Correspondence.

Galvanic Action of Copper Sheathing.

To the Editor of the SCIENTIFIC AMERICAN :

Apropos of article as above in issue of October 6, 1900, it is a matter of great surprise to me that the British Admiralty should not know of the dangers of the copper-steel sea-water combination. Years ago it was common practice to put copper strainers or bilge "strums" at the ends of the suction pipes of bilge pumps in wooden steamships. In course of time, when iron replaced wood in shipbuilding, the copper strainers were retained ; several mysterious losses of ships at sea during fair weather occurred. One steamer went down at her moorings in the Mersey. When she was raised, it was found that there was a round hole in her bottom where the copper strainer had been. This led to investigation, and it was discovered that in many iron boats, where the inner coating of Portland cement (which is usually put in the bilges of iron and steel vessels) had been removed by any means, so that the copper strainer could rest directly upon the iron shell, the galvanic action had eaten the iron almost entirely through.

Lead strainers are now used, and lead bilge suction pipes to a great extent.

I was in an old boat, the "Memling," of Glasgow (subsequently lost on the African coast), that had a patch in the bilge plate where the copper strainer had been, and the old chief told me that when he discovered the weak place one day, when in port, he drove his machinist's hammer through it in testing the strength of the plates. E. A. SUVERKROP.

Philadelphia, Pa., October 13, 1900.

Extending Applications of Alternating Machines.

BY ALTON D. ADAMS.

Alternating electric currents came first into general use for incandescent lighting at a distance. The comparatively low voltage of incandescent lamps, which during more than ten years remained at a maximum of about 125, was a strong incentive to the development of the high-pressure alternating system. With these lamps the direct system has an economic radius of distribution approximating one-quarter mile on the two-wire and one mile on the three-wire plan. Alternating dynamos of one thousand volts, as first introduced, raised the distribution limits, so far as mere weight of copper conductors is concerned, to sixteen miles from the central plant. As a matter of practice, the distance to which energy from the 1,000-volt alternators can be taken with profit is only a fraction of that for constant weight of primary conductors, because of the costs and losses in transformers and other items. Next in the important applications of alternating machinery was that for the long distance transmission of power. This was accomplished on a moderate scale, at pressures of several thousand volts, by the aid of synchronous motors, either with or without transformers. Some advantages existed in this plan over that for power transmission with direct currents, but a material drawback was the necessity for some external source of power to bring the speed of each motor up to synchronism with that of its generator before it would operate. Obvious advantages of alternating machinery for very high voltages and the transmission of power turned much attention to the development of a self-starting alternating motor. The desired result was achieved in the induction motor, adapted to operate on the two-phase or three-phase alternating system. It was soon recognized that the equipment just named is pre-eminent in its advantages for most cases of long distance transmission, and it was generally adopted.

In many instances energy is now being transmitted on the multiphase systems over distances under 50 miles and for a much smaller number of cases over distances of more than 100 miles. While the development of alternating apparatus for distant transmission purposes was going on, its application to the distribution of energy, for lighting and power, from central electric stations was rapidly being extended. The problems of transmission and distribution, now before many electric stations, involve higher voltages, great distances and enormous outputs. Meantime all of the requirements of consumption as to series arc circuits, low pressure supply and service to direct current motors remain. Above all is the desirability of uniformity, multiple operation and complete flexibility of each unit as to all of the load, at the last named plants. The multiphase system seems, by far, the best suited to meet these diverse requirements, and is already extensively applied for the purpose. Small, cumbersome and inefficient dynamos of the series type, for arc lamps, are being replaced by constant current transformers that take their energy from the large alternating generators and are used to supply the series lines. The same generators furnish energy at high pressure to circuits for incandescent lighting and motive power through transformers at considerable distances. Still other lines connect the main generating plant with as many substations as are desired. At these latter are located transformers and rotary converters that supply low-pressure direct current to thickly grouped consumers within a short radius. The diverse forms of electric energy thus delivered are all derived from the output at the main alternating generators. For such plants, the original voltage of 1,000 for alternators has usually been increased to over 6,000. Even in smaller systems, where the substation feature is omitted, the voltage of alternators has commonly risen to 2,000 or 3,000.

In plants of only moderate size the two and three phase alternators are now being installed in preference to those of single phase, because of the ease with which motive power as well as lighting can be distributed from the two former types. Such alternating equipment thus enables electric motors, series lines for street lighting and constant pressure service for incandescent lamps to be economically rendered by the same machines at a single station. During nearly fifteen years isolated electric plants were considered the peculiar and exclusive field for direct-current machines. The very extensive adoption of electric motive power in industrial works has done much to change the type of dynamo equipment in isolated plants from direct to alternating. Such changes have been particularly prominent in manufactories having long, heavy and uniform loads, such as textile mills. For these kinds of work all of the advantages of the induction motor, such as the absence of commutator and immunity from damage to working parts by grease and dirt, are available, while questions as to frequent stopping, starting and variable speeds do not have to be considered. At the present time, as during the past five years, the installation of alternating machinery for both light and power in certain kinds of industrial plants is going on at a rapid rate. The voltage of these isolated alternating plants is by no means uniform, nor is practice as to the use of transformers for the motors with them. In cases where steam power is used to drive the electric generators, pressures of 250 and of 500 volts have frequently been employed, and transformers between the dynamos and motors omitted. Water power at varying distances has been made available to drive the generators in other instances, so that comparatively high voltages were necessary for economy of conductors.

Those plants that combine transmission from a distance with power and light distribution in industrial works necessarily include transformers for the reduction of voltage at motors as well as at lamps. Perhaps the latest field entered by alternating equipment is that of distribution over a limited area, at low pressure, from a generating station whose circuits connect directly with lamps and other consuming apparatus at consumer's premises. Central stations of this class, like isolated plants, have been considered the especial province of direct-current dynamos. Several central stations are now in operation, however, that distribute energy from alternating generators, to moderate distances, without the intervention of transformers. Advantages claimed for the alternating over the direct current equipment, for this low pressure service, are those arising from the absence of commutators and a somewhat larger output per unit weight of material where multiphase apparatus is employed. Owing to the inability of alternating generators to regulate when connected on the three-wire system, these alternating stations at low pressure are limited to the maximum voltage of incandescent lamps, or about 250, on their lighting circuits. Since the inception of electric street railways, their generating plants have had distinct features as to voltage and type of equipment. A voltage of about 500 was early adopted and has since remained standard. Instead of the diversified equipment frequently found in the stations of systems for commercial light and power, street railway plants usually contain but a single type of dynamos, those for direct current output at 500 to 600 volts. As an alternating motor that is satisfactory for street railway service is not yet in sight, there seemed for a long time little opening for alternating dynamos in street railway plants, but this is now changed.

While the limits of single street railway systems have been constantly extending, the highest practicable voltage at the motors has remained at about 500. Such conditions have resulted in very large investments for line conductors, excessive line losses, and often in several generating stations for a single street railway system. A necessity has long been felt for a method of distribution between railway generators and car motors that would reduce the present number of generating plants, increase the size of the remainder, and cut down the costs and losses for line conductors. Alternating equipment has been selected to meet these requirements in a way similar to that by which it supplies low-pressure direct current for lighting and stationary motors. In a few of the more recent generating plants for street railways, and especially in one, the largest power station in the world, three-phase alternating dynamos deliver the electric energy at pressures as high as 6,000 volts. This high-pressure energy is transmitted to any desired number of points at suitable locations along the electric track system, and there changed to direct current at 500 volts by means of transformers and rotary converters. The high voltage at the main plant enables it to supply distant parts of a railway system at a small first cost and small subsequent loss for the conductor system. The small substations, delivering 500-volt current, give to the car motors the same form of energy they would receive if supplied from the usual type of street railway generators. One other important case in which alternating dynamos are being substituted for the purely direct-current type remains to be noted. Among the large class of low-pressure, direct-current stations that distribute energy for light and power on the three-wire system, there are many instances where tractive loads are presented beyond economic limits.

A similar condition exists in many electric railway systems, where much of the track is easily served from 500-volt generators, but a part is at a great disadvantage because of its distant location. For some of these cases double current generators have made it possible to supply both the near-by and the distant loads from the same machines. Double-current generators deliver both direct and alternating currents from the same armature windings, but to different circuits. The direct current flows with that from other machines, through the low-pressure system. The alternating current passes to station transformers, and the energy is thence delivered at high pressure on circuits that feed distant loads. When the current of high voltage reaches the place of use, it is received by transformers only for lighting, or by transformers and rotary converters for service to street railway motors or other direct-current apparatus. The brief glance just given to advances in the applications of alternating machinery shows that it has invaded most of the fields where the direct type seemed most secure. It is now a pertinent question whether the conquest is to be complete. By far the most important factors that have operated to make possible this great increase in the applications of alternating equipments are the induction motor and the rotary converter. Long distance transmission, and alternating-current distribution from central stations and in industrial works, for motive power purposes, depend to a very large extent on induction motors. Direct-current supply from alternating transmission lines, whether for general purposes or street car motors, is effected through rotary converters. It is notable that most extensions of alternating equipment have been made, not to supply new uses for electric energy, but as a means of economy in existing applications. It is to be remarked that while the alternating has in many instances taken the place of the direct type of generators, the direct-current form of energy continues to be delivered, to a large extent, at the points of use. This last is notably true for by far the great majority of electric motors supplied from central stations, whether for stationary or street railway purposes. Secondary batteries for the storage and regulation of electric energy can never come into immediate connection with alternating machinery. The current as delivered to or received from the batteries must in every case have a constant direction of flow. This last is also true in all of the growing applications of electric energy to chemical operations.

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Successful Wood Sheathing.

Chief Naval Constructor Admiral Hichborn has submitted to the Navy Department a report on the "Bache," as to the utility of sheathing naval vessels. The Admiral's conclusions are as follows : To summarize, it may be stated that this vessel, not originally intended to be sheathed, was nine years after her launching fitted with a system of sheathing which involved a neglect of some of the most obvious precautions in such work. She served thirteen years continuously without an examination of or repairs to her sheathing or sheathing bolts, and is to-day in active service, though nearly thirty years old, with her frames and plates in such a condition, through internal corrosion in the machinery and bunker spaces, as would have long since compelled her abandonment or extensive rebuilding had she not been sheathed. That these results are possible under such conditions speaks volumes for the possibilities of an efficient system based upon experience (in which every precaution is taken and neutral non-corrosive naval brass bolts are employed), executed with scrupulous regard for the highest class of workmanship, in a service where periodical examination and proper care are fully provided for.

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Statistics of Japan.

The following figures, taken from different official publications, will give an idea of the progress made by Japan in certain directions since 1890 :

	1890	1898
Population	40,453,000	45,193,000
Commerce (taken for 1892 and 1898):		
Importations, yens	91.102,754	165,662.304
Exportations, "	71,326.079	276.996,526
Total, "	162,428,833	442,658,830
Production of silk, pounds	11,041,624	19,662,852
Production of tea, tons	26,274	34,428
Budget, expenses (1893-94 and 1898), yens	84,581,000	249,547,000

The value of the yen is about $0.50.