the experiment, amounted to one millimeter (one twenty-fifth of an inch). The light, which in this way can be produced by the secondary wire of the induction coil, is seen in the form of a beautiful luminous band, which can be made to attain a much greater length than the induction spark obtained from the Rühmkorff coil alone. But this luminous band, in place of disappearing with the spark, is a permanent source of light, which gives as quiet and steady a light as any other known source. In regard to the intensity of the light, this depends on the amount of wire and the size of the induction coil.

As it is possible to insert a great number of induction coils in the current of a Gramme machine, and as further the induced current developed by every coil can be subdivided into different sections, it is possible to attain a perfect subdivision of the electric light. Nothing is easier than to obtain in this way say 50 luminous points, of any desired intensity.

In the experiments referred to, induction coils of various sizes were used. The intensity of the light was various in proportion to the size of the coils. The intensity of the various luminous points was graduated in such a way that the weakest gave a light of 1 to 2 Argand burners, while the strongest was made equal to 15 burners. When machines producing alternate currents are used to excite the Rühmkorff coils, the contact breakers and condensers of these coils become of course unnecessary. In this case the whole system of subdivision of the current can be reduced to one principal conducting wire, of which the function is performed by the primary wire of a Rühmkorff coil, around which then as many secondary coils are wound as secondary currents are required. Every luminous point is then perfectly independent of every other luminous point, and can be ignited or extinguished without interfering with the others. The division of a current in a building to be illuminated with electricity becomes then similar to gas illumination. In a manufactory the illumination may be so arranged that the large rooms are illuminated by electric candles, the office, the entrances, the halls, etc., by the electric bands. The apparatus for small halls is of a surprising simplicity, and consists of a small porcelain rod, which is kept in incandescent condition with very little wear.

To recapitulate the results obtained by Jablochkoff we may say that they consist: 1. In a perfect subdivision of the electric light. 2. Perfect steadiness of the thus subdivided light. 3. The possibility to give any luminous point every desired degree of intensity. 4. Dispensing entirely with the carbons in lamps of smaller and medium luminosity.

NEW INVESTIGATIONS ON COPPER ALLOYS.

Professor R. H. Thurston has recently conducted, at the Mechanical Laboratory of the Stevens Institute of Technology, an extended series of investigations into the properties of the copper-tin and copper-zinc alloys. From the records of the researches we have, through the courtesy of Professor Thurston, gathered the more important results obtained, and they are herewith presented.

COPPER-ZINC ALLOYS.

The experiments upon copper-zinc were begun by casting one series of 21 bars, each 28 inches in length and 1 inch square in section, and then a second series of 20 bars of similar size. In the first series the proportions of zinc and copper differed regularly for each bar, to the extent of 5 per cent, bar 1 containing 5 per cent of zinc, bar 2, 10 per cent, and so on up to 100 per cent of pure zinc. In the second series the first bar contained 2½ per cent, and the last 97½ per cent of zinc, the relative differences being the same.

By examination of the color of these various alloys it appears that they may be divided into three clearly marked classes, viz: the yellow alloys, which excludes all those containing less than 55 per cent of zinc; the silver white and brilliant alloys containing between 60 and 70 per cent of zinc, and the bluish-gray alloys, containing more than 75 per cent of zinc. On applying tests for transverse strength, it appears that the first class above noted may be divided into two divisions, one showing considerably more strength than the other; in the first are included the bars containing from 17·99 to 33·50 zinc (and probably all the alloys from pure copper to the latter limit). These show a modulus of rupture (by which is meant a value proportional to the transverse strength of a bar, and which is theoretically equivalent to 1½ times the load which would break a bar of 1 unit in length, breadth and depth, supported at both ends and loaded in the middle) from 21,000 to 28,000, and are characterized by great ductility and an earthy fracture. The second division includes alloys from 38·65 zinc to 52·28 zinc inclusive, which show greater strength than the preceding. The point of maximum strength is determined to be between 38·65 zinc and 44·94 zinc. The second class of alloys show great weakness and lack of ductility. The minimum strength was found in alloy of 65 per cent zinc, the modulus of rupture being but $\frac{1}{10}$ of the maximum. Alloys of the third class showed much greater strength than those of the second, but not equal to that of those of the first.

In tensile strength alloys containing up to 50 per cent zinc average 30,000 lbs. to the square inch and are classed as useful metals. 60, 65, and 70 per cent zinc alloys are very weak, the highest average being that of the 60 per cent alloy, which is 3727 lbs. to the square inch. The remainder of the 21, or third class, average from 18,065 to 5,400 lbs. per square inch; pure zinc being the weakest. The maximum strength is possessed by an alloy containing somewhat less than 44 per cent of zinc, and the minimum tenacity is 1,774 lbs. per square inch in an alloy of 70 per cent zinc. In torsional tests the average results agreed with the foregoing. In compression the 55 per cent alloy showed a maximum of 121,000 lbs. to the square inch, pure zinc yielding at 22,000 lbs. Tests conducted on the second series of alloys closely confirm the results already stated and need not be detailed.

It is well known that, no matter how accurately alloys may be compounded, chemical analysis of the metal after casting often reveals a notably different composition. In analyzing the copper-zinc alloys above noted it was found that the only general differences, between the components of the original mixtures and those determined by analysis, was that in almost every case a smaller percentage of zinc appeared and a larger percentage of copper. The real decrease of zinc is believed to be due to volatilization of the metal in melting and casting. The average loss was from 1 to 2 per cent in a bar. In several bars a considerable amount of liquation took place, and in general the upper end of the bar contained the highest percentage of copper.

The variation of specific gravity with change of composition follows a very definite law, decreasing very regularly with the increase in percentage of zinc. None of the zinc-copper alloys have a greater density than that of pure zinc, the only apparent exceptions being caused by the presence of pores and other flaws.

COPPER-TIN ALLOYS.

In the experiments on the copper-tin alloys, bars of the same size as already noted were first cast. Two series of alloys were prepared, the first numbering 30 compositions, beginning with pure copper and then varying in percentages of tin from 1·9 up to 99·44 and ending in pure tin. The second series consisted of 20 bars ranging from 97½ per cent copper and 2½ per cent tin to 97½ per cent tin and 2½ per cent copper, with a regular difference of 5 per cent.

Alloys containing respectively 1·9, 3·73, 7·20, 10, 13·43, 20, and 23·68 per cent tin were found to have considerable strength; and all the rest of series 1 are stated to be practically useless where strength is a requirement. The dividing line between the strong and brittle alloys is precisely that at which the color changes from golden yellow to silver white, viz: at a composition containing between 24 and 30 per cent of tin. Alloys containing more than 24 per cent of tin are comparatively valueless. Tests by tension give results according with the foregoing. Generally it appears that the tensile and compressive strengths of the alloys are in no way related to each other; that the torsional strength is closely proportional to the tensile strength, and that the transverse strength may depend in some degree upon the compressive strength; but it is much more nearly related to the tensile strength as is shown by the general correspondence of the curve of the transverse with that of the tensile strength. The maximum crushing strength was given by the 30 per cent tin alloy and the minimum by pure tin.

The results of the tests for transverse strength on the second series do not seem to corroborate the theory given by some writers that peculiar properties are possessed by the alloys which are compounded of simple multiples of their atomic weights or chemical equivalents, and that these properties are lost as the composition varies more or less from this definite constitution. It does appear that a certain percentage composition gives a maximum strength, and another certain percentage a minimum; but neither of these compositions are represented by simple multiples of the atomic weights. Besides, there appears to be a perfectly regular law of decrease from the maximum to the minimum strength, which does not seem to have any relation to the atomic proportions but only to the percentage composition. On analyzing the copper-tin alloys there appears to be a greater loss of tin than of copper in the bars which contain the greater percentage of copper, and a greater loss of copper, than of tin in the bars which contain the largest percentage of tin; and that the bars which contain about equal amounts of the two metals show a great tendency to liquation. In the alloys containing less than 35 per cent of tin by original mixture there is a greater loss of tin than of copper, with but three exceptions. In the alloys containing more than 70 per cent of tin, there is a greater loss of copper than of tin, with only one exception. In all of the alloys of these two classes the extreme variation of a single mixture is 3·6 per cent, and generally it is less than 1 per cent. It further appears that the actual specific gravities of all the alloys containing less than 25 per cent of tin does not greatly vary from 8·95.

BALANCING EMERY WHEELS.

The proper balancing of emery wheels is of great importance, because the great speed at which they revolve causes the least defect in the balancing to vibrate the wheel when in motion. This vibration causes undue wear to the wheel as well as tending to throw the wheel out of true. Of late cast iron spindles are being introduced for emery wheels above 10 inches in diameter, and they require very careful manufacture to properly balance them. In the first place the existence of air holes is a great disturbing element, and in the next place the position in the mould, in which the iron is cast, is found to be of practical importance, because the iron at the bottom is found to be more dense and heavier than that at the top. To remedy these defects, the castings were given very large gates or runners, the cope of the mould being made extra deep for that purpose. This, however, proved successful for the prevention of air holes, but not altogether so for equalizing the density, the difference between the top and bottom of the metal being very plainly perceptible. This led to the adoption of the plan of casting vertically as well as casting them in longer pieces, using only the lower end for the spindle. The result is, not only is the formation of air holes prevented, but the metal is at any part of its length of practically equal density diametrically. This, however, is of minor importance. The next consideration is to center the spindle to run as true as possible in the lathe, for the metal is always more dense at and towards the outside of the casting; and if more is turned off one side than the other the balance will be, to a like degree, affected. After the spindle is turned, its balance should be tested by placing it upon two knife-edged parallel pieces set horizontally true, and setting it in motion. Note the side that is downwards when the spindle comes to rest. If upon turning it upside down and end for end, and making several tests, the same side is always at the bottom when the spindle comes to rest, that side is the heaviest, and should be adjusted by boring a small hole, either in the end or upon the circumference.

The part of the spindle upon which the driving pulley fits should be made a neat driving fit to the pulley, so as to avoid the use of a key, which would destroy the balance. The centers of the spindle should be center drilled and countersunk, so that the spindle may keep true during the whole turning operation, the end faces being carefully turned true for the same purpose. The pulley should be cast with its diameter standing vertical, the hole should be bored out true and smooth, the wheel should be turned down to very nearly the finished size upon a temporary mandrel, and then placed in position upon the spindle and finished in the lathe while upon the spindle. Then the wheel and spindle together should be tried upon the knife-edged parallel strips in the same manner as the spindle was tested.

The washer should be cast flat and carefully turned true, the inside face being recessed to within about one quarter of inch of the circumference, which is done to ensure that it shall grip the wheel at and near its edge, thus holding it true as well supporting it as far out from the center as possible. The nut should be made very true, the thickness from the bore to each flat side being made quite equal. The best form of nut is a cylindrical one with two flat sides, which is the easiest form to make and ensure truth. The washer and nut should be placed upon the spindle, and the balancing of the whole again tested upon the parallel strips. The emery wheel may then be fastened upon the spindle, the bore being made a neat sliding fit, and then the strips should again be brought into requisition to test the balance while the whole are together. The wheel is very liable to require balancing, because it is very difficult to make a wheel of equal density throughout. If the wheel is out of balance it must be corrected in the wheel itself, and not by drilling holes in the spindle or pulley, because in that case the wheel, though balanced when new, will lose its balance as it wears smaller. It is necessary, therefore, to provide a center piece and to throw the wheel out of true in the lathe, taking care that the densest side is the prominent one; then by taking a cut down the radial face of the wheel, leaving it just true, the balance may be corrected. The center, however, should be thrown out but very little, and the balance tested. The process should be repeated till an exact adjustment is attained. By adjusting the balance in this manner, the spindle will, when once made, never require altering; and all that is necessary is to balance, in the manner described, each new wheel when it is put on, and the result will be sufficiently perfect for all practical use.

THE GREAT RAILROAD STRIKES.

The strike on the Baltimore and Ohio Railroad which commenced about the 16th inst. has assumed such character and proportions that the State authorities of Virginia were unable to cope with it, and the interference of United States authority has been called to quell the disturbance. If the organization of the train men is sufficiently perfect and extensive it will extend to many other roads. A strike and much trouble will result. It has already commenced on the Pennsylvania Central Road, and apprehensions of similar trouble are feared in Michigan. The strike on the Chesapeake and Ohio canal still continues. At Cincinnati developments indicate a strike on the several roads centering at that place. On the Central Ohio division, all freight trains have been detained. The employees of the Great Western Railroad of Canada are protesting against a reduction of wages, but have made no other move.

The employees of the western division of the Erie road have struck, demanding the pay received before the reduction and a free lease of property to squatters on the roadlands, and free passes to firemen, brakemen, switchmen, and trackmen, which the company refuse. Prospects are that the Ohio and Mississippi road may be included among the strike. The trouble on the Pittsburgh and Fort Wayne road is assuming a serious aspect. Meetings are being held by the employees of the Union Pacific, and an outbreak is feared.

The central council of the Labor League of the United States held a meeting at Washington and have recommended moderation and to avoid strikes, and resolved that moral agitation is the strength and power by which labor can acquire tangible reformation and that mob violence and riot lead only to anarchy and final destruction of human liberty.

SHELLAC dissolved in alcohol will be found to be a good cement for broken furniture.