means of the switches *W* and *Z* in Figs. 2 and 6. This improvement is incorporated in all the sixty-five-note standard players. If the author were to use the language of the piano-player advertising agent, he would describe this change as causing the accenting of individual notes and as bringing out the melody. This language is far too strong, and, like all exaggerated language, it is not only harmful in its direct untruth but it leaves one without terms to describe further improvements when actually made. Of course when the notes are thus divided into two groups all notes occurring simultaneously in either group are struck with equal force.

The musical advantage of a distinct individual accent is so great, however, that for two years the author has largely devoted his efforts to securing it, with the results that are shown in the eighty-eight-note player, Fig. 7. The simplest way to get an individual accent would be to practically duplicate the tape, using different electromotive forces on the parts. Imagine the music tape as made up of two parallel longitudinal bands, corresponding to a divided contact bar with a permanently maintained difference in potential. Imagine also the reading fingers, rheostats, and other accessories duplicated in each section, i. e., one wire from each section for each magnet and piano key. Then it will be clear that a note would be accented or not according to which section carried the corresponding perforation. Unfortunately the system calls for music rolls nearly twice the width required for non-accenting rolls, greatly increases the cost of the rolls, and is otherwise clumsy.

To keep the roll within reasonable dimensions, and at the same time obtain the requisite control over the force of the blow supplied to different keys, was the subject of much thought. The author became satisfied that some system of grouping the notes must be used, and worked out several plans for the control of the groups. These plans, with the exception of that now being introduced into practice, it is unnecessary to describe. As to the grouping, the first idea that presented itself was, instead of simply dividing the scale into bass and treble, to cut it up into numerous sections. It would thus be possible to confine the accent within a narrow section. Unfortunately, until the section is reduced to the compass of but a single note it is always possible that it may contain a note which it would be undesirable to acccent. Indeed, the narrower the section the more important it is that it should not contain a second accented note. The next idea that presented itself was to include in each group only notes of the same name: C's in one group, C-sharps in another, and so on to the end of the scale. This is very much more satisfactory. Even if two notes should happen to be sounded in one group, as would occur sometimes, so that both might catch the accent, as the two are consonant, the effect would be substantially that of accenting the single note. Indeed, with the old-fashioned player the accenting of a note can often be simulated by cutting its octave to sound with it. The author thought it desirable, however, to go further than this, and on this octave grouping he superimposed the division into bass and treble. In consequence of this double grouping it is possible to obtain four different strengths of blow on the piano keys simultaneously. This capability, added to the power of control over expression already described, ought to satisfy the most exacting requirements.

The arrangements for carrying out this method are clearly shown in the diagram, Fig. 7. The key-operating magnets are from one end of the circuit divided into two groups, and from the other end into twelve. The source of electromotive force has four terminals, ordinary 0, 2, 10, and 14 volts. Switches are so arranged that the wires leading to the magnets on the one side may be connected either to the 0 or the 2-volt terminal, and on the other to either the 10 or the 14. These changes are independent of each other. It is therefore possible to supply any magnet with 8, 10, 12, or 14 volts at will. The switches are operated by quick-acting electro-magnets, and these, in turn, are controlled either by special perforations in the music-roll, or at will by the operator through specially provided buttons. At the will of the operator, also, any one or more of the means of expression may be left music-roll-controlled while he manually controls the rest. He may pick out that portion of the expression in which he feels he can best express his individuality, leaving the rest of the machine, or he may take entire control and make the expression entirely his own.

A word as to the future. It would seem that the idea is still prevalent that a piano player must be necessarily inartistic. Logically, those who hold this idea should condemn the piano also, for piano playing is but mechanicalized harp playing. In all arts and crafts alike there is, and always will be, a place for hand work. Pioneer work falls to the hand, and in the arts especially there is a peculiar grace arising from the flexibility of the instrument. But power, accuracy, and precision are the features of the machine. The grace of the harp, and the fact that it allows of a more highly individualized playing, have in no wise prevented the more mechanical piano from becoming a hundred times more common, and the favorite instrument of great artists. And while, as in passing from the harp to the piano, so in passing from the simple piano to the piano and player, there may be in some respects a loss, it would seem that for this loss there is a more than equivalent compensation; in speaking of compensation the author has in mind not only that thousands are reached by the player who otherwise would be deprived of all good music, but also that to some extent there are direct artistic compensations. While the piano mechanism restricted the performer in some directions as compared with that of the harp, in others it opened out to him a wider field. And the player in turn will again widen the field. The composer will no longer have to think of the limitations of ten fingers on two hands. Consider what this may mean in transcriptions of orchestral music, or, if we have the daring, let us even dream of what it may mean in original piano music. There is another reason why our ultra-artistic piano lovers should take a more generous attitude toward the player. The growth of the piano trade, if it did not actually hinder the making of harps, at least did nothing to advance that art. The piano-playing business, on the other hand, tends to enormously increase the number of pianos in use, and each of these pianos should be recognized as the possible means of development of a future artist. And surely the struggling musician will be none the less likely to develop into an artist because he has at his disposal a machine which will make it possible for him to hear the great music of the world. As well might we say that it would be harmful to a young painter to be placed in possession of a set of photographs of the world's masterpieces in painting.

THE NEW AUTOMOBILE STEELS.—II.

THEIR USE IN MOTOR-CAR CONSTRUCTION.

BY JOHN A. MATHEWS, PH.D., SC.D.

Concluded from Supplement No. 1747, page 411.

Case-hardened vs. Oil-hardened Gears.—In the automobile trade there have existed two schools, so to speak, one believing in the case-hardened type of gear and the other in the oil-hardened type. As previously mentioned the chrome-vanadium, chrome-nickel, and silico-manganese alloys are made in both high and low carbons. The former contain about 0.45 to 0.60 per cent carbon, and enough other hardening elements so that by merely quenching in oil from a bright red heat a surface-hardening is produced sufficient for ordinary wearing purposes while the hardness does not penetrate deeply into the gear but leaves a core that is tough and strong. The low carbon alloys, with about 0.20 per cent carbon, require to be carbonized or case-hardened in order to produce sufficient surface-hardening for wearing purposes after hardening. The speaker's word on the merits of gears made by these two methods will hardly be accepted as final, as he is not an authority upon gears. Several years of observation and contact with the trade, however, leads me to prefer the case-hardened gear. The result of direct tests upon thousands of gears of both types leads me to the following conclusions: (1) The static strength of a case-hardened gear is equal to that of an oil-hardened gear, assuming in both cases that steel of the same class and appropriate analysis has been used and that the respective heat-treatments have been equally well and properly conducted. (2) Direct experiments proved that the case-hardened gear resists shock better than the oil-hardened. (3) As regards resistance to wear the same type is incomparably better, although perhaps not as silent in action.

One of the leading makers of gears has proved this to his own satisfaction of late by an arrangement of shafts and gears whereby energy is transmitted through two case-hardened gears, in mesh with each other, to two oil-hardened gears. The gears are of the same size. Five sets of oil-hardened gears have been worn out while the original case-hardened gears are still in service and show the tool marks.

Upon the part of many there is strong objection to case-hardening. In nine cases out of ten this is doubtless due to the fact that the case-hardening operation has not been reduced to a science. The depth of case, the relation of case to core, the time and temperature to produce certain results, and the exact control of these conditions, together with an accurate knowledge of the material to be treated, are the factors that enter into successful case-hardening practice. Further points in favor of this method are easier machining of the blanks, and at least equal static and dynamic properties with less chance of injury in hardening.

While considering gears, we may as well dip in a little deeper and consider the relative merits of gears cut from bars and from drop-forged blanks. Parts like spur gears, bevel pinions, and many shafts may either be drop-forged or cut from bars in automatic machines. Contrary to general opinion many parts can be machined out of bars as cheaply as they can be from forgings. Moreover, I am firmly of the opinion that no steel is improved physically by drop-forging, some steels, of course, being less susceptible to injury than others. In good steel mill practice great attention is paid to proper finishing heats, and steel is brought gradually to size. In drop-forging work, in order to give sufficient plasticity to assume various forms in dies, it must be heated very hot. It is then frequently formed with the fewest possible blows. An investigation of drop-forged and bar-cut gears, the former being the product of one of the foremost drop-forging companies, showed that under static test the bar-cut gears, as the average of many tests, were fully 25 per cent stronger, and their resistance to shock test was also much better, but the difference cannot be exactly stated in percentage. The fact that the static test did not show more than 25 per cent average superiority for the cut gear was a surprise to me and speaks well for the forging concern in question. In many cases, I fear a larger difference would be found. It is just such points in the construction of various makes of cars of the same general design that would be of the greatest benefit to the would-be purchaser.

To show that case-hardening is a science, let me quote from Dr. Guillet once more. In reference to the proper procedure in case-hardening he says: "As is well known, the operation of case-hardening consists of placing a steel in some medium capable of imparting carbon to it, at a suitable temperature; after a sufficient interval a steel is obtained the interior of which possesses the same percentage of carbon as before case-hardening, but the exterior of which is much higher (0.80 to 1.00 per cent). On quenching such a steel an extremely high degree of mineralogical hardness is obtained on the surface, while the center of the piece is non-brittle, if, that is, the operation has been properly carried out. One generally uses steels containing 0.10 to 0.25 per cent of carbon for case-hardening. In order to avoid all brittleness in the interior and exterior of the piece, and, at the same time, to obtain a high degree of superficial hardness and a very regular degree of carburization (in carbon steels) it is necessary—

1. "To use a steel containing less than 0.12 per cent of carbon, and with a low percentage of manganese (less than 0.30 per cent) and—

2. "To case-harden with a chemically definite material such as a mixture of 60 parts charcoal and 40 parts of barium carbonate at a temperature between 850 deg. C. and 1,050 deg. C.—the higher the temperature the more rapid the case-hardening—and allow it, after the operation, to cool down just below the transformation point (about 600 deg. C.).

3. "To reheat the piece and quench it at 900 deg. C. (just above the transformation point of the center), this operation having the effect of rendering the center fibrous."

This operation has the effect of toughening the center but the outside will be coarse-grained and brittle. The next operation, according to Guillet, is—

4. "To quench for a second time at 800 deg. C. (above the transformation point of the exterior), to render the skin non-brittle.

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*Journal of the Franklin Institute.

"In any case, the methods by which it is possible to obtain, with low-carbon steel, case-hardened pieces which shall not be brittle, are exceedingly delicate."

How different this is from the operation one too often sees, where the pieces are dumped directly from the case-hardening boxes into water. However, if one uses a good grade of nickel steel, low in carbon, and case-hardens at appropriate temperatures, and then takes the precaution to cool off in the boxes before heating for quenching, and then hardens at about 800 deg. C., the results will be fully equal or better than can be obtained by the most careful handling and double quenching of carbon steels. The saving in cost of the operation can be applied toward the greater cost of nickel as compared with ordinary case-hardening steel.

Better still, however, if nickel steel is used, is to give it a double quenching, too, then one obtains a really admirable product of extraordinary toughness, and remarkable wearing qualities. An ideal way of making a nickel-steel gear consists in first annealing the blank, then rough-machining approximately to size, then giving a light reannealing before taking the last finishing cut. Then pack in suitable mixture and carbonize to a depth of 1/64 to 1/32 of an inch, according to requirements, at a temperature of about 1,625 deg. to 1,650 deg. F. Cool in the pots, heat to about 1,500 deg. F. and quench in a hot brine or calcium chloride solution. This will put the core into excellent physical condition. Finally, reheat to 1,375 deg. to 1,400 deg. F. and quench in oil. This last operation will refine the grain of the case and harden it with best results. The temper need not be drawn.

It will be noticed that the temperatures for treating nickel steels are considerably lower than those advocated by Guillet for carbon steels.

If methods like these are followed it is not likely that a very great difference would be noted between bar-cut gears and gears cut from drop-forged blanks. In the case of medium carbon gears not to be case-hardened but oil-hardened only, one would probably find a greater difference and in this case we have no opportunity to restore the over-heated forged blank by scientific heat treatment. This, in addition to the greater chance of over-heating, and the greater difficulty of machining, also favors the use of case-hardened gears, assuming, of course, the case-hardening is to be skillfully done.

In conclusion, let me bring to your attention certain facts and considerations with reference to springs and spring making. There are in general two kinds of springs used in automobiles, coil and flat springs. The latter may be full, three-quarter, or half elliptic. From observation and general report it appears that the general maker of springs has not kept pace with the improvements in spring-steel, and with the increased severity of the duty expected of springs. With many of them to suggest a change of method is like preaching heresy in a theological school.

The new steels cannot be handled just like the old ones and still obtain from them the maximum development of their powers. However, the new steels, being in general lower in carbon, will stand much abuse in heat treatment, and still produce springs of quality undreamed of a decade ago. But how foolish it is to pay four or five times the cost of regular spring steel and then not adopt methods to develop its maximum excellence even to an increased endurance of a hundred fold over plain carbon spring steel!

While as a class spring makers may have been driven to the use of alloy steels, they have not as a class been forced to handle them scientifically. I am happy to say there are a few exceptions to this and I hope their number will increase. The old practice of forming and hardening springs with a single heating cannot be persisted in if maximum quality and service are to be secured.

Satisfactory tests on flat springs are somewhat difficult to make but in coiled springs quality can be easily shown and the relative merit of different steels demonstrated. The most satisfactory test is to operate the springs—open and close—by some sort of repetitive impact method until destroyed. In order to produce results in a reasonable length of time the duty must be severe, and the rate of alternations of stress rapid. The number of alternations of stress to produce fracture gives a measure of its vitality, so to speak.

The average results of a great many tests made in this way of crucible carbon springs, chrome nickel, silico-manganese, and genuine crucible chrome-vanadium springs prove the extraordinary quality of the last-named product, and the antifatigue qualities imparted by vanadium. The average figures for alternations were as follows: crucible carbon spring, 125,000; chrome-nickel and silico-manganese, each 200,000; crucible chrome-vanadium, 5,000,000, and still unbroken. This, then, is the panacea for all valve, clutch, break, and flat spring troubles. The engineer of a company which makes a very heavy car and uses a semi-elliptic spring told me recently that they had not had a leaf to break or a spring to sag since adopting crucible chrome-vanadium springs made by an up-to-date spring-maker. Prior to this time they were in trouble all the time.

The tempering of this steel is quite simple. The springs should be heated to 1,675 deg. to 1,700 deg. F., and quenched in oil. The temper is then drawn according to the nature of the spring and the duty expected. The drawing range is very wide, namely, from 600 deg. to nearly 1,000 deg. F. In the line of spring-steel this product has my profound admiration.

In what I have said this evening I have tried to impress upon you the importance of using high-class materials when severe duty is demanded, of using discrimination in the selection of special steels for special work, of looking beyond the first cost of your raw materials, and of studying the fascinating subject of heat-treatment. If I have succeeded in a measure in this, our evening will have been well spent. If I have caused any of you to think more deeply on these subjects or have made any one's conscience hurt him just a little bit because of past neglect, or have offered any practical suggestions which you can apply in your daily work to the betterment of your product, then I shall not regret having accepted the invitation to address you upon this important subject.

APPENDIX.

In presenting some tables showing typical analyses, treatments and tensile tests of nickel, nickel-vanadium, chrome-nickel, and chrome-vanadium steels, we have drawn upon many sources of information, as, for example, the data published by the American Vanadium Company, experimental data upon tests made by the writer, and commercial tests made upon the steels of many makers. The temperatures when given are approximately correct. In giving analyses only the essential elements have been given. We have expressed the elastic limits and tensile strength in net tons per square inch, and the elongations are as measured upon a 2-inch test specimen ½ inch in diameter.

TABLE 1.—NICKEL STEELS.

No. of Tests.	C.	Mn.	Ni	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A.	Treatment.
4	.21	.86	3.48	...	...	68	112	13.7	45	1550 F. oil 600 F.
4	.25	..	3.50	...	...	85	109	13.4	..	1550 F. oil 600 F.
2	.27	..	3.50	...	...	86	110	13.3	51	1550 F. oil 600 F.
30	.18-.28	.60-.90	3.5	...	...	68	103	12.9	54	1550 F. oil 600 F.
11	.18-.28	.60-.90	3.5	...	...	84	116	12.4	48	1600 F. brine.
4	.25	.60-.90	3.5	...	...	88	121	12.2	48	1600 F. brine.
7	.23	.61	3.54	...	...	103	114	14.0	50.7	1550 F. water 212 F.
1	.14	.63	3.64	...	...	78	88	15.0	54.6	1500 F. water 212 F.
1	.14	.63	3.64	...	...	30	41	33.5	72.4	1400 F. oil 1200 F.
4	.35	.45	3.39	...	...	77	84	15.5	55.5	1500 F. water 900 F.
4	.35	.45	3.39	...	...	130	137	10.0	36.3	1500 F. water 430 F.
3	.25	.86	3.45	...	...	31	45	31	60	Natural, as rolled.

TABLE 2.—NICKEL-VANADIUM STEELS.

No. of Tests.	C.	Mn.	Ni.	Cr.	V.	E. L.	T. S.	Elong. in 2"	Red. in A.	Treatment.
1	.34	.17	3.88	...	..	29	43	27.3	54	Natural as rolled.
1	.33	.16	3.72	...	.12	41	54	23.8	53	Natural as rolled.
1	.33	.16	3.40	...	.24	49	66	17.8	40	Natural as rolled.
1	.34	.17	3.88	...	..	37	51	16.5	51	1500 F. oil 1150 F.
1	.33	.16	3.72	...	.12	51	59	24.0	61	1500 F. oil 1150 F.
1	.33	.16	3.40	...	.24	59	62	21.0	61	1500 F. oil 1150 F.
1	.34	.17	3.88	...	..	59	66	15.5	55	1500 F. oil 600 F.
1	.33	.16	3.72	...	.12	70	76	14.5	56	1500 F. oil 600 F.
1	.33	.16	3.40	...	.24	82	85	15.0	55	1500 F. oil 600 F.
1	.24	.72	3.33	...	.12	38	49	27.0	64	Natural as rolled.
1	.24	.72	3.33	...	.12	71	100	11.6	36	1600 F. oil.
1	.24	.72	3.33	...	.12	92	117	14.5	52	1600 F. water.
1	.24	.72	3.33	...	.12	91	116	15.2	57	1600 F. brine 400 F.

These tables are given to illustrate the tremendous possibilities of careful heat treatments, and in some instances they illustrate the danger of applying wrong treatments. The effect of variable carbon contents in alloys of the same type is illustrated, and varying qualities that may be obtained from the same alloy by different treatments may be observed.

One point I must mention in connection with these tests is, that in designing parts one must be very cautious not to be misled by the remarkable tests yielded when a standard test piece is treated, and to use these figures as a guide to the physical qualities likely to result when a much larger mass of metal is treated. Because a ½-inch test piece oil-tempered and annealed gives an elastic limit of 75 tons per square inch, it does not follow that a 1½-inch diameter bar similarly treated will yield the same elastic. The hardening action in quenching does not penetrate very deeply in a large bar, while in a small one it may penetrate to the center.

The writer once made a quantitative experiment upon this point, using a 0.43 carbon steel, containing vanadium. The steel was in the form of an inch-round rolled bar. In one case I oil-tempered a full inch section of the bar at 1,600 deg. F. and annealed it at 1,030 deg. F., and from this machined up a test piece. In the other case, I made the test piece from the inch-round bar, and having reduced it to a half-inch diameter test piece, subjected it to the same treatment as I had applied to the full-sized bar. The piece treated in the form of a test piece gave me 42.5 tons elastic limit, 58 tons tensile, 21.5 per cent elongation, and 58 per cent reduction. The other piece was over 4 tons lower in elastic limit; over 3 tons lower in tensile, and 2.2 per cent and 3.6 per cent higher in elongation and reduction respectively. This shows that while it may be quite possible to obtain an elastic limit of 100 tons in a thin spring, one would not have the same elastic by the same treatment had the same steel been made into a massive gear.

Many of the figures given in the tables are the averages of several tests made upon materials of the same general kind, and in the first column of the tables is given the number of tests, either average or single, upon which the figures are based.

In the column marked "treatment" is given the temperature to which the steel has been heated, followed by the liquid in which it was quenched, and then by the temperature to which it was reheated to draw the temper or anneal. This will make clear such terms as 1,600 deg. F.—oil—600 deg. F., etc.

TABLE 3.—CHROME-VANADIUM STEELS.

No. of Tests.	C.	Mn.	Ni.	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A.	Treatment.
3	.26	.39	...	.78	.17	44	68	20	64	Natural as rolled.
1	.26	.39	...	.78	.17	103	139	3	8.2	1570 F. oil 400 F.
3	.27	.50	...	1.00	.17	33	45	28	62	Annealed 1475 F.
1	.27	.50	...	1.00	.17	52	63	21	56	Oil tempered and drawn to various degrees.
1	.27	.50	...	1.00	.17	62	65	17	62	
1	.27	.50	...	1.00	.17	70	74	17	57	
1	.27	.50	...	1.00	.17	100	106	12	51	
1	.27	.50	...	1.00	.17	112	116	11	39	
1	.40	.77	...	1.22	.19	34	50	26	62	Annealed.
1	.40	.77	...	1.22	.19	98	104	10	36	1650 F. oil 840 F.
1	.30	.50	...	1.00	.16	71	76	16	56	1650 F. oil 1025 F.
3	.38	.73	...	1.19	.18	41	65	22	67	Natural as rolled.
1	.38	.73	...	1.19	.18	110	144	10.8	47	1660 F. oil 600 F.
1	.38	.73	...	1.19	.18	64	113	12.9	53	1660 F. oil 850 F.
1	.33	.54	...	1.24	.20	64	71	15.5	56	1500 F. oil 1125 F.
1	.33	.54	...	1.24	.20	95	104	11.0	38	1600 F. water 600 F.
5	.45	.58	...	2.37	.30	88	94	13.2	46	1600 F. oil 1125 F.
4	.45	.58	...	2.37	.30	138	146	6.0	16	1600 F. oil 430 F.
1	.36	.21	...	2.78	.24	60	104	4.1	88	Natural as rolled.
1	.36	.21	...	2.78	.24	65	72	20	56	1500 F. oil 1150 F.
1	.36	.21	...	2.78	.24	98	104	13	45	1500 F. oil 600 F.

TABLE 4.—CHROME-NICKEL STEELS.

No. of Tests.	C.	Mn.	Ni.	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A.	Treatment.
1	.37	..	2.9	1.04	...	60	78	18.5	61	1475 F. oil 1200 F.
4	.37	..	2.9	1.04	...	77	84	16.	56	1500 F. water 1100 F.
1	.45	..	2.0	1.0	...	70	90	8.0	20	Oil-temp. and annld.
1	.25	..	2.0	1.0	...	50	65	12.0	30	Oil-temp. and annld.
2	.25	..	3.0	1.5	...	57	64	15.0	65	Annealed
1	.25	..	3.0	1.5	...	110	116	6.0	40	Hardened—oil.
1	.50	..	2.0	1.0	...	33	46	27.0	64	Natural as rolled.
3	.50	..	2.0	1.0	...	72	134	6.0	23	Tempered.
1	.30	..	2.0	1.0	...	35	53	18.0	45	Natural as rolled.
1	.30	..	2.0	1.0	...	68	98	9.0	37	Tempered.
1	.30	..	2.0	1.0	...	45	55	25.0	55	Oil-temp. and annld.
1	.40	.18	2.1	.80	...	60	76	12.8	37	Natural as rolled.
1	.40	.18	2.1	.80	...	58	66	17.5	40	1500 F. oil 1150 F.
1	.40	.18	2.1	.80	...	106	118	10.0	34	1500 F. oil 600 F.
1	.40	.18	2.1	.80	...	70	79	15.5	48	Annealed 1150 F.

THE ACTION OF SEA WATER ON CEMENT CONCRETE.

In the Journal of the Society of Chemical Industry, C. G. Potter presents his researches on the action of sea water on cement concrete.

As a result of trying various methods of overcoming the failure of Portland cement concrete by softening and expansion which occurs in a very few years or less in sea water, Mr. Potter was successful when calcined red-brick clay was added to the clinker while grinding. Six parts of clay to 10 of cement by weight give the best all-round results, and thorough mixing and fine grinding are necessary. A variety of test results extending over periods up to ten years are given. For at least a few weeks after making, the "red" cement mortar is weaker than the Portland, but in the course of time the strength of Portland, kept in sea water, falls to zero, while that of the red is maintained or increases. As is known, the failure of Portland is due to the presence of about 0.25 per cent magnesium sulphate in sea water. Precipitated magnesia is found in the fracture of blocks of Portland cement concrete which have been exposed to sea water. The destructive action occurs rapidly in sea water to which has been added 10 per cent of magnesium sulphate. In this solution neat Portland cement has a strength of 500 pounds per square inch in one month, and *nil* after one year's immersion. Red cement gradually continues to gain strength, just as Portland cement does in fresh water. The greater the proportion of sand in Portland cement mortar, the more rapid its failure in sea water, owing apparently to its greater porosity allowing more ready access of the solution. The strength of the red cement samples kept in sea water was rather higher than in fresh water. Some results of tests are also given which show that if Portland cement mortar be exposed for some time to the action of a CO_2 atmosphere before exposure to sea water, the action of the sea water upon it will not be so serious as if exposed to sea water immediately. Exposure to CO_2 of "red" cement mortar also increases its ultimate strength in sea water.

Labarthe's Washing Powder.—48 parts ammonia-soda, 6 parts potash (75 to 80 per cent), 8½ parts caustic soda (70 per cent), 36 parts soda water-glass, 1 part permanganate of potash, ½ part oil of thyme. This powder is for use for linen. For woolen articles add soap bark. It must be remembered that all water contains more or less iron in solution. If ever so little is present, its presence will be revealed in the washing in the course of time. This and other causes will contribute to its gradual acquisition of a yellowish tint and it must then be subjected, in some way or other, to a bleaching process.