

SPECIFICATIONS.

IN the course of a recent introductory lecture in opening the Engineering Classes of Glasgow University, Professor Jas. Thomson made the following remarks: "Mathematics and natural philosophy are two of the most important elements in an engineering scientific education; but they are not all that is wanted. In by far the larger proportion of cases in which important action must be taken a rough-and-ready decision is all that is wanted, or, at any rate, is all that is possible. If, however, the engineer or architect is well prepared with scientific principles to aid his judgment—if he is intimately acquainted with the physical properties of materials—if he is accustomed to take a comprehensive view of the relations and mutual influences of the different parts of structures, in numerous and varied cases, with the aid of exact mathematical investigations in cases where mathematics may be truly applicable—and if, too, his mind is amply stored with practical knowledge and experience, his decisions are likely to have more of the ready and less of the rough in their character. The designs for the execution of any important piece of work, and even for the execution of pieces of work of minor importance, in almost all cases, can not be completely made and completely exhibited by drawings alone. It is necessary also in each case for the designer to write out a specification of various particulars to be attended to in the execution of the work. The nature and scope of a specification for the execution of works must depend on the manner in which it is intended that the work shall be carried out; but, in any case, it ought at least to contain clear explanations of many things which the drawings alone do not fully exhibit, and perhaps even could not be made completely to indicate. While an architect or an engineer is proceeding with the making out of drawings for any projected work, he ought constantly to keep at hand a set of sheets of paper on which to jot down his notes for a specification; because, during the attempts to perfect the drawings many things are likely to be thought of which ought to be distinctly stated as written instructions for the builder or maker, but which, if not noted at the time, may be liable to be afterwards overlooked and forgotten. Then, when the drawings are complete, or are supposed to be nearly so, the time comes for writing out a specification in all its desirable completeness. The primary and main object of a specification may be briefly described as being to give, fully and clearly, all necessary and useful written explanations and instructions for the execution of the work; and, in the case of works to be executed by contract, for making due preparations for the effecting of a definite and clear bargain between the contractor offering to execute the work and the person or company accepting his offer. But, while this is the primary and main object, there are two incidental objects of no trivial importance, which I shall now mention: Firstly, the specification, when submitted to the person or company for whom the work is to be done, affords the best possible means for understanding the drawings, and for judging on many points in the proposed scheme, which, though perhaps of great importance, would otherwise have escaped notice; and, secondly, the requirement for a good and clear specification involves this most important condition with the architect or engineer himself—that, in fact, he can not draw it up at all without first finding out what the design or work is that he wants to specify definitely, and what parts of his project must considerably be left unsettled and open for future decision. When he applies himself with earnest determination to draw up a specification well, he can scarcely let much pass unnoticed by mere inadvertence, as he is quite apt to do when he proceeds without a specification. I have been led to make these remarks because I have learned that a practice is adopted and worked upon by many architects—worked upon very generally in the profession, it has been from various quarters strongly asserted, but I will not believe in the imputation as applied to the profession generally—a practice, namely, of giving the instructions to the builders by drawings insufficient to exhibit the work at all completely, and by what are called bills of quantities, and of arranging the bargains by means of 'price lists,' but without any writing whatever of the nature of a specification. What, then, is the obstacle that leads into the omission of this all-important means towards the complete exhibition of a design? It is ordinarily just this—that the designs themselves have neither been fully delineated on paper in the drawings, nor have been formed with sufficient completeness in any human brain. When work is begun in this way, things sometimes go forward at first with great ease and satisfaction—each person is relying upon the others; and even the architect himself has not distinctly realized how incomplete the designs and instruction he has given really are. But soon a time arrives when difficulties begin to show themselves; some things are found to be ill-arranged in their relation to other things; some things essential to be contrived have been unnoticed or forgotten altogether; the builders have to spend much valuable time that ought not to have been required in calling at the office of the architect to ask what they are to do next, or how they are to proceed with some part of the work already begun or far advanced, but in respect to which some alteration of plan is contemplated but not yet arranged or decided on. Troubles and anxieties proceed; but now I will draw the curtain over my unfinished picture of the consequences of proceeding to the execution of important works without a specification."

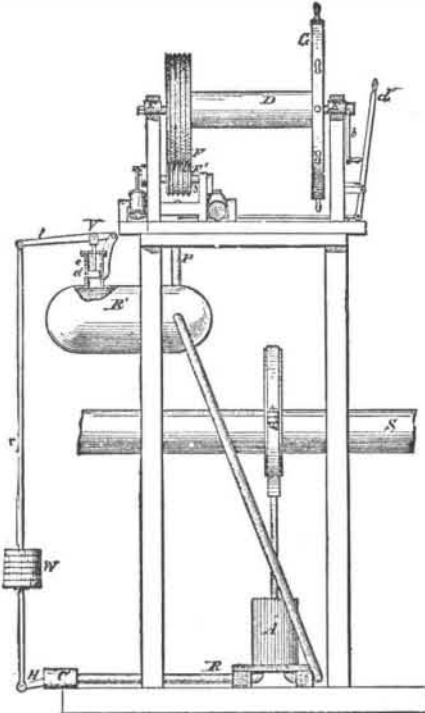
PNEUMATIC STEERING APPARATUS.

By G. W. BAIRD, U. S. N., and J. C. LEWIS, Washington, D.C.

A. AIR-PUMP, worked by propeller-shaft S, which is revolved by the pressure of the water upon the blades of the propeller or by the main engine. R, receiving-pipe, having a valve, C, opened by handle, H, or rod r. R' reservoir, in which the air, supplied by the air-pump, is stored. Attached to this reservoir is a safety-valve, V, having an outlet opening at e, and the motion of whose piston d actuates the lever l and rod r, with weights W and cock C. The object of this safety-valve is two-fold: first, the piston rises by sufficient pressure in the reservoir and closes the cock C, thus shutting off the supply of air to the air-pump, and is thus an automatic arrangement for regulating the pressure in the reservoir; second, in case of a greater increase of pressure the piston will be raised still higher, and permit the air to escape through the opening e, thus forming a safety-valve. A drum, D, is mounted upon and moves freely on an axis or shaft, which may be elevated or lowered by means of the eccentrics E E'. Upon said drum is also arranged a grooved or corrugated friction-gear, F, moved by another small gear-wheel or pinion, F', on a crank-shaft f, which is operated by two small air-engines, one at each end of the shaft. The ordinary ropes are used to connect the tiller with the drum D. The engine cylinders which drive the gearing are driven

by compressed air from the reservoir R' through the pipe P. The wrench or handle b, for elevating the drum, or more properly for engaging and disengaging the gearing, and the lever d' for reversing the engine, are situated in front of the machine, where one man may manage them and observe the compass at the same time.

The operation is as follows: The vessel being in motion, and the screw-shaft S revolving, the air-pump A draws air through the cock C, and forces it into the reservoir R'. Then, by shifting the lever d' forward, the engines are caused to rotate, which in turn revolves the friction-gear, and moves the rudder. By pushing the lever d' backward the opposite motion is imparted to the apparatus and to the rudder. The lever d' simply reverses the engines, and,



when in mid-position, the valve-ports being closed, no air can be admitted into the cylinders.

In case the gears are pressed tightly together, and a heavy sea should strike the rudder, the engines will be pushed backward until the pressure upon the pistons balances that upon the rudder, forming a highly elastic resistance.

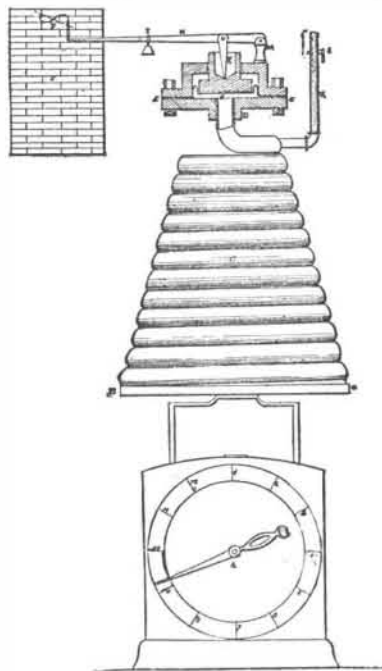
In case the vessel is under sail, the propeller-shaft S is uncoupled from the engines of the ship (as is the custom in our war-vessels), when, by pressure of the water upon the blades of the screw, caused by the vessel's speed through the water, the screw and shaft S revolve, which in turn works the air-pump that supplies power for the steering-engines.

NEW INSTRUMENT FOR REGULATING TEMPERATURES.

By A. CAMPBELL, Woodbridge, N. J.

I EMPLOY a vessel or coil containing water or other fluid, which, when heated to a given temperature, will, by its expansion, give motion to a rod, through the medium of a diaphragm, which rod, being suitably connected with a damper in the furnace-chimney, will cause it to partially or wholly open or close, as the heat around said vessel is increased or diminished.

C is a vessel or coil containing the fluid to be acted upon by the changes of temperature. The lower end of the coil is closed. To the upper end is attached a contrivance E E E, known as Clark's regulator for controlling the fires of steam-boilers by means of steam-pressure; and as the vessel C has



the same relation to said contrivance as a steam-boiler would have, it follows that with a suitable fluid it would, by any change of temperature, actuate the diaphragm of said contrivance, and through it the lever H, which would turn the damper F in the chimney J.

In practice it is found that the fluid contained in said vessel usually wastes more or less away, and thereby deranges the action of the instrument, and the improvement now made is intended to remedy this defect.

The apparatus rests on the platform B B of the spring-balance A, which indicates the weight of the whole apparatus together with its contained fluid. Should said fluid, from any cause, be diminished in quantity, it will be indicated by the balance, thereby enabling the operator to promptly correct it, either by changing the position of the weight I on the lever H, or by supplying additional fluid.

THERMOPILES.

AT the November meeting of the Physical Society, London, the President, Dr. Gladstone, in the chair, Dr. Stone read a paper "On Thermopiles." He has recently been engaged on some experiments with a view to ascertain the best alloy for use in thermopiles. The thermo-electric power of a metal or alloy appears to be quite unconnected with its power for conducting heat or electricity, or with its voltaic relation to other metals; neither does it appear to have any relation to specific gravities or atomic weights. The thermopiles employed were of a form slightly modified from that employed by Pouillet in his demonstration of Ohm's law. Alloys are frequently more powerful than elementary metals. Thus two parts antimony and one part zinc have a negative power represented by 22.70, while that of antimony is 6.96 or 9.43, and of zinc is 0.2. A strange exception, however, is that of bismuth and tin, for while the power of pure bismuth is +35.8, when the two metals are alloyed in the proportion of twelve to one the power becomes -13.67. Dr. Stone first used a couple consisting of iron and rich German silver—that is, rich in nickel. This was characterized by great steadiness, but the electro-motive force produced by moderate difference of temperature was not great. He then used Marcus's negative alloy, consisting of twelve parts antimony, five of zinc, and one of bismuth, but the crystalline nature and consequent brittleness of this mixture were found to be great objections to its practical use. It occurred to Dr. Stone that the addition of arsenic might diminish the brittleness without injuring the thermo-electric power, and on trial it was found that an alloy of zinc, antimony, and arsenic, with a little tin, formed a much less brittle mass than Marcus metal, with quite as great, or greater, thermo-electric power. A set of twelve couples of this alloy and German silver was exhibited. The electro-motive forces of this set, and of a similar one of twelve iron and German silver couples, were determined by Mr. W. J. Wilson, and found to be, for one alloy and German silver couple, with difference of temperature of 80° C., $\frac{1}{18}$ of a Daniell's cell. The electro-motive force of one couple of the iron and German silver set was $\frac{1}{18}$ of a Daniell's cell. The ordinary method of applying heat by a trough of hot water is objectionable, for the water short-circuits some of the current. This is evident from the fact that, if oil heated to the same temperature be substituted, a considerably greater deflection is obtained. Another method suggested by the author which would tend to economy is to allow petroleum to volatilize in the neighborhood of one face of the pile, thus chilling it, and to ignite the mixture of air and gas so produced at the other face. Clamond's pile, consisting of iron and an alloy of zinc and antimony, was employed for some time; but, although good results were obtained, the iron is liable to rust at the connections.

ON THE SINKING OF A PAIR OF IRON SHAFTS FOR AN EXPERIMENTAL AMBER MINE.

THE supply of amber in commerce is mainly derived from the district of Samland, near Königsberg, in Eastern Prussia, where it occurs in a deposit locally called "blue earth," in a brown coal formation of the Tertiary age. Until lately amber was got chiefly by dredging and by collecting the fragments thrown up during heavy gales on to the sea-coast, or by shallow, irregular diggings a short distance inland. Recent geological researches having proved the continuity of the amber-bearing beds, the Prussian Government considered it desirable to start an experimental mine, to determine the conditions upon which concessions might be granted to private individuals, the right of working amber being one of the Crown privileges in Prussia.

The locality selected is at Nortyken, in Samland, where the amber-bearing bed has been found by boring to a depth of 140 feet. The section is as follows:

	Feet.
Hard blue earth, without amber.....	2
Blue earth, rich in amber.....	4.9
Barren earth, no amber.....	1

The level of the bed is 18.7 ft. below the level of the Baltic. The overlying strata, 140 ft. thick, consist of sands and clays belonging to the brown coal formation. The works planned for laying out the mine consist of two winding shafts, two bore-holes for pumping, and the necessary engines and boilers. As a large quantity of water was to be looked for in sinking, it was decided to bore the shafts and line them with wrought-iron tubes. The depth of both shafts is about 147 ft., and the distance between them is 72.9 ft.

The boring-head was a horizontal bar, carrying four chisels for cutting into the bottom of the hole, and two at each end radially for describing the outer curve of the shafts. It weighed about 17 cwt. The boring-rods of wrought-iron were of two sizes, one being an inch square, used in boring percussively; and the other 2 inches square, used when a twisting strain was applied.

The sand pumps, or shells, for removing the detritus produced in the boring, were of two sizes; the larger being 3.1 ft., and the smaller 2.1 ft. in diameter, the length in each case being 6.4 ft. They were wrought-iron cylinders with clack valves at the bottom, but the suspension was so arranged that when brought full to the surface they could be emptied by being tipped like a bucket, without the necessity of being detached from the rods. The iron tubes lining the shafts are of best boiler plate, 0.8 in. thick, and 4.6 ft. internal diameter, in lengths of 4 ft., joined by internal rings of the same thickness and riveted. The tube is further strengthened internally by three longitudinal strips of iron of the same thickness. The bottom length of tube is of double thickness, and terminates in a cutting shoe of triangular section. The total weights of the lining tubes are 44 tons for shaft No. 1, and 45.6 tons for shaft No. 2, or rather more than 1 ton per lineal yard.

The sinking of the tubes was effected by pressure applied by screws. A cast-iron ring grooved underneath to fit the tube, and having four perforated lugs through which the pressure screws passed, was placed on the top of the tube, and the pressure was applied to the nuts by men working spanners. The lower ends of the screws were attached to a fixed point or abutment formed by a timber platform loaded with cast-iron; four screws were placed at equal distances around the circumference of the tube. The spanners were slung by tackles for convenience of manipulation, and from four to five men worked at each, so that from 16 to 20 men were employed in pressing down the cylinder. The amount of material displaced for each length of tube was about 53 cubic feet, which was removed in four or five fillings of the larger-sized shell in about six working hours. The sinking of the tube occupied about four hours, so that one complete length of the shaft tube was sunk and a fresh length slung