ing owing to particles of foreign matter on the clips, or on the briquettes themselves.

The soundness of cement is of paramount importance, and numberless methods have been suggested for ascertaining the extent to which this property exists in any given sample. In the paper under discussion, only the well-known Fajfa hot-water test is mentioned, since this is now practically universal. It appears that in America the test in question, especially when temperature is raised to the boiling point, is the *déte noir* of the cement manufacturer, who uses sulphate of lime as an adulterant in his endeavor to make the material pass the required ordeal. In the opinion of competent judges, the rational and careful use of sulphate of lime is desirable to render cement slow setting, while excessive admixture is clearly to be deprecated. Mr. Humphrey appears to fully realize the difficulties which are attendant upon hot water or boiling tests, and he suggests the sample pats should be immersed in water, maintained at a temperature not exceeding 170 deg. Fahr., after setting hard, for a period of twenty-four hours. At the end of that time well-made Portland cement should develop no objectionable qualities, the cement ought also to be perfectly sound in cold water. The suggestion comes as a mean between accelerated tests and the normal test adopted in Germany, which is as follows: Small pats of the cement are made and allowed to stand twenty-four hours in damp air, and are then placed, some in water and some in the air, and observed until twenty-eight days old. If they do not become distorted or cracked during that time, the cement is considered to be sound. The opinion of Mr. Humphrey is that this test is not sufficient to develop the unsoundness of cement in time to be of practical value. On the other hand, after a lengthy investigation, the German Society of Cement Manufacturers recently arrived at the conclusion that the normal test is not of less value than the so-called accelerated tests. As the Society in question includes the heads of all the important departments of public works in Germany, and the head of the German testing laboratory, this expression of opinion is one that cannot be readily set aside. Yet, as the accelerated test is of sufficiently trying character to induce manufacturers to admix substances with the object of enabling cement to pass muster, we are inclined to think that the test ought not to be abandoned. It can certainly be employed with advantage by the manufacturer for his own information and guidance, and by the user for similar purposes, and if it were no longer regarded as affording a criterion by which the acceptable or non-acceptable character of a cement should be judged, there would be no temptation for the manufacturer to add an excess of sulphate of lime in his product. A difficulty attending tests for soundness is found in making the pats. On this point Mr. Humphrey makes the practical remarks that, "Simple as the making of these pats may appear to be, it is extremely difficult for inexperienced persons to make them correctly. Pats may be so troweled as to give initial strains which develop cracks during the test." If the pats should dry out shrinkage will follow, giving an impression of unsoundness, and if the cement should set before the pat is finished the lifting of the outer edge may mislead the inexperienced. The soundness and constancy of volume of cement is undoubtedly of great importance, but from what we have said it will be realized that room for improvement still exists in connection with tests for its determination.

Beyond the tests made for ascertaining the acceptable quality of cement as delivered for use, there are many others which belong more properly to the regularly equipped laboratory. Operations for determining compressive, transverse, and adhesive strength, and others for ascertaining the effects of frost, sea water, and porosity are extremely useful, for they are the means of contributing general information for the guidance of those concerned in the design of structures where cement is used. With regard to the ordinary tests, it may be remarked that the interpretation of results is not the least of the difficulties to be encountered. It is never possible to insist upon an exact compliance with the terms of a specification, because it is difficult to define the influence of fortuitous circumstances connected with testing. For example, as the author hints, the sand used may be of poor quality, water used in mixing may have been excessive or deficient in quantity, the strength of the briquettes may be affected by drying out, or by the conditions under which they were preserved. Again, the operator may not apply the same amount of energy to each test, the influence of this factor being particularly remarkable when a large number of tests is in question. Altogether, there can be no doubt that present methods of testing are capable of improvement. It is nevertheless equally clear that the practical trials demanded by engineers have been largely responsible for the very great improvement in the quality of cement that has taken place during the past twenty years. What we now want is the formulation of a scheme by the aid of which uniform and readily comparable tests can be obtained, and we trust that the deliberations to which allusion has previously been made may conduce to so desirable a result.—The Builder.

COMPOUND LOCOMOTIVES ARE TWENTY-FIVE YEARS OLD.

It is now the twenty-fifth anniversary of the application of the compound system to locomotives in France, says Machinery. The first compound locomotives were designed by A. Mallet and operated on the railway between Bayonne and Biarritz, France. They were built at the Creusot works and had one high-pressure and one low pressure cylinder, with provisions for working either simple or compound. In that year the Institute of France awarded to Mallet the Fournayron prize for mechanics, in consideration of his achievement. The use of the compound locomotive has extended throughout Europe since its introduction by Mallet and it is estimated that nearly 15,000 are now in operation on various European roads, of which two-thirds are of the Mallet type. In marked contrast to the development of the compound system abroad is the growth of compounding in this

country. The first compound engine of any consequence to be tried in the United States was Dunbar's five-cylinder compound, which first ran on the Boston & Albany Road in 1883, or six years after the successful introduction of Mallet's locomotives in France. Dunbar's engine was a failure and compounding made no progress here until 1888-9. In these years Webb's three-cylinder compound was tried on the Pennsylvania Railroad; the first Baldwin-Vauclain compound was built for the Baltimore & Ohio Railroad, and the first Schenectady compound having an intercepting valve to allow high-pressure steam to be used in the low-pressure cylinder was introduced.

CHAMOIS SKINS.

By HERBERT T. BLAKE.

WITHOUT intention to deceive, this name, strictly speaking, is a misnomer as applied to skins commonly sold as "chamois." It is now the peculiar process in preparation that gives the skin its name.

The Rupicapra Tragus, the chamois of the Alps of southern Europe, long ago lost to the sheep of England, France and Australia its supremacy as the chief source of the "chamois skin."

The chamois is a little animal not larger than a small goat, the largest seldom weighing over seventy-five pounds. It is the only member of the antelope family now inhabiting the continent of Europe. Its skin is used almost exclusively for rugs and gloves, and is of exceptional value because of its very fine texture and its uniformity in thickness. In this latter respect it is superior to all other skins used for similar purposes. These characteristics make it of great value as a "chamois," but its high cost and small size are disadvantages which make the less expensive, larger and nearly equally soft and durable sheepskin an all-conquering competitor.

The doe-skin, which has been stated to be the source of the best grade of "chamois," is not now used for this purpose, being more suitable for the manufacture of gloves. The part of the pelt of the sheep used as the "chamois" is the under skin, termed the "flesher," which was, until comparatively recent years, discarded as of little commercial value. This is secured by splitting the skin through the center by a machine especially constructed for this purpose. The upper of the two skins thus produced is termed the "grain" or "skiver," and is used in the manufacture of thin, fancy leather for book-binding, portfolios, etc.

Before it is ready for splitting the skin must pass through the preliminary processes necessary in the preparation of leather. As taken from the sheep the skin is first thoroughly cleansed of blood and dirt by steeping in water for a few hours and then washing for a short time in a wash-wheel or tumble, a large rotating perforated drum.

The wool is now removed by one of the various methods, the most common of which is by the use of lime. This consists in placing the skins in a pit filled with milk of lime and alternately drawing them out and putting them back until the wool is easily removed. A series of pits is usually used, the strength of the solutions gradually increasing from a very weak solution in the first to one that is quite strong, the skins being immersed in each in the order of their strength. The milk of lime dissolves the epidermis, and also swells the fibers of the skin and splits them up into their consistent fibrils, both of which effects are necessary in the production of good leather, or "chamois." This process is termed "swelling," "raising," or "plumbing."

The lime is now removed by immersing the skins in a dilute acid solution and dissolving out with water the salt thus formed. It is, perhaps, more commonly the practice to secure this result by a method known as "bating" or "puering," which consists in placing the skins in a solution of hen dung or excrements of dogs and subjecting them to the action of the enzymes which bacteria have formed together with the compound ammonias which have resulted from their action on the organic matter present. By this process not only is the lime removed, but also other results obtained which are not fully understood but which certainly tend to improve the quality of the resulting skin. Efforts are being made to find a substitute for this disgusting mixture, and a solution containing pepsin, finely cut meat, meal, etc., is used to some extent, and is claimed to give equally good results.

If an acid solution was used, the skins are covered with whiting to neutralize the excess of acid, and then after the whiting is removed the skins are in shape for splitting.

At the present time, both because of the high price of the domestic skins and because they are coarser in texture and less easily split than the foreign, very few if any are split in this country, practically all of this being done in England, France and Australia. The skins in this splitting machine move with lightning rapidity, cutting only a very small part of the skin at each movement.

In the process of "chamoising," the flesher is first thoroughly drenched and then placed in the trough of a fulling machine and pounded with large mallets until nearly free from water, and its fibrous structure has become loose and open, sawdust usually being used to facilitate the process.

Fish oil, usually codfish oil, is then sprinkled over the skins. After being wrapped in bundles of about four each they are again pounded or "milled" until the oil is evenly and thoroughly distributed. They are now hung up, and after partly drying are again oiled, milled and dried, this process being repeated again and again until they are thoroughly saturated with oil, it having replaced all moisture and foreign matter. From three to five gallons are used for each one hundred skins. The value of the finished skins depends very largely upon the quality of the oil used in this process, and the care taken to prevent the skins being over-heated during the milling.

The skins at this point are hung in a room having but slight ventilation, and kept warm and at an even temperature by steam heat for several days. A slight fermentation takes place, which dilates the pores and promotes an even more thorough incorporation of

the oil with the animal fiber, resulting in the formation within the skin of a sort of "oleate of gelatin." This thorough incorporation serves to make the fibers of skin non-adhering, thus preventing its hardening on drying, which is due to the adhesion of the fibers. The excess of oil is removed by pressure and saponification with an alkali, as potassium hydrate, and then the skin is hung in the open air to dry.

The skin is now of that deep yellow color characteristic of the chamois, no coloring agent being used during any part of the process. It is, however, stiff and hard to the touch and in every way, except in color, quite unlike the finished chamois.

To develop the soft, velvety skin to which we are accustomed, this is first stretched and worked by a process called "staking," over a post tipped with a wedge-shaped piece of steel, the edge of which is rounded. To aid in getting the necessary purchase and to prevent abrasion of the skin, the right leg of the man at work is bare from a little above the knee to the ankle.

The skin, after this process, is soft and flexible, but its surface is still smooth. "Buffing" or "prizing" is the next and last procedure. The buffer is a corundum wheel about ten inches thick and with a rounded edge. Each portion of the skin is held against this rapidly-revolving stone until its whole surface, either on one or both sides, is slightly raised, giving it the plush-like finish of the commercial chamois.

All domestic skins are trimmed and cut over forms of definite size and shape, but abroad skins are sold in just the shape they leave the buffer. The skins are packed in bundles or kips of thirty each, each kip containing skins all of approximately the same size. The small and imperfect skins are cut to the best possible advantage into many different sizes and shapes. Not the smallest piece is wasted, even the dust from the buffer being used in polishing. The bits cut from the ragged edge are used to polish small pieces of jewelry and for watch pockets, etc.

Double-dressed chamois differ from single-dressed only in being buffed on both sides, this necessitating the use of a skin having no very thin places and therefore requiring their special selection for this purpose.

Chamois of almost every color may be had from the manufacturer, but, due to the difficulty in distributing the dye evenly throughout the whole skin, their price is nearly twice that of the common yellow chamois. In dyeing, the skins are treated with a dilute solution of sodium carbonate to remove oxidized oil left after the tanning process, and then mordanted by drumming in a 1 per cent solution of titanium salts.

In drumming, a rotating drum similar to the contrivance which aids in the washing of the skins is made use of. They are transferred without washing to the dye bath, which is best made in the drum. The colors most suitable are the alizarin colors, James colors and the natural dyes. The goods are run in the dyes in solution at a temperature of 45 deg. to 50 deg. C. for about one-half hour, when they are removed and lightly fat-liquored, which consists in rubbing lightly with a specially prepared emulsified oil. After this they are dried.

There are on the market imitations of the chamois, alum, chrome and other tannages being used in tanning the skin. These may readily be distinguished by the peculiar softness and flexibility of the oil-dressed skin, and also by the interior color, which is always dark yellow when freshly cut. Even when bleached the skin retains this property. A good, oil-dressed skin should absorb moisture very readily. When wet it should be treated like a flannel, and when dirty a liberal application of soap is beneficial to the skin. If, after thoroughly washing, it is rinsed in soap-suds, the skin will dry up soft and shrink but a trifle.

The imported chamois cost about 5 per cent more than the American skin, due to their being firmer in texture and therefore less easily stretched, and for these reasons more durable. They are usually preferred for livery use. For light work and toilet use the American chamois is preferable.

A very attractive show window may be made with chamois, but care should be taken to avoid strong sunlight, as it rapidly bleaches the exposed portion of the skin.—The Spatula.

A NEW DEFINITION OF PORTLAND CEMENT.*

By A. D. ELBERS.

FROM the article "Tests and Constitution of Portland Cement," published in the SCIENTIFIC AMERICAN SUPPLEMENT of April 19, 1902, the following definition may be derived:

Portland cement is a sintered compound of clay and lime, which has approximately the constitution of a half silicate ($0.5:1$) with lime for its principal base, and alumina, ferric oxide and alkalies as minor essential constituents. It is an unstable compound which gradually releases under atmospheric influences nearly all of the lime that it holds in excess of a two-thirds silicate ($0.66:1$); and it takes up water of crystallization in setting, and thereafter hardens in the air as well as in water without undergoing any material change of volume. Exposed to the air, the set cement hardens principally through the absorption of carbonic acid gas by the liberated lime, and in water it hardens principally through the formation of hydro-silicates out of a portion of those of its constituents that are reacted upon by the liberated lime that dissolves.

The most suitable composition for Portland cement appears to be that which yields in the fire a sintered compound having its chief constituents in such proportions that the oxygen of the silica amounts to half of that of the lime, alumina and ferric oxide, and that the oxygen of the alumina and ferric oxide, added to that of the silica, is equal to that of the lime and magnesium oxide.

Ferric oxide and alkalies, though only desirable in small proportions, have to be considered essential

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

constituents for the following reasons: The ferric oxide, being present in the uncombined state, readily forms during the burning calcium ferrate; and thereby incites the alumina of the clay to assume also the character of an acid constituent, and to bind the remaining free lime. Finally, both sesquioxides are overpowered or subjugated by the silica, and then resume their basic character, which leads to the gradual release of the lime in excess, and to the hardening of the set cement.

The alkalies act during the burning as fluxes, and in the new cement as solvents of silica, which they yield later on to the lime.

All bases that assume under atmospheric influences a higher degree of oxidation, such as the protoxides of iron and manganese, are objectionable constituents.

From a synthetic point of view it might not seem necessary to define Portland cement as a compound of clay and lime, inasmuch as an equivalent substance could, possibly, be produced by substituting free silica and alumina for the clay. But aside from the fact that it is not practicable on account of the cost to use alumina for the composition of a mix unless beauxite is available, it is advisable to adhere to that definition because it indicates the difference between true Portland cement and slag cement that has been burned in the same manner.

Since slag cement is now burned in rotary kilns, whereby the sulphur, the worst feature of the unburned slag-puzzolanes, becomes eliminated, it can only be distinguished from true Portland by its lower specific gravity. As Portland is made by combining hydro-silicate of alumina by hard fritting with nearly twice as much of lime, whereas slag cement is made by combining completely melted compound silicate of lime, alumina, etc., with a much smaller proportion of free lime, the one necessarily undergoes more intense reactions during the burning than the other; and the resulting difference in the density of the respective products is apt to be in most cases a rather accurate indication of their comparative efficiency in the finished state.

ELECTRICALLY-OPERATED AIR COMPRESSORS.

ONE of the most remarkable developments in the recent history of engineering progress is the constantly increasing use of compressed air as a medium of performing numerous and various industrial operations.

Pneumatic tools and other appliances for the utilization of compressed air have been introduced into one field after another with such successful and gratifying results that the advantages of using compressed air for a wide variety of purposes are now fully recognized.

The present general use of electricity renders it advantageous to operate air compressors with electric motors. The convenience and economy of this method is apparent when it is remembered that an electrically-driven compressor can be operated from any lighting power or railway circuit that may be available.

To meet the constantly increasing demand for an electrically-driven, simple, compact air compressing unit, the Christensen Engineering Company, Milwaukee, Wis., are manufacturing a complete line of motor-driven compressors ranging in capacity from 4 to 1,000 cubic feet of free air per minute. The smaller sizes are made for portable as well as stationary service. The following description of these machines will be of interest to our readers.

The type "M" motor-driven air compressor, illustrated herewith, is for stationary continuous service. It is built in capacities from 50 to 1,000 cubic feet of free air per minute.

The electric motor and the compressor have been designed to form a compact self-contained unit. The air is compressed in the cylinder, shown on the left, by a double-acting piston which is operated by means of a connecting rod and steel crankshaft. The latter is mounted in bearings located within the frame of the machine. This shaft carries on the motor end a helical gear which is driven by a pinion on the armature shaft of the motor. The entire machine is mounted on a substantial cast iron base.

Both the cylinder and the valve heads are water-

tion is reduced to a minimum. The suction and discharge valves are identical and interchangeable. Only one connection is necessary when piping from the compressing cylinder to the reservoir.

The piston is provided with an improved form of packing rings which are carefully fitted in place so that they form as near a perfect sliding joint as can be obtained. The piston rod is of steel, carefully ground true on dead centers. The rod passes through a self-adjusting metallic packing box.

The connecting rod is composed of steel and is arranged to receive oil for lubricating the crank pin, wristpin and piston. The crosshead is provided with adjustable shoes of extra large area and with an accurately ground hardened tool-steel wristpin which fits into a phosphor-bronze bearing in the rod.

TYPE "I" COMPRESSOR WITH MOTOR REMOVED.

The crankshaft is composed of a high-grade steel, and is provided with extra large bearings, thus avoiding the frequent adjustment of the bearing boxes which is usually necessary with bearings of ordinary size. The shaft is carefully balanced and accurately turned true to receive the connecting rod.

The crankshaft is extended at the motor end to carry the gear which is driven by a pinion on the armature shaft of the motor. The gear and pinion are of the helical herring-bone type with teeth cut by special machinery in the most perfect manner, thereby reducing the noise so that it is almost unnoticeable.

The gear case and the crank chamber are connected and form an inclosure which is partly filled with oil, with which all the working parts are automatically and continuously lubricated, including the air cylinder. The latter is connected with the oil chamber so that the proper quantity of oil for lubricating the surface between the cylinder and the piston is automatically supplied and no sight-feed lubricator is required. The motion of the crankshaft in the oil causes continuous lubrication of the main bearings, the crankpin bearing of the connecting rod, the crosshead guide, the piston rod, the wristpin in the crosshead and the piston. Oil is also supplied automatically to the bearings at the pinion end of the motor. The gear and pinion operate continuously in the oil bath. The machine will remain lubricated as long as the oil is kept up to a level determined by a filling plug on the side of the crank chamber. Experience has shown that, after being supplied with oil, the compressor runs for several weeks before replenishing is necessary.

Either an alternating or a continuous current motor may be used. The illustrations herewith show the continuous multipolar type that the Christensen Company built for this service. The lower frame of the motor is of cast iron and the field is composed of low-

ment. The bearings are so designed that it is impossible for oil to get into the armature.

The brush holder is of the simplest possible construction. It is provided with an instantaneous tension adjuster arranged so that the tension can be increased while the motor is running.

The design of the motor and compressor is such that every part is easily and quickly accessible.

By unscrewing a few bolts the armature and the field coils can be removed or exchanged. The gear, pinion, valves or cylinder heads may also be removed without disturbing any other parts.

Access to the crosshead and wrist-pin is obtained by doors conveniently arranged on the side of the slide-frame. The crank chamber is constructed so that it is completely closed, but the upper part may be quickly

removed, giving free access to all the working parts, while a smaller handhole covering is provided and may be easily removed for inspection of the interior.

An automatic governor starts and stops the motor compressor at the desired minimum and maximum pressures. It is a very simple piece of apparatus, consisting of an ordinary pressure gage mechanism with a special hand which, upon coming in contact with a conducting stud at the position of minimum pressure, allows current to flow through a magnet coil. This coil operates a plunger to which the contact pieces for the motor circuit are attached, thereby closing the circuit and starting the motor.

As soon as the pressure reaches the desired maximum, the hand strikes another stud and current passes through a second solenoid magnet, thereby pulling the plunger in the opposite direction and opening the motor circuit. By this mechanism it is possible to get a close margin between maximum and minimum pressures. This margin is readily adjusted by moving the contact studs.

The governor is provided with a magnetic blowout for extinguishing the arc and preventing the burning of the contact pieces.

All the working parts are easily accessible for inspection, and the governor is protected by a cover not shown in the illustration.

A smaller compressor for stationary continuous service is built in capacities from 4 to 35 cubic feet of free air per minute.

These are known as type "L," and they are similar in design and construction to type "M," described above. The motor is mounted directly over the compressor instead of on the side. The compressor has two cylinders which are water-jacketed throughout. Each cylinder is provided with a single-acting plunger piston which is operated by a connecting rod from a

TYPE "M" COMPRESSOR. CAPACITY, 75 CUBIC FEET PER MINUTE.

jacketed throughout. The clearance spaces have been reduced to the lowest practicable limit, thereby correspondingly increasing the economy.

The suction and discharge valves are arranged in cast iron heads bolted directly to the cylinder. They consist of seamless cold-drawn steel cups, so arranged that each is removable independent of the other. No springs are used with these valves. They are operated by the compressed air itself and are reseated by gravity. The peculiar construction of these valves renders a small lift possible, hence the noise from their opera-

carbon cast steel with detachable steel pole pieces. The motors are series wound and are started and stopped without using resistance of any kind. The armature is of the latest ventilated type, built up of disks of soft steel and slotted to receive the winding. Machine-formed armature coils are used; the insulation and other materials are of the highest grade obtainable. The commutator is built up of hard-drawn bars of the best lake copper insulated from each other by segments of mica. The armature shaft revolves in extra long bronze bearings with ring oiling arrange-

well-balanced steel crankshaft. The shaft is extended at one end to carry a helical gear which is driven by a pinion on the armature shaft of the motor directly above. The base of the motor forms a cover for the compressor frame, and the gears are also inclosed in a suitable casing. The interior of the compressor is therefore completely inclosed and protected from injury. This compressor is a modification of the type "H," the water-jacketing feature being added to make it suitable for continuous service.

The suction and discharge valves are of seamless

MOTOR FOR TYPES "L" AND "I" COMPRESSORS.