.

The close of last month brought little change in the Illinois situation. According to the operators' association, 85 mines employing 25,000 to 26,000 men were working normally Sept. 20. This total included 10 strippers.

Southern Illinois continued to operate to the fullest extent permitted by market requirements, but, with a few minor exceptions, the "Progressive Miners of America" were successful in preventing mines in the Belleville, central Illinois and Fulton-Peoria districts from resuming at the new $5 scale. Operators in these districts early in the month echoed the refusal of the Illinois Coal Operators' Association to deal

U. S. Wins First Round in District Agency Bout

Operation of Appalachian Coals, Inc., formed by 137 producers in the Southern high-volatile fields of the Virginias, Kentucky and Tennessee, was held to be in restraint of trade and a violation of the Sherman Act in an opinion handed down by the U. S. District Court at Richmond, Va., Oct. 3. The court, however, denied the government's claim that Appalachian Coals' control of production and markets would be monopolistic, and held that the defendants should seek legislative relief from the distress conditions brought out at the hearings. An appeal to the Supreme Court is planned.

with the insurgents. On Sept. 18, the Progressive Miners declared that 115 mines in Illinois had signed up at the old basic scale of $6.10. However, the operations in question, according to reports, were all small and employed only a few men each. The outstanding exception was the Hillsboro Coal Co., employing 250 men in normal times.

Malcontents from southern Illinois were ejected from Braidwood, in the Wilmington district, on Sept. 16, thus ending attempts to close down operations there. On the same day, John L. Lewis, president of the United Mine Workers, revoked the charters of five recalcitrant locals at Springfield and two at Peoria. Two hundred National Guardsmen used tear gas in repulsing pickets at Langleyville, Sept. 23. The clash grew out of the attempt of the Peabody Coal Co. to reopen its Christian County mines, closed down in August by the insurgents. Two mines succeeded in remaining open. National Guardsmen moved to Canton, Oct. 4, after an employee of the Pschirrer & Sons Coal Co. was critically wounded by snipers.

A meeting of United Mine Workers' representatives at Springfield, Sept. 25, to discuss plans for reopening Sangamon County mines ended in a street battle with supporters of the Progressive Union. A detective sergeant was killed and two other participants were critically injured.

Personal Notes

A. V. Sproles, safety director, Pocahontas Fuel Co., also has been appointed assistant general superintendent, with headquarters at Pocahontas, Va.

W. H. Lesser, combustion and mechanical engineer, Penn Anthracite Mining Co., Scranton, Pa., has been appointed assistant to the general manager in charge of the Randolph colliery, Port Carbon. Stephen J. Conners, inside foreman, was made superintendent of the operation.

C. A. Hamill, assistant general manager, Sycamore Coal Co., Cinderella, W. Va., was elected president of the Safety Institute of the Williamson Field at the annual meeting held in Williamson, W. Va., last month.

Peter B. Thomas Dies

Peter B. Thomas, 81, a pioneer in the development of the Alabama coal industry, died at Birmingham, Ala., Sept. 18. Mr. Thomas was born at Easton, Pa., and spent his early days in the anthracite region. He migrated to Helena, Ala., in 1877, and in 1905, after holding a number of managerial positions at coal mines in Alabama and Texas, acquired, in company with the late Truman H. Aldrich, the Aldrich mine at Montevallo, now operated by the Montevallo Coal Mining Co., of which his son, Darius A. Thomas, is now president. The elder Mr. Thomas retired in 1913. In addition to Darius A., he is survived by two other sons, Howard J., identified with the coal industry in Alabama for a number of years and until recently superintendent of mines for the Sloss-Sheffield Steel & Iron Co., and Truman A., now in the steel business.

Outlines Coal Stabilization Plan

A plan for rehabilitating the coal industry, based upon the British stabilization efforts, was discussed by Charles E. Stuart, president, Stuart, James & Cooke, Inc., New York City, in a radio address, Oct. 7, over WJZ and an extensive National Broadcasting Co. network.

Coal Mine Fatalities Rise

Coal-mine accidents caused the deaths of 61 bituminous and 18 anthracite miners in August, 1932, according to information furnished the U. S. Bureau of Mines by state mine inspectors. This compares with 59 bituminous and 15 anthracite fatalities in July, and 87 bituminous and 30 anthracite deaths in August, 1931. The death rate at bituminous mines, however, dropped to 2.71 in August of this year, while the anthracite fatality rate rose to 5.19. Comparative figures are as follows:

BITUMINOUS MINES

	Aug., 1932	July, 1932	Aug., 1931
Production, 1,000 tons......	22,489	17,857	30,534
Fatalities..................	61	59	87
Death rate per 1,000,000 tons	2.71	3.30	2.85

ANTHRACITE MINES

	Aug., 1932	July, 1932	Aug., 1931
Production, 1,000 tons......	3,465	3,021	4,314
Fatalities..................	18	15	30
Death rate per 1,000,000 tons	5.19	4.97	6.95

Comparative fatality rates for 1932 and 1931 are given in the following table:

FATALITIES AND DEATH RATES AT UNITED STATES COAL MINES, BY CAUSES*

Cause	Bituminous Number killed	Bituminous Killed per 1,000,000 tons	Anthracite Number killed	Anthracite Killed per 1,000,000 tons	Total Number killed	Total Killed per 1,000,000 tons
January–August, 1931						
All causes.....................	716	2.863	265	6.657	981	3.384
Falls of roof and coal...........	420	1.679	144	3.617	564	1.945
Haulage.........................	141	.564	31	.779	172	.593
Gas or dust explosions:						
Local explosions...............	6	.024	7	.176	13	.045
Major explosions...............	41	.164	5	.126	46	.159
Explosives......................	8	.032	18	.452	26	.090
Electricity.....................	37	.148	2	.050	39	.135
Surface and miscellaneous........	63	.252	58	1.457	121	.417
January–August, 1932						
All causes.....................	526	2.844	148	4.829	674	3.126
Falls of roof and coal...........	290	1.568	82	2.675	372	1.725
Haulage.........................	80	.432	22	.718	102	.473
Gas or dust explosions:						
Local explosions...............	9	.049	6	.196	15	.070
Major explosions...............	54	.292	...	.....	54	.250
Explosives......................	8	.043	9	.294	17	.079
Electricity.....................	27	.146	4	.130	31	.144
Surface and miscellaneous........	58	.314	25	.816	83	.385

* All figures are preliminary and subject to revision:

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