

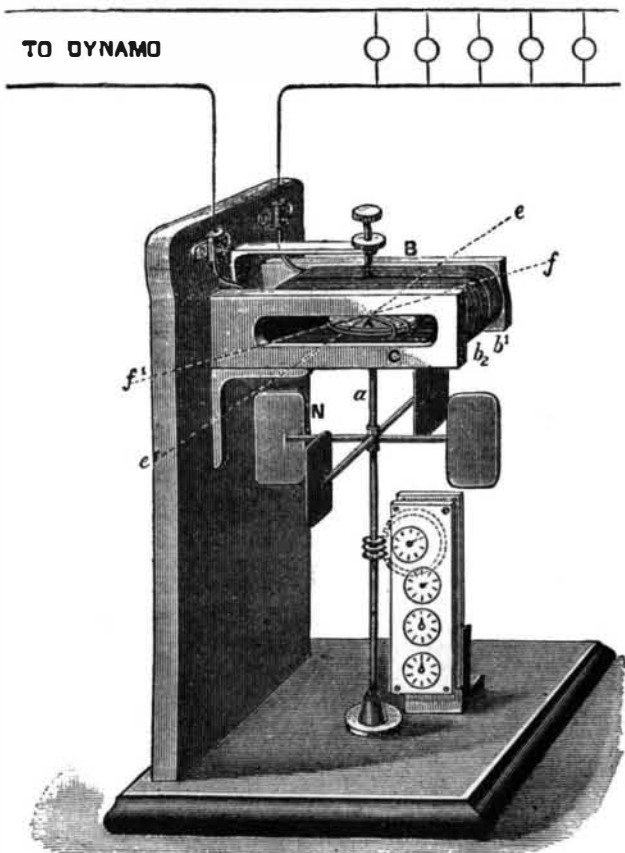
to drive over the mountains, some 150 miles, to Tiflis, whence train would be again taken to Baku, on the western shore of the Caspian. Thence a steamer would convey him to Ouzoun Ada, the western terminus of the Transcasian Railway, from which place the line now runs to the once famed capital of Tamerlane—Samarkand. An interesting account of the journey has been given by the St. Petersburg correspondent of the *Times*, whose narrative does not inspire the reader with any frantic desire to follow his example until the traffic arrangements have been somewhat improved. With the exception of bridging three rivers, the Tejend, the Murghab, and the Amou Darfa (or Oxus), few engineering difficulties have been encountered—the chief difficulties to contend with being the shifting and drifting sands and the liability of certain parts of the line to be suddenly flooded. These have been combated by the planting of a curious shrub, "saxaul," which takes root in the sand, and eventually forms a protective screen, and by the construction of numerous conduits to carry off the flood water. The line has been very cheaply built, costing without rails about 2,850¢ per mile, native labor at a few pence a day being utilized, and General Annenkoff had a special train fitted up as bedroom, dining room, kitchen and all, so as to be always in the van.

As the rails were laid down, on moved the train. The ordinary carriages on the line at present can hardly be termed luxurious. There are no first-class, but in the scorching weather of a Central Asian summer cushions would be decidedly at a discount—the pleasantest part of the train being the upper or third-class story of the carriage; for many of the carriages, as may be seen in one of our illustrations, have two floors. The fuel used in the engine is petroleum. To return to Ouzoun Ada, the *Times* correspondent describes it as "a bivouac on the edge of the desert." A number of slight, narrow wooden piers jutting out all round the semicircular sandy bay, a few dozen sailing brigs, barges, and small craft, and two or three steamers at anchor, with straggling rows and clusters of small wooden houses, huts, and warehouses, belonging to the railway officials and different shipping companies, the whole framed in all round by hills and mounds of sand as far as one can see from the water—such is a picture of Ouzoun Ada. We will further describe the route in our subsequent articles, but we may mention here the bridge at Chardjui, across the Amou Darfa, or Oxus, shown in our illustration, which is a light structure of wooden piers, and stretches nearly two miles across the wide river bed, including an intervening island.

The first or principal bridge is 5,740 English feet in length, and there are two smaller bridges near the Bokharan side. As we have said, the line has been mainly constructed by General L. M. Annenkoff, one of the most distinguished officers in the Russian service, who had had railway construction experience in Lithuania. General Annenkoff himself took part in the last Central Asian campaign, and was wounded by the side of General Skobelev at the taking of Geok Tepe, which now forms one of the chief stations at which the "Shaitan Arba," or Devil's Cart, as the locomotive is known out there, now halts. He showed the most untiring energy, and among the workmen he was called the "nagaika," or whip, of construction, on account of the indefatigable manner in which he urged on everything and everybody. He has been rewarded by the Czar with the Order of St. Alexander Newsky, the appointment as chief director of the line for twenty years, and by a congratulatory imperial rescript, in which the Czar wrote: "For three years you have labored with characteristic energy at the accomplishment of this task, sparing neither health nor strength, in a constant struggle against natural obstacles which seemed almost insurmountable."—*London Graphic*.

SHALLENBERGER ALTERNATING CURRENT METER.

We illustrate in the accompanying engraving a form of electric meter designed by Mr. O. B. Shallenberger,



THE SHALLENBERGER METER.

electrician of the Westinghouse Electric Company, and in which electrical energy is converted into mechanical motion, the rate of which is directly proportional to the

energy being consumed. We take our account from the *Electrical World* of New York.

The principal elements employed in the construction of the meter are—first, an armature of metal capable of rotation; second, an electric circuit, which is so arranged that when it is traversed by alternating electric currents a field of force is induced having a given polar line or axis with reference to the armature; and third, a circuit so related to the first circuit that currents are produced in such second circuit by the action of those in the first, the phases of which succeed those of the currents in the first circuit and set up for the armature a second field of force, the axis of which intersects that of the first. The armature may be built of soft iron, or of copper or other non-magnetic metal, or it may be composed of a core of soft iron having a conducting circuit of other material surrounding.

Referring to the engraving, A represents a circular armature mounted upon a shaft, *a*, and placed within a coil, B. The coil is made in two sections, *b*¹, *b*², for convenience of construction, the shaft, *a*, passing between the two.

Alternating electric currents traversing this coil tend to establish a field of force whose polar line or axis is approximately in the direction, *ee*, at right angles to the shaft, *a*. A second conductor, C, is placed in inductive relation to the conductor, B, and armature, A. This conductor is closed upon itself. It is placed with its magnetic axis at an inclination to that of the coil, B. Alternating electric currents traversing the conductor, C, establish a field of force for the armature, whose polar line or magnetic axis is approximately in the direction, *ff*—that is to say, inclined with reference to the polar line of the coil, B. It is found in practice that when the coil, B, is traversed by alternating electric currents, the armature will revolve.

In order to produce a rate of rotation of the armature proportional to the amount of energy supplied to the circuit, it is necessary that some retarding force should increase in its effect by the same law as that of the rotating effect produced by the current. If, for example, the tendency to rotation increases as the square of the current, then the retarding effect should increase as the square of the speed. Such a definite law of increase of retardation is secured by the application of fans or vanes, N, fixed to the shaft, *a*. The resistance offered by the air to the rotation of these vanes affords the required retardation.

This meter is said to respond to the currents traversing the coils, B, in such a manner as to obtain a reliable and accurate measurement of the current, the number of revolutions performed in a given time being directly proportional to the current consumed during that time.

It is found, in practice, that the resistance of the coil, B, may be made very small, and the current consumed in operating the meter itself quite insignificant.

The number of ampere hours are recorded by the registering train geared to the shaft.

ELECTRIC WELDING.*

By OTIS K. STUART.

THE process of electric welding, which was discovered by Professor Thomson some eleven years ago, while lecturing at the Franklin Institute of Philadelphia, has been developed in the past two years to a far greater extent than is generally supposed. We started in with the welding together of small wires of iron and copper, and have been so successful in the development of apparatus that we are now able to weld bars of a very large size and of almost any shape or metal.

The principle involved is that of forcing through a conductor an amount of current which the conductor will not carry without heating. Any conductors when placed in abutment have as their point of greatest resistance the point of abutment or contact, and consequently it is at this point that the heat is first generated; and as is well known, this heat increases the resistance of the conductors at that point so greatly that more heat is developed at a remarkably rapid rate.

A consideration of the above facts will prove at once one of the advantages of electric welding, as practiced by Professor Thomson, namely, the localization of the heat to the points or point at which it is desired, thus saving an enormous amount of energy which is usually wasted in welding with the forge or flame. So absolutely is the heat localized, that pieces of iron 3' long and an inch in diameter can be welded together and then held in the hands for some time without any danger of burning, the only heat which is felt at all being that which is conducted along the metal to the hands after the welding is completed.

A further consideration of these facts will also demonstrate that it is possible by the Thomson process to weld any metal, including even those which melt at a very low temperature, such as lead, zinc, and tin, and those which melt at enormously high temperatures, as for instance iridium, platinum, etc. Of course it goes without saying that we can weld any of the metals used in ordinary manufacture.

It is plain that if the heat is developed so rapidly, a very delicate means of controlling it must be provided, and we are glad to say that we have been able to provide arrangements for this purpose which are almost absolutely perfect—I am inclined to say absolutely perfect, for the reason that the control of the current can be made entirely automatic.

We are able to take a bar of inch iron 4' in length, raise it to a dull red in twenty seconds and hold it there for an indefinite period; to increase the heat to a bright red in a very few seconds, and hold it there; then to still further raise the temperature to a welding or vaporizing point, in a remarkably short space of time. This indicates the delicacy of this apparatus, and I would add that no very great skill is required to operate the machine, a boy learning to weld iron and steel with great facility in a week or two. The time required to weld metals depends, of course, upon the power of the apparatus and the skill of the operator. We have made strong and practically perfect welds in half-inch round wrought iron in six seconds; in inch round wrought iron in forty-five seconds; and so on. Experiments have proved to us that the power required to weld is proportional, or very nearly so, to the area of cross section of the pieces; this is true of nearly all

* A paper read before the Association of Railway Telegraph Superintendents, New York, July, 1888.

the metals, though, of course, the relative resistance and welding temperature of the several metals may interfere with this ratio.

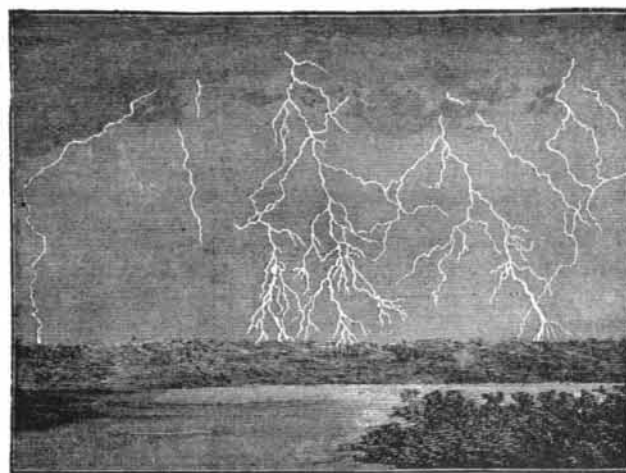
For welding small wires, such as telegraph or telephone, and the smaller sizes of electric light and power lines, the power required is very small indeed; the momentum of heavy machinery being more than enough to effect the weld. In this connection I desire to say that we are now working to perfect an apparatus for welding telegraph, telephone, and electric light wires and lines of pipe on the line. Our experiments in this direction have been successful, and we now think it possible to construct an apparatus which will be capable of being moved about by one or two men, and which will make joints in wires correctly and durably, the energy used being supplied by storage battery or batteries, forming a welding outfit. For repair work and in general construction it is our belief that this apparatus will be found very useful and effective; in fact, we hope to do away entirely with the ordinary solder and link joints used at present.

The cost of such an apparatus will be very slight, and there would be a small royalty of a definite amount per 100 or 1,000 welds, as the case might be. This policy of placing an apparatus on the market has been adopted for the reason that our patents cover not only the apparatus for electric welding, but the art or process as practiced by Professor Thomson. It is hardly necessary to add that, by the same process, we can solder, and braze, and anneal, and temper, and do other heating, local or otherwise, which cannot be done economically by present methods. All these operations can be performed with the same apparatus, though, of course, it is better to have machines specially constructed for particular work.

At the conclusion of the reading Mr. Lang stated that he had seen one of these machines in operation when a bar of cast steel and one of copper were welded together.

One would suppose that the metal most easily fused would burn away before the other was brought to a welding heat. This is not the case, however, and it is very simply provided against. The current is brought to the bars through clamps which grasp the bars near to the ends to be welded, and the current is brought through these clamps. Where copper and steel are to be welded together, the clamp is placed about six inches back on the copper bar, while it is only about one inch from the point of contact on the steel bar. In this case the heat is diffused through a large body of the metal which is most fusible, so that they are both brought to a welding point at the same time. The process is something really wonderful, and promises to revolutionize the ordinary method. In reply to an inquiry by Mr. Lattig, Mr. Lang stated that the system is now in constant use at the Thomson-Houston factory in Lynn.

PHOTOGRAPH OF A LIGHTNING FLASH, TAKEN AT WAKEFIELD, MASS.



THE above figure represents a remarkable lightning flash which was photographed recently during a storm at Wakefield, Mass.

PROTECTION OF WATCHES AGAINST MAGNETISM.*

By C. J. H. WOODBURY, Boston, Mass.

THE growing and even general use of electricity for illumination and for the transmission of power has added much to the knowledge of electrical phenomena, and also called the general attention of the public to matters long known to those familiar with physical science.

The introduction of iron ships first presented new problems of compass adjustment and chronometer protection, in which the disturbing effect of the magnetism in large masses of iron is compensated by means of smaller masses of iron, arranged to turn or to counteract these lines of force.

Public attention was first called to the influence of magnetism on watches at the Paris Electrical Exposition, where visitors could leave their watches near the entrance—an arrangement which gave wits ample opportunity for comparisons with pawnbrokers and bathing houses.

My first experience with the effects of electricity on a watch was comparable to that of the good old soul who was advised to try electricity for some chronic ailment, and declined, saying that she was struck by lightning several years before, and it had not done her "a morsel of good."

I was struck by lightning in July, 1881, at a time when I was thoroughly drenched with water; and the only permanent damage was received by my watch, which was marked on the back of the case with two straight black stripes, each about half an inch in width, extending across the back and joined together at one end like a letter V. Three of the arbors in the movement were broken, but there was no discoloration except on the outside.

Another watch, which possessed a remarkably uniform rate, and was highly valued for its accuracy,

* Read before the American Association at Cleveland.