

ward. There would thus be a very slow but continuous transference of free solid particles from the summits of the mountains toward the plains, uncovering fresh surfaces in the higher regions, and this creeping effect would necessarily be much more rapid on such steep declivities as the eastern face of the Apennines than on the gradual slopes toward the west. If then, the very tenuous atmosphere which we may readily believe to exist upon the moon be capable of effecting some slight tarnishing or darkening effect in the course of centuries, or if the deposition of meteoric dust, which must be much the same as upon our earth, slowly coats our satellite with a thin, dark veil, we shall find a sufficient explanation for the difference in albedo of the mountain peaks and of the great plains.—Knowledge and Scientific News.

A STRANGE SUBSTANCE FOUND IN AN EGYPTIAN TOMB.

MESSRS. Lortet and Hugouenq have lately made an analysis of a substance which was found in the tomb of Prince Mahepa, Thebes XVIII. Dynasty; this tomb was explored not long ago. It lies in the valley of Biban-el-Molouk, near Thebes, and contained a quantity of interesting objects, which are now in the museum at Cairo. Among others were eight large jars stoppered with care, containing a pulverent yellowish mass. It was supposed that this substance was used in the mummifying process, but it had never been analyzed. Some of it was sent to Paris not long ago by Prof. Maspero, and it has been examined by the two experimenters. It is a grayish yellow and non-homogeneous substance, showing vegetable debris, sand, and clay. A quantity of it was treated first with alcohol, then with water. The alcohol dissolves out a yellowish-brown resinous matter, which has no doubt been changed with time, but it still possesses an odor. It is probably a mixture of resinous products in which the principal one is myrrh. It will be remembered that myrrh entered along with other ingredients, *Cyperus rotundus* and *Calamus aromaticus*, into the composition of kephi or kyphi, a sacred perfume which M. Lortet has reconstituted. Water dissolves out another portion, leaving a residue of quartz sand and clay mixed with sawdust and vegetable fragments. The primitive substance thus contains: Odoriferous resin, 19.53 per cent; organic debris, 3.68; sand and clay, 12.44; water, 9.52, and a mixture of soluble salts forming a natron, comprising sodium chloride, 14.88 per cent; sodium sulphate, 22.90; sodium sesquicarbonate, 17.05 per cent. The composition of the natron is more or less variable. A specimen from Gournah, near Thebes, gave sodium chloride, 62.00 per cent; sodium carbonate (dry), 18.44; sodium sulphate (dry), 11.40. Others are still different, such as one from Ouadi-Natroun. It is not only the origin and state of dessication which causes the difference, but the process of collecting it. The natron is found in flakes on the banks of the lakes or is scraped from the surface of aquatic plants. This latter method accounts for the vegetable debris which it contains.

As to the resinous substances found in the mixture, they cannot be identified with certainty, owing to the modifications which have been brought about by time and the surrounding media. In the alcoholic solution, myrrh seems to predominate, but it is accompanied by gliban and bdellium. There is no doubt that the substance found in the jars was used in preparing the mummies. The part which dissolves in water gives a brown color to the pieces of cloth which are dipped into it, and this is the same color as is seen on the bands in which the mummies are wrapped. When dry, the cloth presents an odor and appearance which are quite characteristic, owing to the deposit of alkaline soap which is produced by the resin mixed with the natron.

SCARLET PHOSPHORUS: A NEW CHEMICALLY-ACTIVE VARIETY OF RED PHOSPHORUS, AND ITS USE IN THE MANUFACTURE OF MATCHES.*

PART I.

By W. MUIR.

THE following observations sum up the results of experiments commenced by myself five years ago, to make a strike-anywhere match without white phosphorus.

After working on the substances that usually appeal to inventors, I tried the so-called red sulphides of phosphorus described by Berzelius, and found that they made good matches. I showed the matches prepared from those compounds to Mr. Boor, who took the matter up very heartily, and induced Dr. Marquart, of Messrs. Marquart & Schulz, Bettenhausen, Cassel, to make these sulphides (so-called) in large quantities. Matches also were made, but difficulties and doubts arose. We could not get the so-called red sulphides free from the ordinary yellow sulphides. The residue left, after extracting as much of the yellow sulphides as was possible, showed on analysis very little sulphur left, but it was unchanged in appearance and still made fair matches.

At this point we noticed an account of a peculiar form of phosphorus made by Prof. Schenck, of Marburg, with whom we got into communication through Dr. Marquart, and learned from him definitely, what we had already suspected, namely, that the so-called red sulphides of phosphorus are merely solid solutions of the ordinary yellow sulphides in some form of red

phosphorus, and Dr. Schenck advised us that he had produced a new bright red preparation of phosphorus in his laboratory without the aid of any sulphur at all. I obtained quantities of this material, which we call Schenck's phosphorus, and made good matches. The result of our friendly intercourse was that we all joined our several discoveries and our practical knowledge together for the production of matches with this new scarlet preparation of phosphorus. (Specimens of the compound and of matches made from it were exhibited.)

We find that Schenck's phosphorus is a satisfactory basis for the production of strike-anywhere matches. It is not poisonous if swallowed, and it does not fume in working. It abolishes the special ills that have troubled match makers, and can be used with the ordinary glue mixture that is used with ordinary phosphorus. The matches made with it stand even better than those made with ordinary phosphorus. We have sent such matches to the most trying climates in the world, and have damped them and dried them twelve times without harming them.

PART II.

By R. SCHENCK, PH.D., and P. MARQUART, PH.D.

You are all aware of the great importance of the two varieties of phosphorus as agents in many of our industries, and especially in the manufacture of explosives and matches. We now introduce a third form to you, which in some of its properties is intermediate between them.

The manner in which considerable quantities of our new form of phosphorus may be obtained has lately been demonstrated by one of us, who has also described its characteristics (Jour. Soc. Chem. Ind.), 1902, 368. See also 1903, 494). A very good sample of the new substance is obtained by heating a 10-per-cent solution of white phosphorus in phosphorus tribromide to boiling, and on this basis the firm of Marquart & Schulz, Chem. Fabrik, Bettenhausen, Cassel, have succeeded in working out a process which allows of the application of this new invention on a large scale.

The product is a fine powder of bright scarlet color, containing, however, still many impurities, as is shown by its weight, which may much exceed that of the white phosphorus used.

Its propensity to take up foreign matters from the solvents is very great. Michaelis and Pietsch tell us that red phosphorus formed by the effect of light on a solution of phosphorus in carbon bisulphide contains a large percentage of carbon and sulphur, and we, ourselves, have observed that foreign substances like iodide of phosphorus and sesquisulphide of phosphorus, which may be dissolved in phosphorus tribromide, together with the white phosphorus, are precipitated with it. This strong tendency to form solid solutions permits of the conclusion that the red phosphorus in the products is amorphous, as crystalline bodies rarely possess the capacity of dissolving foreign matters, except in cases of isomorphism.

On being raised to higher temperatures in an indifferent current of gas, Schenck's phosphorus becomes darker (while phosphoreted hydrogen is formed by the decomposition of the phosphorous acid), and finally turns black, recovering, however, its former redness on cooling down after some time. This reversionary alteration of color through change in the temperatures is a purely physical process, which has a good many analogies. Scarlet phosphorus that has been kept for a long time at high temperature retains, when cooled down, a deep red color.

The great chemical activity of this form of phosphorus is shown by the violence with which it becomes oxidized by diluted nitric acid; it is shown also when treated with hot caustic soda solution which causes a generation of phosphoreted hydrogen, and a solution of the scarlet powder into the subphosphorous acid. Ordinary amorphous phosphorus is hardly attacked by hot caustic soda solution; it may be indeed freed from small quantities of white phosphorus by being boiled down with this liquid. A weak solution of indigo in sulphuric acid is decolorized if boiled with scarlet phosphorus.

A particular characteristic of scarlet phosphorus is its action toward ammonia and bases of medium strength, such as dilute piperidine and diethylamine. They turn its bright red color black, phosphoreted hydrogen being formed to a small extent. Acids will reproduce the scarlet product from the black. The black products seem to be salts, and successful experiments have been made to fix the nature of their acids. The salts are those of a solid polyphosphoreted hydrogen, which certainly is not usually regarded as an acid.

Difficulties which have not been removed yet by industrial science have prevented the introduction of the amorphous red phosphorus, which at first seemed predestined for the preparation of non-poisonous strike-anywhere matches, and the hopes entertained in that direction have not been realized. The mixtures of amorphous phosphorus with oxidizing substances, such as chlorates, and with other bodies, such as filling and cementing agents, which are used at present to form match heads, possess the objectionable quality of being highly explosive, so that great losses are incurred through their employment, and the workman is exposed to considerable danger.

If, therefore, in the tips of matches, the scarlet phosphorus be substituted for the white phosphorus, an article will be obtained, which, while non-explosive, after drying will easily ignite on any rough surface. A technical problem of long standing will thus have been definitely solved.

DISCUSSION.

Sir Wm. Ramsay said he had recently visited Marburg, and had been shown a cat which had swallowed about 50 grammes of this phosphorus without suffering any harm. This substance had a slight smell resembling that of ordinary phosphorus, which appeared to indicate that it formed the oxide of phosphorus, P_2O_5 , discovered by Dr. Thorpe, some years ago, which was the cause of the "phosphorus" smell. It was a curious fact that yellow phosphorus was an unstable substance, or, more correctly, a meta-stable substance; it was in the same condition as water cooled below zero, which yet did not freeze. Yellow phosphorus changed so slowly that it could not be seen to change under ordinary circumstances; even when kept below water, its transformation into the red variety was very slow, but if it were dissolved the rate of transformation increased very greatly, and on that depended the merit of this discovery, dissolving the phosphorus in the bromide. He saw the experiments which had been described, and it occurred to him whether this new form was not conceivably a solid solution of hydride of phosphorus, P_2H_2 , in red phosphorus, or a mixture of the two. This was suggested by the action on ammonia and certain bases described. No doubt these formed compounds which strongly resembled polysulphides. A precipitate was obtained which turned red, which Dr. Schenck said was hydride of phosphorus, mixed with ordinary phosphorus. In the same way if an acid were added to polysulphide of sodium a precipitate of sulphur was formed, with the difference that in this particular instance a solid sulphureted hydrogen was not obtained, but merely sulphureted hydrogen gas; whereas, in the case of phosphorus, the solid hydride P_2H_2 , remained mixed with the precipitate of phosphorus. He was not clear whether Dr. Schenck thought the substance was really this mixture of hydride and red phosphorus, or the latter only. So much for theory; on the practical side, it occurred to him that there must be a considerable loss, if the phosphorus tribromide adhered so strongly as only to be decomposed by boiling water. It was possible that the hydrobromic acid might be recovered, and also the phosphorus, but he should have thought there was a considerable amount of loss possible from the fact of having to decompose a large amount of phosphorus tribromide which had to be reconverted from its elements before they could be again utilized. That loss might not be sufficient to negative the gain, but it must be reckoned with. The differences might be got over, but he should have thought, owing to the waste, that it was an uneconomical operation. He should be glad if Mr. Muir could give any information on this point.

Mr. L. G. Boor said that, with regard to the practical side, what they had done so far was to provide a match which could be made with the ordinary 20 per cent gelatin composition, and would stand any climate. They tried it with the idea of producing a match which would strike anywhere. They simply substituted this red phosphorus for the common yellow, so that the match maker could use the same composition which he had used for years without altering his plant or his process. With regard to the cost, it would always be higher than that of yellow phosphorus, but with the question of prohibition looming in the future, and matches at 1s. a gross, he did not think an extra ¼d. a gross would prevent the use of this kind of phosphorus.

Mr. Bale asked the price of this particular compound.

Mr. Boor said, as produced at present in small quantities, it worked out about 2s. 3d. per pound, but he believed that, when made in large quantities, the price of this red phosphorus would be brought down to about the same as that of amorphous, about 1s. 9d.

Mr. Clayton asked the ignition point of the new phosphorus, and if the substance described in the first paper was the same as that prepared by Dr. Schenck.

Dr. Divers remarked upon the interesting fact that a body which has been known to every chemist from the time of Thénard and even before it, should only quite recently have been shown by Dr. Schenck to be very stable and apparently very useful. It seemed important that its non-poisonous character should be further tested upon herbivorous as well as upon carnivorous animals; parts of the human alimentary tract secreted alkaline fluids which might act upon this body and generate poisonous products.

Prof. Mills asked if any figure could be given as to the yield of this phosphorus from a definite quantity of common phosphorus, and also, as phosphorus tribromide was rather expensive, whether the trichloride could not equally well be used under pressure.

The chairman said one point appeared to him to require some further experiments, namely, the action of the phosphorus itself on the cementing material, which Mr. Boor said was gelatin or glue. He asked Mr. Muir whether any experiments over any length of time had been made on the action of phosphorus on this organic material. Of course, it was a very great advantage, not only from the point of view of the swallowing of matches, but also of their contact with the skin that the phosphorus was inert. If an absolutely non-poisonous phosphorus were introduced into the match trade it would eliminate much serious suffering. The poorer classes of operatives engaged in the match trade suffered very seriously, in spite of all that had been done by legislation for their protection; in fact, so great was this evil that the use of ordinary phosphorus for this purpose had been prohibited in many European countries.

Mr. Muir, in reply, said he found the ignition point

* Read before the Society of Chemical Industry.

was about 170 deg. C. A good deal would depend on the rapidity in the rise of temperature. The substance mentioned in both papers was the same. The matches shown were made with it; they were produced from material sent over by Prof. Schenck. He had tried phosphorus trichloride, and he thought under pressure it might give some results. They had had matches in stock which were two years old, and they were as good now as when they were made.—*Jour. Soc. Chem. Ind.*

TRADE NOTES AND RECIPES.

Vegetable Substitutes for Soap.—The adaptability of plants for washing purposes has long been known. They possess the advantage over soap in that their effective substance, saponine, is a neutral or slightly acid body, while soaps always form free alkali with water, which often attacks the colors of the material. So far as is at present known the cleansing effect of saponine results from its ability to produce in water a great quantity of insoluble particles very finely divided in the form of an emulsion.

Its peculiar property of foaming when shaken is intimately connected with this.

Of *Musa paradisiaca* alone it is said that the sap contains a solution of sodium oleate, and that it may be used in the place of soap, without containing any saponine.

Mr. L. Rosenthaler presents a list of vegetable substitutes for soap which shows a preponderance of the leguminous plants, at the head of the list the *mimosala*—*albizzia* and *acacia*.

In the second place come the *caryophyllaceae* with our indigenous *saponaria officinalis*, after them come the *Rosaceae*, containing exclusively *quillaja* varieties.

The roots and root stocks and bulbs are used for the most part, then the bark, and some times the leaves and fruit; the *Phaseolus mungo* indigenous to the East Indies is the only species of the *papilionatae* given of which the blossoms may be used.

Practical Hints in the Production of Artificial Kindling Sticks.—Pitch, gum, rosin, or any similar easily-burning and melting resins are melted in an iron pot; in this molten mass a given quantity of calcined lime is sifted and vigorously stirred, and when the compound flows thin it is set aside to settle.

The addition of lime is ordinarily about one-tenth of the amount of rosin or pitch used.

Prepare, furthermore, in large earthen pots, aqueous solutions of all sorts of aniline dyes with which to stain sawdust. The very finest dust must be removed and the coarser sawdust poured into the dyes until it takes them up completely. Next dry and mix certain amounts of all the colors with a sufficient quantity of unstained sawdust to form a brilliant and pleasing combination of color. Finally, dip thin bits of wood or thick shavings in the still warm fluid rosin and sprinkle them lightly with the variegated sawdust and stand apart to dry.

Any rosin which is easily ignited is suitable for saturating the splints or shavings; the main desideratum is that it be cheap.

The calcined lime is added only to cause the rosin to harden more quickly, and if hard rosins be employed the lime may be left out of the compound.

Of course economy will teach the operator that the rosin is to be kept as thin as possible, and for the dyes the cheapest aniline colors will do, since they serve no other purpose than to make the kindling sticks acceptable to the eye.—*Erfindungen und Erfahrungen.*

On the Warping of Circular Saws.—This damaging defect in saws of this description arises from the unequal tension existing in the metal itself, and may come from a variety of causes.

To begin with, according to the *Zentralblatt für die oesterreichische-ungarische Papier-industrie*, this may occur during the manufacture of the saw, either in the annealing or hardening, or may be discovered after long use; as a general thing it may be accepted that a fault consequent upon one of the former causes will be discovered early enough to prevent the article from reaching the hand of the consumer.

It often happens also that too great speeding of circular saws will cause warping, for during excessive revolutions the centrifugal force, particularly in the larger saws, tends to stretch the plate unevenly.

It is important, then, when buying circular saws to inquire of the maker or dealer at what rate the saw may be safely run; or, in other words, for how many revolutions per minute is the saw calculated.

It is natural enough to conceive that, with so great a variation in the speeds—from 800 to 2,500 turns a minute—all saws are not fitted for the same velocity. Warping of a saw disk that has become hot may be avoided if it be properly treated; it should, for instance, not be cooled too rapidly. In all mills where saws of this description are used it should be an established rule not to cool an overheated saw with water, as is indeed the practice in nearly all mills, nor should its power be instantly shut off and it be allowed to stand either.

At least five minutes of free running should be allowed such a saw, and then run it down gently, so that by degrees its particles may assume their normal positions.

At most a current of air only should be used in the cooling; from water the shock to the internal structure is too great.

ELECTRICAL NOTES.

A scheme, undoubtedly new to many, for the delicate balancing of armatures and other revolving parts, is illustrated in the July issue of the *Electric Club Journal*. The shaft supporting the armature is not laid directly upon the balancing ways, but is encircled with a hardened steel ring at each end, which has been accurately ground and polished. Though these rings do not fit the shaft, they make the balancing test perceptibly more sensitive. When a soft steel shaft carrying a considerable weight is laid upon the balancing ways, there is some local deformation at the points of contact that tends to make it lie in whatever position it happens to be. With the hardened rings around the shaft this local deformation is largely neutralized; the rings being hard do not change shape so much as a steel shaft in contact with the ways, and the shaft itself bears on the inside of the rings where it is supported by a considerably greater area of contact, even when the rings are two or three times larger than its diameter.

An international congress will be held in Paris in June, 1905, with the object of investigating apparatus to insure the greater safety of workmen employed on high-tension conductors. The form the apparatus should take is a device indicating safely and clearly whether any conductor is alive or not. It must be equally applicable to direct and alternating current of all voltages, must be thoroughly reliable and incapable of doing damage to itself, the operator, or the distribution system under any circumstances. The congress is being organized by the "Association des Industriels de France contre les Accidents du Travail," and a prize of 6,000 francs will be awarded to the exhibitor whose apparatus most nearly fulfills the conditions. Intending exhibitors should send a full description, with necessary drawings, of their apparatus, to the president of the association, 3, Rue de Lutèce, Paris, before December 31 next. All systems presented will remain the property of the inventors, who should take the necessary measures to protect their rights. Further information may be obtained from the director of the association at the above address.

In the *Elect. World* and *Engineer* S. E. Doane gives a résumé of the different methods used for exhausting incandescent lamps, and considers seriatim their respective advantages and disadvantages. He deals at some length with mercury pumps of the Sprengel type, and the Geissler form of pumps, and points out that the chemical process of exhausting is the more satisfactory one than the mercury-pump system. The chemical process, which is fully described by the author, consists roughly of mechanically exhausting a heated lamp to a pressure represented by a column of mercury of 0.125 millimeter high. The lamp is sealed off from the pump, and phosphorus is vaporized, and passes into the lamp bulb while the filament is very hot, and while an electric current is passing through the gaseous contents of the bulb. The vapors of this metal enter into an electro-chemical combination with the gases, forming solid precipitates if the conditions are proper. A series of useful hints are given, which have to be observed if good results are to be expected. Much of the improvements in lamp quality can be traced to better methods of exhausting. The present existing system has its faults, and they are as follows: We must still depend upon the skill and judgment of the individual operator. We still depend upon a system of pipes and valves which will occasionally develop leaks. Pumps occasionally get out of order, and the chemical reactions which produce the vacuum are sensitive, and atmospheric and chemical conditions occasionally give us new problems.

C. P. Steinmetz has discovered that magnetite, the black oxide of iron, is suitable for use as an electrode in an arc lamp. From investigations which have been made with different materials, it appears that the arc flame issues from the negative terminal, and striking the positive produces heat. If the positive electrode cannot convey the heat away fast enough, it becomes hot, as in the case of the carbon arc. For this reason the flame-coloring substances are introduced into the positive electrode in the Bremer and other lamps. In the magnetite lamp the positive electrode is a copper segment, which is of such size that it does not get too hot, and therefore does not wear away, forming a permanent part of the lamp. On the other hand, it gets sufficiently hot to avoid the deposition of material on it which may be shot out from the negative electrode, consisting in this case of fused drops of magnetite. Among the conducting oxides magnetite is best suited for the arc lamp, since it conducts well, is stable at all temperatures, very plentiful in nature, and gives a white arc of high efficiency, about twice as great as that of the carbon arc. It burns at the rate of $\frac{1}{4}$ inch per hour, which is low as compared with the rate of burning of the flame arc, which is from 1 to 2 inches per hour. Other substances, such as titanium compounds, are, however, added to the magnetite to reduce the rate of burning. With small sacrifice of efficiency 8-inch electrodes can be produced which will burn for 500 to 600 hours. A simple and satisfactory form of electrode is that in which the material is compressed in the form of an impalpable powder within a thin iron tube, which is then sealed up in the arc. In this lamp none of the light comes from the positive terminal, but from the column of vapor, which is from $\frac{3}{4}$ inch to $1\frac{1}{4}$ inch long. The feeding mechanism is so arranged as to maintain the electrodes in fixed positions till the length of the arc has increased to such an extent as to cause the feeding arrangements to reset the arc to its original length.

ENGINEERING NOTES.

The United States consul at Birmingham, England, reports that some of the tube-making mills in his district are being "Americanized," skilled tube makers having been imported from Pittsburg and vicinity to reform the British system of tube making. The consul remarks that the men are brought over under five, three and one year contracts at wages several times greater than the ordinary wages paid in the Birmingham district, and at an advance over the wages paid for such labor in the Pittsburg district, but that there are some disappointments in store for them. In the first place the common impression abroad that living is cheap is erroneous—that is, on the scale to which the average American workman has been accustomed. Food and clothing are dearer than in the United States, and it is difficult to find houses with modern conveniences for rent that are within the reach of the imported workmen and near the works. Moreover, the imported men have to pay a good big income tax—something that they had not calculated on when accepting the job.

The problems of deep hoisting may perhaps be arbitrarily assigned to depths below 2,000 feet vertically. The iron mines of the Lake Superior district I believe have no shafts reaching this limit, but the copper country offers a variety of solutions of the problem. The depths here exceed those in any other locality, Tamarack No. 3 being 4,990 feet and No. 5, 4,935 feet deep vertically. The single vertical shaft of the Calumet & Hecla reaches 4,900 feet, while there are many shafts on the incline exceeding 5,000 feet. I believe that here there are more really great hoisting engines in a small area than can be found in any other district. That these engines are not of a single type, even when the service to be performed is identical, shows that the several designers have by no means arrived at an entirely satisfactory compromise of the conflicting requirements of the ideal deep hoist. To propose a solution solely from the viewpoint of the mechanical engineer is but to include half the elements of the problem, for the success of the hoist depends on a sympathetic treatment of the miner's needs, not only in times of smooth and normal running of mining affairs, but in times of disaster and mishap. Where the quantity of material to be handled through a single shaft is as great as it is in this district and where the cost of a shaft before the period of production may reach well toward the million mark, the interest cost due to a shut-down on account of the failure or complication of the hoisting mechanism must also be carefully considered in connection with the mechanical solution of the problem.—O. P. Hood, in *Mines and Minerals*.

Auxiliary relief valves were used some fifty years ago on steamboats on the Mississippi River, and old hoisting engineers report having seen them in use on the Comstock Lode at an early date. William Bates, hoisting engineer at Mine No. 5 (which shaft is now used as an escape shaft), Consolidated Coal Company, Staunton, Macoupin County, Ill., probably first applied the relief valve to Litchfield hoisting engines; and he doubtless was the first to use such valves in the Middle West. These particular engines are first-motion, 16-inch x 30-inch x 8 feet drum, and were among the first, if not the first, double-hoisting engines made by the Litchfield Car and Machine Company. They began the work of hoisting coal in October, 1881, and were run without a relief valve until July, 1882. During the eight months these engines were in operation, several accidents occurred, while new or strange engineers were lowering men in the morning, and the miners became timid. The engines would often come to a dead stop or rebound 10 or 20 feet up the shaft. Several men were injured by rebounds of cage while stepping on or off the cage at the shaft bottom. Mr. Bates conceived the relief valve (it is doubtful whether he had ever seen one, although they were in use in other parts of the country) and advocated its adoption in the face of some opposition. The relief valve was finally installed and adjusted to the requirements of the load, and the 250 miners were lowered in safety from this time on. Mr. Bates, who is still alive, and has kindly furnished this historical data, says he never heard of an accident in lowering men when the engineer used the relief valve. This is a rather strong statement to make, but I can say that in my experience the relief valve is a very valuable accessory to a hoisting engine. Our engines in the Middle West can reverse in less time than any other hoisting engines of which I know, and are easier handled than large engines not equipped with relief valves. The relief valve consists of an arrangement of pipes and a quick opening valve, located within easy distance of the hoisting engineer. These pipes are connected with the throttle on the dead side and discharge the steam or air into exhaust pipes near the cylinders. The object of the latter connection is to return the hot air, or steam, to the engines to be used over and over again to keep the cylinders hot, as an outside discharge would cause excessive cooling, especially in winter. The object of the relief valve is to regulate and maintain a uniform velocity when lowering heavy loads. Both engines are converted into air compressors when reversed against their run. The engineer simply discharges or retains the air to meet the requirements of load and speed. The relief valve is useful in discharging water due to condensation of steam in the steam pipes, in relieving steam pressure of the boilers when hoisting stops, preventing dangerous accumulations of steam pressure, keeping water hot in the heater, and, lastly, in avoiding danger due to runaway of engines, due to leaky throttle valves.—J. J. Rutledge, in *Mines and Minerals*.