dynamos could be connected with either of the three engines. The wires leading to the switchboard were carefully protected, as in the large central stations which have been established in New York city and elsewhere by the United States Electric Lighting Company, which, as said before, uses the Weston patents. Any combination can be made by means of this switchboard with any combinations of machines, and by means of cables the circuits are connected with the machines. A plug on either end of the cables serves, the one end to connect with the circuits, the other with the machines. In order to prevent lightning from reaching the dynamos during thunder storms, lightning arresters are affixed to each circuit. From the switchboard the circuits are extended, and so arranged that the lamps may be adjusted to each circuit. It does not injure the outside circuit when these lamps are either placed in position or removed. All the lamps are tested upon the circuit upon which they are to be used before being regularly adjusted on the line.

The types of dynamo machines exhibited for the arc and incandescence systems, as devised by Weston, do not materially differ, save in the winding of the armature and field coils, these being somewhat modified in order to produce the different kinds of currents that are demanded. The current generated by these machines does not pulsate, but, on the contrary, is continuous, which, besides giving a very steady light, is less dangerous than that of the pulsating type.

In the Weston arc lamps exhibited, the arc or distance between the carbons is short, being one thirty-second of an inch in length or thereabouts. There is a palpable advantage in this, for it permits a given number of lamps to be worked with a current the tension of which is correspondingly low.

The large incandescence lamps shown in such profusion in the Weston exhibit were really the only lamps in the Exposition which showed a new and important departure in this type of illumination, although there were those of the smaller description which exhibited marked improvement when considered from an economical standpoint. The big lamp can be used in multiple arc or multiple series at points far removed from the generator.

In the Weston dynamo the current generated has an E. M. F. of 1,500 volts. In the two great incandescence machines exhibited the E. M. F. was shown to be of 160 volts, the small lamp machines having an E. M. F. of 120 volts or thereabouts. The field magnet of the Weston machine resembles the letter C, having the poles in the center; the magnets are wound in shunt circuit, and are oblong in section.

The armature, which revolves between the poles, is composed of a core of iron disks strung like beads upon the shaft, being insulated the one from the other by disks of paper. The type of cylinder thus constructed may be said to be a modification of that employed in the Siemens machine. There are numerous coils, which serve to equalize the current generated, and brass bearings serve to insulate the shaft from the magnet.

In the automatic rheostat exhibited in connection with the arc lights, a magnet wound in shunt circuit attracts an armature connected with ratchet wheels. When, by reason of the turning off of lights, the current shows too great intensity, the armature acts, rotates the wheel, and this leads to more resistance being thrown into the field circuit. The field magnets, as a consequence, exert less magnetism; a smaller current results, and the power which has been driving the machine may be reduced. The resistance is released by an opposite process, and the full power of the shunt circuit may be thrown upon the magnet.

The incandescence system of lighting must be able, if it would be generally employed, to compete with gas in cost. Hence it may not prove uninteresting, having described the Weston incandescence light, to explain what it has accomplished when practically compared in cost with gas by persons having no interest in the one or the other. A large manufacturing firm of Olneyville, R. I., recently tested two Weston dynamo machines, one of one hundred lights capacity and the other of fifty lights. The test was made during an entire year, from April 15, 1883, to April 15, 1884 —3,397 hours, an average of 11 hours each working day; the object being to discover whether incandescence lighting or gas was the cheapest. The following figures were given by the firm as the result of their experience:

Number of lamps in the two circuits	170
Number of lamps broken in 3,400 hours	133
Average life of lamps	2,207 hours.

The cost of operating for the entire year was as follows:

133 lamps broken, at $1.50 each	$199.50
Cost of power	500.00
Cost of attendance	468.00
Cost of brushes, oil, and other supplies	52.00
Interest, 6 per cent, on $4,100	246.00
Total	$1,465.50

They compare this with what they had previously paid for gas as hereunder:

Cost of gas, 170 seven-foot burners, 3,397 hours, 4,042,430 feet of gas, at $2.00 per M	$8,048.86

In Providence, where they say gas may be had for $1.75 per M., this cost would have been reduced to $7,074.26. This shows, as they say, that their Weston incandescence lamps cost them only one-fourth cent per lamp per hour, which is equivalent to gas at 37 cents per thousand feet.

ACCORDING to the last annual report, the American Association for the Advancement of Science had 2,011 members.

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COMPOSITE STEEL AND IRON.

According to the recently published statements of a master railroad car builder, the union of ordinary machinery steel scrap with iron scrap in making a pile for forging into bars is ruinous to the entire work. The bars showed handsomely on the surface, but when broken the fracture showed that the metal was unsound and not homogeneous; the steel and iron had not welded. In some of the bars the flaws were in the form of wide cracks, while in others there were seams completely separating the two metals; true welding had nowhere taken place.

If this result of experiments is to be received as conclusive, working mechanics must have been greatly mistaken in their estimates of machinery and other low steels. The general belief has been that these steels were so scarcely removed from iron that their union by welding was one of the easiest of processes. We find no difficulty in uniting by welding the highest cast steel with iron; all our large cutting implements are so made; and the union of the two is not a mere cementing or gluing together, but is a chemical combination. It is somewhat singular (if it is true) that low steel and iron cannot be thoroughly united under the influence of the welding heat and the compressive action of making a bar from a fagot. Certainly such a union is possible; for in the ordinary scythe there are three equally longitudinal strips of iron, low steel, and crucible steel, and it would be difficult to find cracks or seams in any one of the thousands of scythe blades turned out every week from the factories of Western Connecticut. The report of the master car builder was probably based upon imperfectly recorded experiments.

USES OF GAS PIPE.

The machine shop is a great user up of "unconsidered trifles"—at least the job shop is. There was a shrewd job shop machinist in an Eastern city who procured a large portion of his stock at the junk shops or the sale of the results of fires. Gas pipe, shafting, iron plates, rods, bars, and all sorts of metallic fixtures found a congenial home in his shop. Gas pipe he doted on. From pipe he fashioned a number of articles which otherwise would have been made of the solid bar.

Gas pipe of convenient diameters was cut off in the lathe to lengths, plugged at one end with iron, and at the other end with iron and steel, and welded and finished into barrels for ratchet drills. The iron plug was drilled and tapped to receive the screw of the drill, and the iron plug with a steel center became the conical top of the barrel. The barrel thus made was sufficiently strong, was much lighter than one made from solid iron, and cheaper.

A very particular workman at the lathe, who prided himself on his skill with the hand tool, made a set of handles for his turning tools from gas pipe. He cut off the pipe to length; heated and drew it near the end by means of "fuller" and the anvil horn; turned and polished it; filled it half full or more of plaster of Paris; then put the shank of a tool in the handle, and poured melted lead around it. The tool could be readily removed, and the lead held the shank or tang of another tool just as closely as the first.

For bolting work to a chuck on lathe or drill, or securing it to a planer or boring machine, long washers—tubes—are frequently required. If thin washers are used, it is almost impossible to get a hold on a pile of twenty or more so as to be secure. Varying lengths of gas pipe do the business thoroughly.

It is possible to make very effective hollow shafts for some small machines from piping; there is generally stock left enough after turning and finishing to secure a pulley, or other wheel, by set screw or key; or in some cases the pulley, if of iron, may be shrunk on.

For truing the grindstone there is no better hand implement than a piece of gas pipe from half inch to full inch, according to the fancy of the workman. Such a razer will always present a cutting edge.

DRILLING AND BORING WOOD.

The hand drill or breast drill, originally intended for the hand drilling of metals, has taken its place among woodworking tools, In many instances it has displaced the bit-brace, or at least has filled a requirement left unsatisfactorily supplied by the bit-brace. The breast drill may be used for drill, gimlet, or bit, and its speed—on the best forms—may be changed at will without a change of speed of the hand. It has its advantage, also, in the more natural motion of the hand—the vertical crank movement instead of the horizontal crank motion. A drilled hole in wood, for whatever purpose, is better than a bored hole. The drill cuts a clean hole; not merely finding its way between the fibers by displacing them, but removing the material entire as it advances. The gimlet form of wood borer is crude at best; a thread at the end is supposed to enter the solid wood, and by spiral friction pull the cutting portion after it. This cutting portion is a twist like a twist drill or auger, supposed to deliver the chips—which it never does deliver. The pressure of the hand is necessary to force the gimlet into the wood, and the pull of the hand is required to release it and empty the chips.

The drill cuts a clean hole, and has none of the objections of the gimlet. Unlike the gimlet, it may be resharpened so long as it lasts. Its speed in the breast drill is very much greater than that of the gimlet in the bit-brace.