sult is not very good, because the sensitive layers cannot be well placed in contact and owing to the inevitable loss of the brightness of the colors. The inventors, instead of fixing the developed plate as usual in the hypo bath, dissolve the reduced silver by means of the acid permanganate of potash method, then in daylight they proceed with the second development or reversal, which changes the plate to a positive plate and thus gives the actual colors of the object without needing a second plate. Thus in the first band, the reduced silver bromide which stops off the violet and green particles (leaving the orange) will dissolve in the permanganate bath. Upon placing in the reversing bath, the non-reduced bromide will now blacken under the orange particles. These will be masked, and as the green and violet are now uncovered, their mixture will give the sensation of blue for the first band. In the same way the black band will become white and the green, red, giving the original colors. For other shades of color the action is the same, and each colored particle lets the light pass which is needed for reproducing that special shade.

As to the manipulation of the plate, it is scarcely more complicated than for an ordinary plate. The first development by pyrogallic acid and ammonia is done in the dark quite automatically in a fixed time of 2½ minutes, which can be timed by an hour glass, keeping the plate away from the rays of the red lamp. After a good washing, the plate is plunged in a bath of acid permanganate and now white light can be used. In a few minutes the reduced silver is dissolved and the colors begin to appear, but they are faint. After washing, a second development is made by a diamidophenol bath, and this blackens the silver which is not reduced by the first development, giving a much greater brightness to the colors. After a rapid passage in a bath of dilute permanganate, the plate is intensified in a bath of pyrogallic acid and silver nitrate, when the colors become very brilliant. The plate is placed in neutral permanganate and then in an ordinary fixing bath. The operations are carried out rapidly and the whole takes but 15 or 20 minutes to obtain the colored plate. As the gelatine layer is nine or ten times thinner than the ordinary layer, the washings are reduced to a few minutes, and the drying is very rapid. A special varnish is added which increases the transparence and brightness of the colors, and protects the plate.

If the manipulations of the plate are simple, on the other hand the practical difficulties in the manufacture of the plates were considerable. A sifting process had to be devised which would give the grains of the proper diameter, then after coloring the grains they had to be well mixed so as to have a uniform layer. The colors must be permanent, and the grains spread on the plate in a single layer. A varnish had to be invented which was waterproof in a very thin layer and having an index of refraction near that of the particles, and this was a difficult point. The gelatine layer must be as sensitive as possible and be panchromatic, but as the best of panchromatic preparations give a much greater effect for the blue and violet, a yellow screen is needed for the camera, of special composition. One advantage of the new plates is that they give no halation. This phenomenon is due mainly to the reflection of the rays on the front surface of the glass plate, and the rays are sent upon the sensitive film with an intensity proportional to the thickness of the glass. Another cause is the diffusion of the light in the gelatine layer itself. In the new plates the first cause is quite suppressed, since the plates are placed backward. As to the diffusion in the layer, it is scarcely appreciable, owing to the very thin layer which is used. For these reasons there is scarcely any halo, and operators can take interiors, cathedral windows with brilliant colors, and especially the glowing colors of the sunset.

The process invented by Messrs. Lumière thus marks quite a step in advance, and color photography will no doubt come into extensive use. Besides the great interest for amateurs, it will render service in the different sciences. Explorers will thus have geographic, ethnologic, and botanic data of value. In astronomy, the new plates will be specially valuable for registering with scientific accuracy the colorations of phenomena of short duration, such as solar eclipses, Aurora borealis, solar halos, etc. In medicine we will have colored plates for anatomy and surgery. The time may not be far distant when we will be able to make colored photographic prints by an analogous method from such plates. At present, mechanical reproductions have already been made. L'Illustration was the first to demonstrate this and by the use of the well-known three-plate process it was able to publish some very fine views, in color, which for a first attempt are remarkable. Among these are a portrait of the king and queen of Norway, taken at Paris, also a view of soldiers, fruit and flowers, and a sunset on Lake Leman. A public demonstration of the process was made by the inventors at the lecture hall of the journal and aroused great interest.

THE RAIL SITUATION.

BY J. KENT SMITH.

The practical importance of the subject is supreme, for it is a case where the momentous elements of public safety and human life are involved, so that no cheeseparing in first cost can be considered; for such economy is ethically inadmissible, if it be gained at the expense of human safety.

The contention that the open-hearth rail must replace the present Bessemer rail is without a shadow of doubt absolutely sound, as not only can a steel of much greater purity be obtained as far as the usual elements reckoned injurious are concerned, but the open-hearth process admits of far greater regularity in product, and the liability of over-oxidized steel (a fruitful source of mischief) is greatly minimized. The pernicious effect of oxygen in steel has not received the full amount of recognition and investigation in the past that it should have had. This fact alone, putting aside any question of purifying unsuitable metal by substituting any modification of basic for acid Bessemer conversion, is a strong indication of the advisability of considering seriously a change in the process of the manufacture.

The Bessemer process (essentially a "hit and miss" one) has done yeoman service, and no one can gainsay the inestimable value which it has rendered to us, but *"Tempora mutantur, et nos mutamur in illis"*; and the plain fact is staring us in the face that the practical requirements of to-day have advanced beyond the pale of its usefulness. Thus its supersession should be viewed, not as summarily discharging an old employee who has well and faithfully served us, but rather as granting him an honored and well-earned retirement at the end of his useful period of service.

Here it is advisable to sound a note of warning to the engineer as to hasty deductions on wearing quality based on strictly comparative analytical data, as the careful observations of Harbord, Ridsdale, and Haarman in Europe, amply confirmed by other investigators in this country, show that a higher carbon content is necessary in "basic open-hearth steel" than in "acid Bessemer steel" to secure the same degree of surface hardness and static strength, keeping, of course, static ductility the same.

The manufacturer on the one hand minimizes, and the user on the other hand lays great stress upon, the injurious effects of piping and segregation. The mitigation of these troubles is very largely a question of mill practice; and it must be remembered that such phenomena are due to natural laws, and must be obviated as far as possible in methods of casting, stripping, reheating, etc., no matter what process of steel manufacture is indulged in, or what composition of steel is made. Details of casting temperature, etc., due to differentiation of the manufacturing process, have of course some influence as to their amount, and here again the open-hearth possesses manifest advantages.

Processes of fluid compression, either from the top, bottom, or side of the ingot, and of many varieties, have been devised, but it is entirely in the prevention of piping and segregation that these processes have virtue; for no one could contend reasonably that pressure applied to an incompressible fluid could change its fundamental attributes; and "working" the ingot sees to physical disposition of its components.

It is a moot point with many, if no doubt exists in the mind of the writer, as to whether judicious cropping of the vertically solidified and "soaked" ingot ("bleeding" and "running back the pipe" being thus averted) does not reasonably take care of piping and segregation troubles, when this procedure is rightly followed along the lines of good specifications.

No sane man would gainsay the desirability of absence of both segregation and piping; but the published experience of Mr. J. E. Stead (a most eminent metallurgist whose dicta are authoritative in every sense of the word, and whose experience, crudely but succinctly comprised, points to the fact that segregation generally occurs on the "neutral axis," and that approximately the same proportion of segregated rails leave the mill as are found broken in service) would seem to indicate that attempting to minimize these evils, while undoubtedly a step to the good, does not mean any serious attempt to ameliorate the *real* cause of most rail failures.

Statements have been made in the public press that every rail leaving the mills is already cracked at the junction of the web and flange, as a result of rolling to its present finished shape. To this view I cannot subscribe, though I am willing to fully admit that physical and mechanical considerations necessarily make this the weakest part of the rail.

To my mind the real reason lies in the development of that "potential brittleness" so extensively worked upon by Arnold, which is brought about by the continued hammering and rolling strains, combined with wave motion, due to the passage of heavy traffic at high rates of speed over metal that apparently was ***initially*** ductile. This brittleness is naturally developed at the weakest part. Therefore we must make the metal dynamically as good as possible, and much better than that now in use, consistently with such reasonable simplicity as makes this end commercially attainable.

Of all the alloys, vanadium has been proved, both by exhaustive scientific investigation and extended trial, to be so pre-eminent in this property of conferring upon steel resistance to repeated stresses (thus retarding the genesis of the brittleness spoken of) as to practically stand alone; and to its use we must, I am convinced, turn for a true solution of the problem. Nature teaches us the extraordinary value of the element in no uncertain manner, for certain Swedish irons which are distinguished by their "vitality" under trying conditions, contain notable quantities of vanadium.

And here I am able to give a word of encouragement to the steel maker and the consumer as to the ultimate economy attending the alloy's use. It is notorious that those steels which best combine non-brittleness with the presence of the hardening constituent carbide in its emulsified sorbitic form, are also those which wear best with safety; in fact, several processes, more or less elaborate and more or less practical, have been devised for treating carbon rails, in order to attain this sorbitizing action alone.

Now vanadium, when employed in judicious admixture, automatically produces well-disseminated sorbitic carbide; and consequently the first cost of a vanadium rail, comparable on all counts with that of a nickel-steel rail, may be more than repaid by increased duration of service; in which case insurance against accident will have been attained and present troubles overcome at no added expense in the long run.

ENGINEERING NOTES.

Without entering upon the relative merits of different structural materials, we refer here to three railway bridges with spans of 187 feet, 211 feet, and 211 feet, respectively, which have lately been erected in plain concrete on the three-hinged principle. All of the structures were designed by Mr. Beutel, chief engineer to the Bavarian state railways. One of them, at Lautrach, crosses the river Iller, with a main arch span of 187 feet, and two smaller arches at the abutments. As the rise of the main arch is only about one-sixth of the span, the three-hinged system is particularly advantageous. The arch rib in this instance carries cross walls connected by small arches surmounted by the road upon which the permanent-way is laid. The other two bridges cross the river Iller close to Kempten station, where there is a network of several branch lines. One of these bridges carries four railway tracks, and the other only two, but their structural features are practically identical, the main arch of each bridge having the clear span of 211 feet, with the rise of about four-ninths of the span. We are glad to say that all three bridges were finished without the casing of stone or other veneer which some engineers seem to imagine is necessary for decorative effect. It is stated that the cost of the Lautrach bridge was 17 per cent less, and the cost of the two Kempten bridges was nearly 20 per cent less than the estimated cost of steel bridges. The ultimate saving should be considerably more, owing to the fact that practically no maintenance is necessary in the case of concrete structures.

Believing that prompt and effective application of State laws and its own rules is the best preventive of accidents in anthracite coal mines, and realizing that the rules are readily forgotten unless constantly discussed, the Delaware, Lackawanna & Western Railroad has instituted a plan to hold competitive examinations every six months concerning the details of the regulations. State mining laws and company's rules must be on the "tongue's end" of every mine foreman, fire boss, barn boss, or driver boss employed in the D., L. & W. mines. The company's collieries have been divided into four districts, each under a superintendent and assistant. The districts each average about five collieries and examinations in each district will be carried out separately. An examining board, consisting of the general manager, his assistant, and the chief engineer, are to examine the men in a hall specially engaged for the purpose. To each man will be given practical questions to answer. A man's answers will indicate his knowledge of the application of State law or company's rules. After all examinations have been completed, the answers, recorded by a stenographer, will be carefully gone over and receive marks of relative merit. To the district showing the highest average for all men examined, will be awarded a handsome trophy which can be retained until the next competitive examination. If any district wins the trophy three times in succession, it is then to own it. Mine foremen and assistant foremen are examined by boards appointed by the State, before receiving certificates which permit them to hold their positions. The examinations conducted by the company are intended to supplement those prescribed by the State, and it is believed that their effect will be very beneficial.