The Roden Co.'s Plant in Alabama

By C. A. Tupper*

Description of a carefully designed and well equipped plant in which no expense has been spared to bring the working costs to a minimum. The installation is replete with examples of permanent steel and concrete construction as applied to coal mining and some interesting conclusions relating to long-distance electric transmission are presented.

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The property of the Roden Coal Co. consists of about 4000 acres in Bibb County, Ala., in the famous Cahaba field. The point selected to work this area was on the L. & N. Ry. and the Southern Ry., 31 miles south of Birmingham, at a point afterward named Marvel.

The country in this locality is a succession of hills and valleys. At Marvel, the workable seams outcrop on the side of a hill which is separated from the main line of the railway by a valley and another intervening hill, approximately 125 ft. high. The expense of bringing the railway to the outcrop was prohibitive, and it was decided to bridge the valley to the top of the interevening hill and place the tipple on the far side. The connection to the railroad was then made with a 3-track siding on a 2 per cent. grade for the first 2000 ft. and 1¼ per cent. for the remaining distance from the main line of the railroad to the tipple.

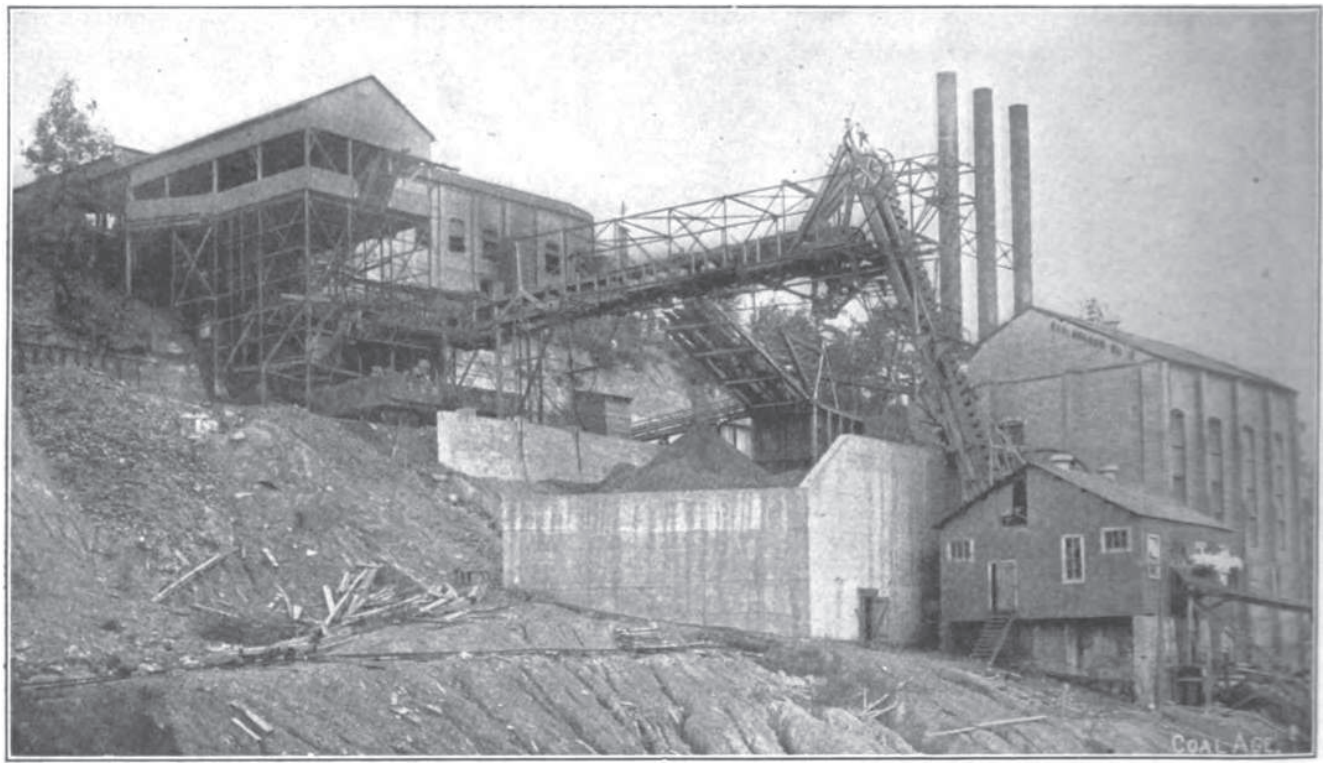
Steel Viaduct and Car-Haul

The total length of the viaduct is 600 ft., of which 300 ft. is steel, fabricated by the Converse Bridge Co., Chattanooga; the maximum height is 78 ft., and it contains about 50 tons of steel. It carries two tracks of 42-in. gage, 9 ft. centers, laid with 40-lb. rail, and was erected entirely by the Roden Coal Company.

In considering the type of structure to place at this point, cost of material, erection and upkeep were all thoroughly studied, accurate estimates being made for both a wooden and steel structure, and the advantage was decidedly in favor of the steel. The estimates of the engineers proved finally to be correct as both the cost of material and erection were less than if lumber, of even 80 per cent. heart stock, had been used.

The grade of this viaduct is 8.9 per cent.; at the bottom end, one track breaks to 21 per cent. in order to reach the bottom seam, the other continuing at 8.9 per cent. At the upper end, the two tracks split into three; the two outside, or empty tracks break to a 4.8 per cent. grade for 240 ft., and thence run on 3 per cent. for 156 ft. to the top of the empty car-haul. The middle or loaded track continues for 225 ft. to the knuckle, from which point it drops for 150 ft. on a 2 per cent. grade, thence for 109 ft. at 2.5 per cent. to a Phillips automatic dump. From this point the track drops on a 15 per cent. grade for 15 ft., giving the empty cars ample velocity to take the kick-back and be returned to either one of the empty track car-hauls.

A steam brake is provided for holding the loaded trip after it is over the knuckle, and the operation of this brake, the dump and the switch from the kick-back, is all handled by one man. In approaching the dump the loaded cars are weighed in transit, a long, 12-ft. platform scale being installed 12 ft. ahead of the dump. The scale house is built over the scale, and the latter is provided with a quick weighing attachment which greatly facilitates operations. A small



General View of the Roden Coal Co.'s Plant, at Marvel, Ala.

In any commercial operation, the object sought is to secure a maximum output at a minimum cost. The plant described in this article, data for which were prepared by W. F. and G. C. Thornton, the engineers who designed it, and B. F. Roden, president, has been built with that end in view, rather than with the idea of conserving on first cost and thereby eventually creating a higher net cost of production.

belt conveyor, motor-driven, handles the miners' checks from the dump to the weighman. The two car-hauls, 42 ft. long, and having a grade 20.2 per cent. and capacity of 100 cars each per hour, are driven from one line shaft, which in turn is driven by a 15-hp. 220-volt, 3-phase, 60-cycle induction motor, back-geared.

The Tipple

The tipple, of steel construction throughout, is equipped to screen slack, egg, nut and lump, and has a capacity of 250 tons per hour. Lump and mine-run are loaded on the outside track. The screens are provided with blank plates to cover any of the various openings. The coal is dumped from the mine cars into a bin of 25 tons capacity, whence it is automatically fed to the screens; the screens and feeder are driven by a 40-hp., 220-volt, 3-phase, 60-cycle induction motor, back-geared. All the chutes and screens are adjustable for height and load parallel to the track; by making these chutes long enough, and raising them as the car is loaded, the breakage of coal has been reduced to a minimum.

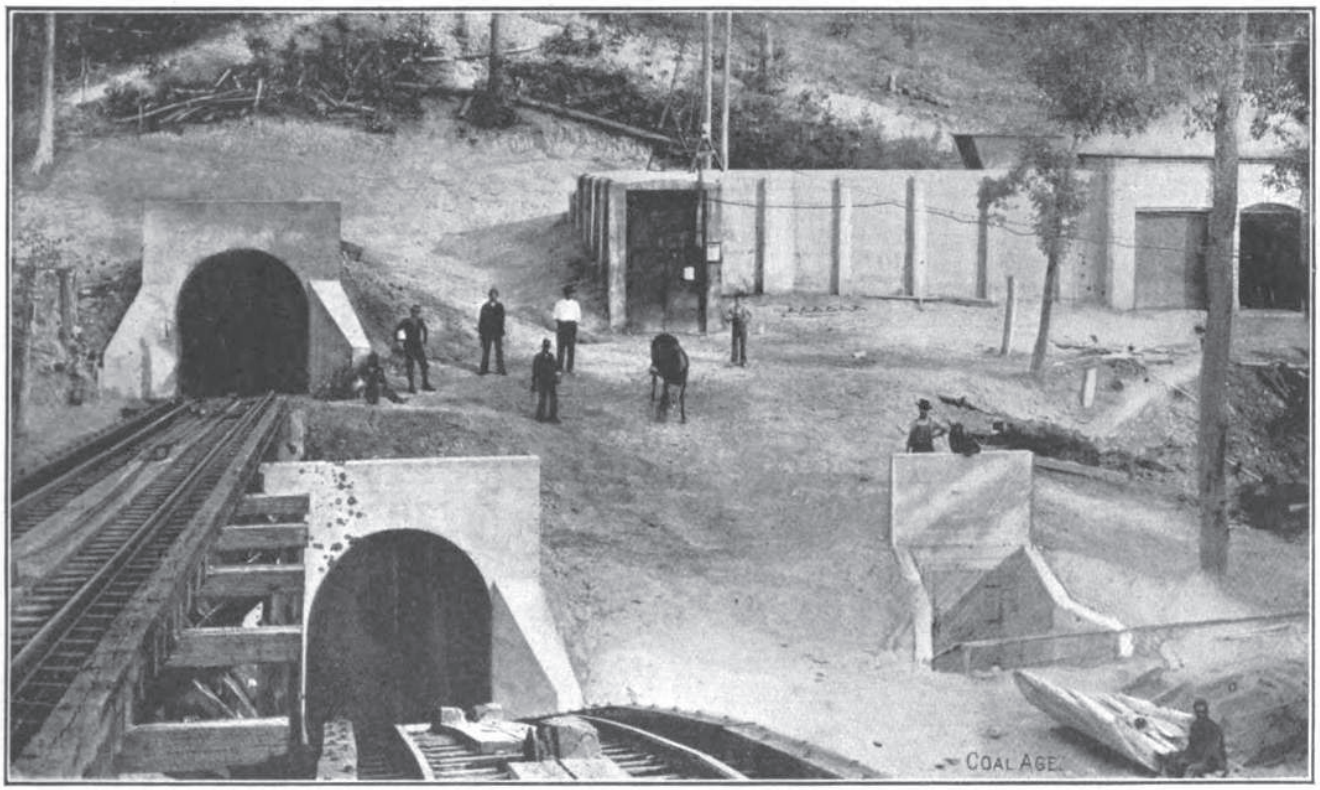
All the motors used on the tipple are constant-speed and are back-geared in order to secure the necessary low speeds without going to the expense of slow-speed motors; they are provided with special oil cases for the gearing. The screen load is thrown on the motor gradually through a friction clutch. The total capacity of the screens is 250 tons per hour.

For loading lump, the original design of tipple called for a curved chute from the end of the screen to the car but in practice this had to be abandoned, as the velocity attained by the coal caused considerable breakage; the chute being necessarily a spiral, the difference between the maximum and minimum limits of raising and lowering the outer end to attain a slow or rapid velocity was too small for practical purposes. For this was substituted a straight chute 4 ft. 6 in. wide, and 14 ft. long, hung at right angles to the center line of the screens, and sloping about 30 deg. To bring the coal from the screens to this chute without having a maximum drop of more than 18 in., which was prohibitive, a small connecting chute was built of angle-irons, 2x2½x⅜ in. One flange of these angles was cut out to fit over a 1¼-in. rod which was supported on the framework immediately under the end of the screen, the other ends, beveled on a 30-deg. angle, rested loosely on the surface of the 14-ft. chute, thereby forming a warped surface over which the coal flows easily and with no breakage; furthermore, this surface is adjustable to all positions of the loading chute, as it is lowered or raised to suit various cars.

The slack coal goes into a 12x24-in. flight conveyor and is conveyed to a 2500-ton, raw-coal bin located on the ground below the tipple. By means of a concrete tunnel under this, the coal is drawn off on apron conveyors to the washer jigs. This washer, like the other equipment, is fireproof, being constructed of concrete and steel throughout. The washer is driven by rope drive from a double engine. The refuse is sluiced away. Only one man is employed at the washer, which is handling 800 tons per day of 10 hours.

Hoisting and Power-house Machinery

It was decided as impracticable to have a straight pull from the hoisting engine, down the main slope and, as the contour of the ground permitted little choice for the site, the hoisting engine was placed in one end of the power house building, at right angles to the tipple center line; this necessitated two 8-ft. sheave wheels (for two 1¼-in. wire ropes, one for each slope) suitably mounted on steel head frames, to carry the rope "around the corner."



Concrete Mine Entrances and Beginning of the Steel Viaduct

The power house is 38 ft. wide and 88 ft. long and will be increased in length as additions to the plant are made. The walls are 17 in. brick, with pilasters spaced 11 ft. 1 in., steel roof trusses and tile roofing laid on angle-iron purlins; a 10-ton, hand-power crane runs the length of the building, the runway being supported by brick pilasters. This crane was installed when the two side walls were finished and before the end walls were put up, and was of material assistance in erecting all the machinery. This building is lighted by 19 windows, each having double sashes operated on pivots. Glass-top ventilators are placed in the roof and the building is provided with a basement for the piping, traps, etc.

The equipment of this building at present consists of a 28x48-in. double-cylin-

der, double-drum, first-motion hoisting engine. The drums are 8 ft. in diameter, and each has a capacity of 5000 ft. of 1¼-in. wire rope; the flanges are detachable and will be replaced with higher ones later, as the slope lengthens. The engine is fitted with steam-operated brakes, friction and reverse, and Corliss valves, although the dashpots have been left off, to be added later when length of haul becomes a serious item. Extension piston rods, through the back cylinder head, equipped with crossheads, are provided to take up the weight of the piston. There is 140 lb. steam pressure at the throttle. This engine handles 15-car trips, each car weighing loaded 5000 lb., at a speed of 1500 ft. per minute.

Other units are a 250-kw., 3-phase, 60-cycle, 2300-volt generator, direct connected to an 18x24-in. Corliss engine, having a speed of 120 r.p.m., and a 25-kw., 125-volt, direct-current generator, direct connected to a high-speed 8x7-in. engine, running at 350 r.p.m.; this latter is used as an exciter set and is of sufficient capacity to take care of additional units. There is also a 40-hp. motor-generator set which is used as an exciter set while running, and the engine exciter is used only for starting and as an emergency unit.

The decision to adopt alternating current was due to proposed additional openings to be made later, a mile or more from the present one, and the intention to provide power for both mines from this one plant. The flexibility of the alternating current was also taken into consideration. Then, again, although the first cost of alternating current machinery is slightly in excess of direct-current apparatus, the low maintenance and operating cost of induction motors, as compared with direct-current motors, is so great that in 12 months it would more than pay the difference in first cost.

Boiler House and Steam Lines

The boiler house, 41x51 ft. 3 in., is located 79 ft. below, and 197 ft. horizontally from the power house. In locating this building, advantage was taken of the profile of the ground for fuel- and ash-handling. Coal is drawn from the slack bin into a one-ton side-dump car which is pushed on a track running into the boiler house on top of the furnaces, on a 0.5 per cent. grade in favor of the load. The ashes are drawn from hoppers under the furnaces into a similar car, operating in a concrete tunnel running the length of the building; this car, when loaded, is pushed out on the track supported on a pole trestle along the hill side, and the contents dumped down the bank.

The building is similar in construction to the power house and contains three 300-hp., vertical water-tube boilers, having 150 lb. working pressure, set singly, in steel casings, and equipped with automatic stokers, feed-water regulators and automatic valves. Although at first glance this may appear an unnecessary refinement in equipment for a coal mine, it is justified by the saving in labor, one man handling this entire 900-hp. plant, including the firing and ash removal.

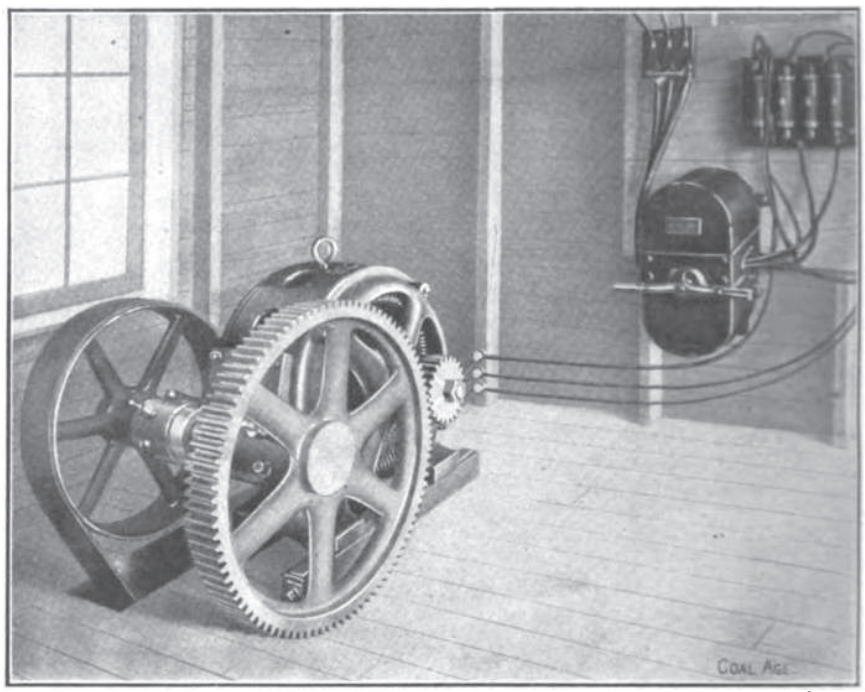
The 12-in. steam main from the boilers to the power house, 168 ft. long, is carried on a suspension bridge over the three side tracks. The span is 99 ft.; difference in elevation of the foundations of the towers is 49.75 ft., and of the tops 27.88 ft. The bridge consists of two ⅞-in., galvanized, steel-wire cables, spaced 48-in. centers, and ⅝-in. suspension rods, with longitudinal spacing of 5 ft. The minimum clearance from the top of rail is 22 ft. The bottom tower is 35 ft. from the track and behind a 6-ft. bank, while the upper tower is on the top side of a cut, 41 ft. above the rail, so it is plain that the danger of damaging either tower by a derailed car is eliminated. The grade of the bridge floor is 15 degrees.

All steam piping is of standard-weight pipe, lapped at the ends, and having rolled-steel flanges, forming a "Van Stone" joint. The connection from the 12-in. main to the boiler header is made with a 12-in. Harter flexible joint, which takes care of all expansions, the main connecting at the upper end to a long-radius, cast-steel L, securely anchored in the basement of the power house, from which distribution is made to the machinery. All valves are Fairbanks, extra heavy.

General Utility Shops

One large building houses the blacksmith, machine and carpenter shops. It is 35x82 ft. and 16 ft. high, of brick and steel construction, tile roof and contains a circular saw, boring machine, lathe and planer in the carpenter shop, and a power hammer, down-draft forge, blower, exhaust fan, pipe-cutting and threading machine, drill press, emery grinder, etc., in the machine shop. All machinery is driven from line shafting, to which is belted, in the carpenter shop, a 10-hp., 220-volt, three-phase induction motor, and, for the other machinery, a 15-hp., 220-volt, three-phase induction motor. A branch from the empty coal track outside leads into and runs the length of the building, ending over a concrete-lined pit in the machine shop for repair of the electric mine locomotives, of which there are at present two in operation, both being 4-ton Westinghouse Baldwin, having wrought-steel frames and fitted with arc headlights.

The locomotive trolley poles are located to one side of the center, which is necessary in low-roof mines to prevent accidents to employees. In addition to placing the wire to one side of the entry close to the rib, additional safety is provided by a wooden guard on each side of the wire which extends from the roof to 3 or 4 in. below the wire. While only 250 volts is carried on the trolley wire, which would not do material damage to persons coming in contact with it, the extra precaution of the wood guard has reduced danger of accidents of this kind to a minimum. This building, as well as the boiler and power house, is lighted with three 5-light cluster, 40-watt, tungsten lamps.



Conveyer Motor, Showing Potential Starter and Fuses on the Right

The Water Supply

Unfortunately, the nearest source of an abundant and pure water supply is over a mile from the town. This, of course, means pumping all the water used both

for domestic and boiler purposes. For the former, a storage supply is provided by a concrete tank of 50,000 gal. capacity, set on a concrete tower, 60 ft. above the ground. For the latter a 500,000-gal. concrete-lined reservoir was built on the crest of a hill beside the power house; from this reservoir, water flows to the feed pumps and later, when condensing apparatus is installed, will supply the condensers also. At present it is necessary to feed cold water to the boilers, but this is only temporary.

The proposition of handling the water from the stream is taken care of by two three-stage centrifugal pumps, direct-connected to three-phase, 2300-volt, 60-cycle induction motors, operating at a speed of 1700 r.p.m. One of these has a capacity of 150 gal. per min., and the other 250 gal. per min.; both operate under a 300-ft. head. The motors are 35 hp. and 60 hp., respectively, and only one pump is operated at a time, the other being held in reserve.

This plant is located in a brick building, 12x16 ft., and about 10 ft. from the bank of the stream. The motors are started and stopped by starters, located over a mile and a half away, in the power house. This use of starting apparatus, with a remote control, is one of the advantages of alternating current, as no extra or increased sizes of wire are necessary. The 4-in. suction from the pump leads into a sump on the outside of the building, which is connected to the stream by a 6-in. pipe provided with necessary strainers, check valves, etc. The building is waterproofed 6 ft. above the ground to prevent damage to machinery through high water.

It might be well to mention here that this source of supply was finally decided upon only after an exhaustive series of analyses of the water at the two extreme seasons of the year. A 6-in. cast-iron pipe carries the water from the pump to the 50,000-gal. tank, and thence to the reservoir in a 4-in. pipe, suitable valves being placed to turn all the flow into the latter without interfering with the domestic supply.

Electric Transmission System

The pole-line construction conforms to the best standards for this work. All poles are either 35 or 45 ft. long, spaced 100 ft. apart, and of good, straight, sound chestnut. Main-street poles, running through the town, carrying circuits of 2300 volts, are 45 ft. in length and placed 5 to 6 ft. in the ground; all corners are substantially guyed. On every fifth pole is placed an arm which extends out to the center of the road, about 20 ft. above the ground, on the end of which is hung a 60-watt tungsten series light, there being 26 of these distributed along the highways, on an independent 2300-volt circuit.

On each pole danger notices are printed in large black letters on a white background, which can be read from a distance. Some of the poles are equipped with steps from the top to within 8 ft. of the ground, and the management found that to protect the public as well as the company, it would have to prevent young boys from ascending these poles and stealing insulators; therefore, in addition to the "Danger" sign, there were placed on these stepped poles a $25 reward notice. Since this, there has been no trouble from that source whatever.

The Ventilating and Direct-current Plants

The ventilating equipment is in a large general building, divided into three compartments. One end contains the fan, 72 in. in diameter, delivering 100,000 cu.ft. of air per min. at a 1½-in. water gage and 300 r.p.m. The fan is belt driven by a 75-hp., 2300-volt, three-phase induction motor and starter. A reinforced-concrete tunnel carries the air from the fan to the two air courses. Concrete is extensively used in the mines for overcasts, etc. The middle compartment is a hospital for rendering first aid.

The third compartment, separated from the rest of the building by a 13-in. brick wall, contains a motor-generator set. Provision is made for three sets, but, at present, a 75-kw., 250-volt, direct-current generator, driven by a three-phase, 2300-volt, 60-cycle, 112-hp. induction motor, and a starter, is all that is necessary. The motor-generator set is mounted on an iron sub-base, and the speed is 650 r.p.m. A skeleton wood switchboard, for the outgoing mine circuits, completes the equipment of this room.

The machinery at present installed in the mine using the direct current supplied by this generator, is: Two locomotives, two small triplex sinking pumps, driven by back-geared, 15-hp. electric motors, two electric air rock drills, one 250-gal. triplex station pump, back geared to a 40-hp. motor, and six 20-hp. electric single-drum hoists. All the power leads run down the lower air course and at intervals branches are tapped off and run where necessary. Little water has been encountered so far in the mines, but a station pump will be installed later. All the motors for the plant were supplied by the Allis-Chalmers Co., Milwaukee.

The mine is being equipped with a complete telephone system, also electric indicators for showing the engineer the location of the trip he is handling. Shotfiring will be done entirely by electricity from the outside of the mine, while a system for checking the men going in and out will be established to prevent accidents happening from firing shots while anyone is in the mine. Electric air drills are being used for drilling the sandrock top in the headings and air courses.

Sociological Conditions

For the use of the miners, a bath house of brick will be built, equipped with 20 showers having both hot and cold water, and a locker for each man. The building will be divided into two compartments, one for the colored and the other for the white miners. A system of steam heating will be installed and an attendant, in charge at all hours, will be responsible for the proper care of the building.

The fire protection at Marvel has been given careful consideration. Fire hydrants are established at regular intervals throughout the camp, and hose carts are placed at convenient points, with plenty of underwriters hose to reach any desired locality. The water pressure from the concrete tank alone is sufficient to throw a stream from a 2-in. nozzle the necessary distance, while the pressure obtained when the pump is in operation and feeding directly into the mains is, in some places, more than 150 lb. per sq.in. Fire companies have been organized to fight any conflagration which might occur.

All the miners' houses are wired and the light is supplied at a flat rate, which is charged in with the rent. All lamp renewals are purchased at the commissary by the consumer. For use in the mines, 220-volt lamps are provided, but 110-volt lamps are used in the houses.

A 10-ton ice plant will be located convenient to the commissary, and a refrigerator will keep all the fresh meats in perfect condition until used. Ice will be supplied to neighboring camps at a minimum charge throughout the summer. An amusement hall, having opera chairs and seating 600 people, provides for moving-picture shows weekly.

Experiments on Explosive Dust at Pittsburg Testing Station

Experiments made at the Pittsburg testing station have shown that a charge of 1¼ lb. of black powder is capable of igniting 60- to 80- or 80- to 100-mesh coal dust and propagating an explosion. Dust larger than 60-mesh was not ignited. A 2½-lb. charge, with 2 lb. of clay tamping, ignited 60- to 80-mesh dust and propagated an explosion. Also 40- to 60-mesh dust mixed with 20- to 40-mesh was ignited, but only a partial explosion took place, although the indications were that a still larger charge of powder, with a correspondingly increased concussion and heat, would produce a complete explosion. Under mine conditions, where there is an abundance of fine dust to sustain the flame, coarser sizes of dust may be able to propagate an explosion if the shot is very large; but until further tests are made 20-mesh dust is the dividing line between fine coal and dust.