Cacti and Their Uses

A Discussion of This Interesting Family and Some of the Things It Is Good For

By Dr. William A. Murrill, New York Botanical Garden

Photographs by courtesy of the United States National Museum

A desert is not necessarily a monotonous waste

It is estimated that there are three billion acres of desert land in the world; and, if these unattractive and unproductive wastes are ever to "blossom like the rose," it will be the cacti or plants similarly adapted to desert conditions that will furnish the flowers. Desert plants were like other plants once, but the vital necessity for preserving moisture gradually wrought a wonderful change in their appearance and structure. Few of the cacti now have any conspicuous leaves, their place being taken by flattened joints, or pads, which are modified portions of the stem; and even the sap has become mucilaginous or milky, preventing the loss of water to the hot, dry air by which these plants are continually surrounded. Spines of various shapes and sizes serve to protect them against grazing animals that are often killed when driven by hunger and thirst to devour these plants in spite of their spines. The few forms of spineless cacti that occur in the wild state always frequent rocky ledges and other situations

that are inaccessible to most animals, if not to all.

The number of species of cacti recognized is large, amounting to about one thousand, and half of these are found in Mexico. They vary from tiny plants no bigger than one's finger to trees sixty feet in height, presenting all manner of queer and interesting shapes and furnishing the botanist with no end of knotty problems. Extensive collections of living plants may be seen under glass at the New York Botanical Garden, the Department of Agriculture in Washington, and the Missouri Botanical Garden in St. Louis; while others in the open are to be found at Riverside, California; Tucson, Arizona; Mesilla Park, New Mexico; Laredo, Texas; Miami, Florida; and elsewhere.

Cactus plants are certainly not ornamental in the ordinary sense, but beauty is relative. A forest of giant cactus trees stretching mile after mile in the desert with nothing to rival them may be decidedly attractive. In Mexico the cactus ornaments the national banner and is stamped on many of the older coins, while in Arizona and New Mexico it has been selected as the state flower.

The cactus family is noted for the magnificence of its flowers, which are usually large, often fragrant, wide-spreading or tubular, diurnal or nocturnal, evanescent or persistent, and vary in color from white, yellow, or orange to rose-colored, deep-red, or purple. The calyx and corolla are not distinct, but the numerous stamens in the center are often differently colored and lend an added charm to the flower. The fruit is often brilliantly colored, highly ornamental as well as useful, and lasts for a long time.

The cactus plant has indirectly added much to the attractiveness of certain manufactured garments by supporting the cochineal insect, from which the famous cochineal dye is made. This insect occurs on a species of *Opuntia*, the cochineal fig, and its near relatives, along with other mites and scale-insects, but it is so minute and difficult to distinguish with the unaided eye that it was long thought to be the seed or bloom of the plant itself. Leeuwenhock, in 1703, discovered that it was the female of an insect (*Coccus Cacti*), which never moved from a certain spot on the cactus, the male being the active member of the family but colorless and therefore useless. These insects are harvested three times during the dry season, being swept from the cacti into wide-mouthed bags with stiff brushes and killed in boiling water or hot ovens, after which they are dried in the sun and put up in small packages for the market. In this thoroughly dried condition 70,000 insects are required to make a pound.

The ornamental value of cacti, although important, is not uppermost in the mind of the average inhabitant of arid regions. The trunks furnish him material for

The splendid flower of *Heliocereus* Mallisoni

houses, corrals, firewood, etc., and, when planted close together they form hedges that are lasting and impenetrable. It is here behind a shield of thorns that the little cactus wren finds a refuge from hawks where she can build her nest and rear her young in safety.

The cactus trunk is composed of a woody axis, or skeleton, surrounded by pulp. From this skeleton table legs, chairs, napkin rings, canes, veneering, etc., are made. The spines also are useful, serving as needles, toothpicks and pins for mending leather or cloth. Some are curved and supply ready-made fish-hooks, while the straight ones are bound to slivers of bone to form very efficient barbs. One species of cactus bears fruits that resemble great chestnut burs, and these have been used by the Indians for ages as hair brushes.

The pulpy parts of the stems and fruits are highly valuable as food both for man and beast. The young

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Left: The mescal button, or peyote, in flower. Center: A species of *Opuntia* from Kansas. Right: A rather curious species of *Echinocactus* found in Mexico

Several cacti of widely differing types

less tractive effort than any other type of prevailing roadbed. Concrete structures will stand up under fire where stone buildings would be apt to succumb; and experiments have been made which reveal that gravel concrete columns can be rendered further immune to flame by coating them with plasters composed of gypsum, hydrated lime, and kieselguhr. And bitter experience has emphasized that the round concrete column is better able to endure intense heat or a blaze than one that is rectangular in section. In brief, a great deal has been learned latterly about concrete, and yet the investigator is busy seeking further enlightenment. The quest for knowledge is for the purpose of widening the ways in which concrete can be used confidently—eliminating the while the hit-or-miss methods of the past.

Making the Airplane Fireproof

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vents the fire from entering the helmet. A small window of two thicknesses of $\frac{1}{8}$ -inch mica with $\frac{1}{4}$ -inch air space is provided. The suit proper is made of $\frac{1}{4}$ -inch sheet asbestos with a $\frac{3}{8}$ -inch inner lining of hair felt. Both shoes and gloves are made of the same material as the suit. The weight of the suit with the helmet is 15 pounds, but with a few refinements this could be brought down to about 10 pounds.

Because of the fireproof nature of an airplane treated by his process, Mr. Bradley has gone a step further and equipped aircraft with fireworks and flares for exhibition purposes. The wings, struts, turtle back, tail and other parts of a fireproofed plane are covered with fireworks, and under the fuselage a dozen huge flares are mounted, all being wired for battery ignition, so that the pressing of a button by the pilot sets off all the fireworks and flares at one time. The effect at night is, obviously, most spectacular—and absolutely safe, according to the inventor.

The Craters of the Moon

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be a good deal of fractured and crumbled material in the ridges and peaks?

The bombs dropped on Langley Field were all of them moving at a much less speed than a representative meteoric body. Meteors are understood to enter the earth's atmosphere at velocities ranging, generally, between 10 and 40 miles per second. Such a body striking the moon's surface with its velocity unimpaired because of the absence of a substantial atmosphere would, Maj. Ives calculates, if all the heat generated be retained in the meteor, produce a temperature of 270,000° F. This temperature would gasify all known materials, even if nine-tenths of it were dissipated into the materials surrounding the meteor; so that finally we should have an explosion. A military bomb will, accordingly, be a better experimental substitute for a meteor than non-explosive objects. In common with the objects used in early experiments, the bomb generates but little heat in the surroundings at the moment of impact; but, in contrast to them, it does imitate the explosive effects. The calculation of the temperature produced was based upon the minimum speed of 10 miles per second. The higher velocities would naturally produce still more excessive temperatures. One reaches the conclusion, then, that meteors behave upon impact much as do military bombs—that is, they give rise to an explosion.

The ability of a bomb to produce the central peak in a depression is shown very markedly in our third photograph. This is perhaps a more pronounced case than any on the moon itself. But the holes made on Langley Field are of all descriptions. Thus we have the extreme case of a crater floor free of projections, except perhaps close up at the foot of the circular cliff.

In our final picture we have the lunar craters Theophilus and Cyrillus, the one

overlapping the other. A similar instance on Langley Field is shown in the second view of page 490.

In conclusion, one may say that the new evidence tends to rehabilitate the impact hypothesis; and that we still have a formidable alternative to the volcanic idea, notwithstanding Professor Pickering's vigorous handling of the subject in favor of the latter, in his work on *The Moon*, published before this evidence from Langley Field was in existence.

Cacti and Their Uses

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pads, or joints, may be cut into strips and cooked like string beans, or boiled as greens, or stewed like okra, or fried like eggplant, or pickled, or made into sweetmeats like citron. "Tuna cheese" is made from the fruits of certain cacti, while the juice of red fruits is often used in coloring ices, jellies, and candies, and even in water-color painting.

The traveler who "knows how" need never lack for water where there are cacti. He may cut off the top of a barrel-cactus, pound up the pulp and squeeze the water from it into his drinking cup. He will find it slightly salty and bitter, but clear and rather palatable. Or he may support a cactus trunk on stones, build a fire under each end, and make a hole in the middle, from which the water will gradually trickle.

The Indian traveler also uses the milky juice of *Mamillaria* for healing cracks in his feet or for internal complaints when on long journeys. One of the most curious and interesting of the cacti is the "mescal button," or "peyote," which is a strong stimulant and allays all hunger and thirst and fatigue for the time being. The Tarahumare Indians and Huicholes of Mexico make a cult of the "peyote," going on long pilgrimages in search of it and employing it both medicinally and religiously as a cure for all bodily ills and a powerful aid to abstinence.

In certain parts of Mexico, Sicily and elsewhere, the natives live almost entirely on fresh cactus fruits when they are in season. They grow them in gardens and orchards and often gather them at dawn when they are coolest, although their temperature is always below that of the surrounding air. They are also used in salads, preserves, pickled with lemons, dried, fermented as a beverage, made into a syrup called "tuna honey," a thin paste called "melcocha," or a thick paste similar to guava jelly. Even the seeds are sometimes dried and saved to use when the fruits are gone.

The Barbados gooseberry, used for tarts and sauces in the West Indies, is apple-shaped and decorated with small leaves or bracts. The plant, *Pereskia aculeata*, is a straggling shrub with slender branches, recurved prickles, glossy-green leaves, and clusters of pale-yellow bowers.

The prickly pears, or tunas, are abundant and much used. They are pear-shaped or globular, weighing from an ounce to a pound; red, yellow, or purple in color; and usually sweet, though sometimes acid in flavor. The skin contains clusters of tiny spicules, or glochidia, which are very irritating if taken into the mouth, so that care is required in peeling them. They are sometimes called Indian figs or Barbary figs because of the numerous small seeds which they contain. Several species of *Opuntia* are cultivated for their fruits as well as for their edible joints. The flowers are large, usually yellow or orange, rarely rose or red.

Delicious fruits are those of *Cereus pitahaya* and its relatives. This species grows to the height of sixty feet and its trunk reaches two and a half feet in diameter. The fruit is gathered at dawn with long reed sticks armed with several prongs.

The fruits of *Cereus giganteus*, a handsome cactus of the Southwest, are also much esteemed either in the fresh state or preserved. They are egg-shaped, two or three inches long, green on the outside and

"... Places far apart are brought together, to the present convenience and advantage of the Public, and to the certain destruction, in time, of a host of petty jealousies, blindnesses and prejudices, by which the Public alone have always been the sufferers." From Charles Dickens' Preface to *Pickwick Papers*.

The Advance of Understanding

Even romance of sixty brief years ago could not imagine the great advance heralded by the passing of the stage coach. The railway and telegraph were coming into their own; but the telephone had not been so much as dreamed about.

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crimson, within. The strawberry pear, obtained from *Cereus triangularis*, is pear-shaped, bright-red, with slightly acid pulp, making it desirable in the fresh condition or as an ingredient of the "pepper pot" of the West Indies. Excellent fruits are also produced by *Lemaireocereus thurberi* and certain other large tree-cacti, and these "pitahayas" do not have the annoying prickles found in the fruits of *Opuntia*.

"Garambullas" are the small currant-like fruits of *Myrtillocactus*. They are eaten fresh or dried like raisins. The melon cacti produce a number of small edible fruits resembling tiny scarlet radishes or red peppers. The Mexican strawberry, found on a species of hedgehog cactus, is salmon-colored, two inches in length, and very sweet in flavor. It gets its name from its numerous minute seeds. Tetezo figs, so important to the natives of southern Puebla, are the fruits of a species of *Pachycereus*.

Although many of the wild cacti furnish valuable food for man and beast, it must be admitted that there is room for improvement both in the quantity and the quality of this food. I have visited Mr. Burbank's experimental grounds in California and fully realize the difficulty of his task in dealing with the cacti and the importance of his results. His problem was to take a vagrant, forbidding plant, and divest it of its thorns and prickles, breed out its indigestible woody skeleton and improve the size and flavor of its fruits.

Of the twenty or more genera in the cacti he selected *Opuntia* because it was widely distributed, readily adaptable to soil and climate, hardy, thrifty, with edible pads and fruits, and already represented by some spineless varieties. He secured 75 species and 600 varieties of this genus from all parts of the world and selected from them plants that appeared to possess the greatest number of good qualities. Seeds from these plants were sown by the thousands and the new plants hybridized in order to break up their fixed habits. Gradually a few plants were obtained by crossing and selection that were spineless. After obtaining and fixing one good quality, he sought another and another, until, after ten years of very exacting labor, he gave to the world his "spineless cacti."

A number of these spineless forms, obtained from Mr. Burbank may be seen growing in the conservatories of the New York Botanical Garden. Some are especially suitable for feeding cattle, while others bear delicious fruits. Before the cuttings will grow they must be wilted in the hot sun for a week or more, after which they are partly buried in soil or ashes. When planted out in fields or orchards, they should be set three or four feet apart in rows eight or ten feet apart.

The fruits of these Burbank creations are over three inches long, usually yellow or red in color, and have flavors all their own, resembling those of peaches, melons, pineapples, etc. The amount of sugar is large, being 12 to 16 per cent which gives the fruits their sweetness and much of their food value. They may be sold for the price of oranges and it costs only half as much to grow them, while there need be no fear of a poor or failing crop. The food value of the spineless pads for stock is about half that of alfalfa, and enormous crops can be grown without irrigation on arid or sterile land unsuited to other crops.

Colorado's Cloud-Burst

(Continued from page 494)

Pueblo, situated at the confluence of the Fountain and the Arkansas Rivers, got the full benefit of the flood in both streams.

The map on page 494 shows the part of the Arkansas drainage system in which the flood had its origin. The contour lines are drawn for intervals of 250 feet. They indicate the great difference in pitch between the Arkansas on the one hand and

its tributaries on the other. Without cluttering the map up with so many lines as to make it unintelligible we found it impossible to do more than suggest the facts that the banks of these creeks are likewise steeper than those of the main stream, and that the latter is really bordered, below Turkey Creek, by a very considerable alluvial plain little higher than the water. We have been able to locate approximately one of the dams that broke; but the Geological Survey maps, the source for this as well as for practically all commercial maps of the United States or parts thereof, antedate the dams; so we are not able to show all of these.

Floods are nothing new to this region. Heavy rainfalls are common in the mountains, and it is a frequent occurrence to find the Arkansas occupying more or less of the broad flat space between its normal banks and the foothills at either side. The extreme severity of the present visitation is due to the fact that many days of unusual rainfall were followed by the cloud-burst and the going out of the dams. The damage may be roughly divided under three heads. Most of the loss of life was in the low parts of Pueblo, which were completely inundated, many houses being swept off their foundations by the unexpected rush of the water before their occupants could make a move toward safety. Then the floor of the river valley, as it gradually widens from the mouth of the canyon to Pueblo and beyond, is occupied by farms, which have suffered a great deal of damage to their standing crops as well as to their buildings. Finally, the railroads, building as they must along the line of the streams, have had much of their track swept away, while there has apparently been some loss of life from trains that were overtaken by the flood and swept from the tracks.

The floods at Denver and other points in the northern part of the state appear to be due entirely to the gradual rise of the streams under the influence of many days of rather steady, heavy rain. We read of no cloud-bursts in this section, and of no dams going out. This is the reason why the floods here, while severe enough, have not approached those at Pueblo and other points in the Arkansas River drainage system. But the Platte, which will eventually receive the flood waters from the northern part of Colorado, has even less of a real channel or valley where it passes through Nebraska than has the Arkansas through Kansas; so we may look for more serious secondary effects here than in the case of the Pueblo floods.

The Farm Market for Trucks

(Continued from page 495)

the size of the farm nor the type of farming has any monopoly on the interest in trucks.

"We believe we know fairly well why some farmers have bought trucks, but what about those who have not bought trucks? We want to know if this negative is a permanent one; if they are not buying trucks, is there any possibility of showing them the real economy of this kind of hauling? With this in mind, we find thirty-three per cent of the farmers give as a reason for not buying trucks some reason that is classified as 'Financial.' We find eleven per cent give bad roads and, incidentally, that is somewhat lower than we anticipated. We find that of those who say that they do not have the cash or credit with which to buy motor power for transportation, sixty-two per cent own automobiles and eighteen per cent own tractors. In other words, they have actually paid out money for the purchase of motor power in some of its phases, but are not as yet sold on the fact that this is applicable to the transportation of their crops, though they recognize the value of the same kind of power for personal transportation or for use in plowing and harvesting the crops.

"Of the farmers using trucks, forty-two per cent are using tractors. Here we find that the truck and tractor are not competitors as the smaller farmer is a less extensive user of the tractor than the larger farmer, while the truck is equally applicable to all sizes of farms. The size of the truck best suited to farm use is a subject of much discussion among truck manufacturers and salesmen as well as farmers.

"Regardless of the size of the farm, there is relatively little interest in a truck of less than one ton. We find from the report a very marked interest by those who have not yet bought trucks, in the one-ton trucks, in the ton-and-a-half and two-ton trucks. If we take this by the size of the farm, for example, we find forty-one per cent of them with farms of one hundred acres and less are interested in the one-ton truck. Of those farming over two hundred and forty acres, twenty-two per cent of them are interested in the one-ton truck, while only one per cent are interested in a truck of less than one ton. We find in the larger acreages thirty-nine per cent are interested in the two-ton truck, while twenty-six per cent of the farmers farming less than one hundred acres are interested in a two-ton truck."

Labor-Saving Truck Bodies

(Continued from page 495)

leys at each end of the tubular support, these cables being operated by means of gearing from the power take-off of the transmission. When the body is carrying a load of brick it rests in a horizontal position and the actuating member attached to the body frame is down at the lower end of the tubular support near the large sheave. When it is desired to dump a load of brick the engine power is diverted to the cross-shaft carrying the two large pulleys over which the cable runs, and as these pulleys rotate the body-actuating carriers are moved out on the tubular supports and the body is shifted from the horizontal position it normally occupies to the angular position necessary to dump its load. The construction outlined makes it possible to clear the rear end of the chassis with the body and have it assume a nearly vertical position so that the bricks may be deposited on the ground in the same orderly way in which they were loaded into the truck body.

Another use of the power take-off is outlined in the photograph of the 2½-ton truck which is equipped with a special log loader which makes it possible for one man to load or unload large logs unaided, except for the engine power, that would require a gang of men to handle with the simple skid equipment ordinarily provided for lumbering operations. The log-loading mechanism is very simple. It consists of a windlass roll carried at the side of the chassis by suitable bearings and extending from the cab to the rear end. The log to be loaded is encircled by a chain, the end of which is attached to one of the hooks on the windlass. When the engine power is diverted to the windlass-operating gear by the simple foot-pedal control, mounted on one of the steps, the chains roll up and drag the logs up the skidway and on to the truck frame.

Another simple device which saves considerable time is fitted to a truck of the Kansas City, Mo., Telephone Company. This truck is equipped with a simple hoist or derrick for raising and setting telephone poles. Recently the truck and a gang of three men, one of whom was the truck driver, made a record of setting forty poles in one hour. The holes had been dug and the poles distributed before the feat was attempted. It is stated that before this truck equipment was put into service it required six men to raise and set eight poles an hour. The truck is not only useful in general construction work, such as installing pole lines, but it is also valuable for drawing cables through conduits and for general emergency wagon work.

A Money-Saver in Locomotive Repair

EVERY steam locomotive carries from four to twenty-eight bearing boxes for the truck and driving wheels. Each of these boxes has a hubliner—a metal disk protecting the driving box from the friction of the wheel hub. This hubliner is ordinarily cast on from babbitt metal, by means of an operation that is difficult and dangerous for the machinist and inordinately costly to the railroad. The machinist has to raise the bearing box with a chain hoist and put it in a fire pot, where it must remain half an hour before becoming hot enough. When it attains this point it is again hoisted out of the fire and put on the floor, where a workman builds a wall inside and out of fire clay, large enough to cast on a two-inch liner. After some five hours, the box has cooled sufficiently for it to be moved into the machine shop. Here the babbitt is shaved off to the proper thickness, the shavings falling to the floor and mixing with the iron and steel scraps which lie there, making necessary a separating process before the latter can be used. The babbitt scrap is waste pure and simple, since a second heating renders it second class metal. After this planing the box is carried to the locomotive erecting shop, where the necessary holes are drilled for assembling it on the engine—a difficult task, and one invariably resulting in loss of one or more drills. The entire process requires the services of five men and extends over two to three days.

A Newark, N. J., machinist has devised a hubliner mold that eliminates all this. It makes possible the installation of a hubliner within an hour and a half. No heating, soldering or fireclaying is required. The lubricating holes are cast direct in the liner, saving all drilling. The liner can be cast right on the cold box at the point where it is taken from the wheel, so there is no chain-hoisting or other moving of the work about. Although cast on the cold box without soldering, the inventor guarantees that the liner will not come off. He points out that when cast this way the liner has a "skin," which is not the case where it has to be shaved off; the period of renewal becomes a year instead of six months.

The apparatus by which all this improvement is attained is simple enough. Our photograph shows it after it has been taken down off the completed liner, which is seen as cast on the box. It will be at once understood how the pattern is clamped to the backpiece, and the latter turned over and clamped to the end of the box, preliminary to the casting. Patterns of various shapes and sizes may be used with the single back-piece to produce liners of any desired model.

Ornamental Typewriting

AT the time, a year ago last fall, when the editorial typewriters kept the SCIENTIFIC AMERICAN in the ring while most of our contemporaries were suspended because of the compositors' and pressmen's strike, none of our readers was more interested in our efforts than Mr. Jacob Backes, of this city. Mr. Backes has for some years been interested in the possi-

bilities of photographic reproduction from typewritten copy as an alternative for type-set material; and he has written several articles explaining his ideas, and even gone so far as to induce the Century dictionary to

written copy, and he now finds that he can produce title lines of various degrees of fancifulness with the one machine. It will be recalled that when we were typewriting our issues we had a special machine for printing the main titles, and that we made subtitles and authors' lines by using the capital letters on two ordinary machines of slightly different type-face. Mr. Backes has found seven characters on the keyboard of his typewriter that can be dispensed with—we can count without any particular exercise of the imagination nine such characters on the machine which we are using at the moment, the very one, it so happens, that produced 95 per cent of our emergency issues of 1919. He has replaced these seven dispensables with seven arbitrary signs—a simple curved line in four positions, an upright of ordinary type thickness and one of solid black much thicker, and a diagonal line sloping backward. Taking these seven in conjunction with the ordinary hyphen, dash and diagonal fraction bar, he is able to execute a large variety of ornamental lettering. The series of SCIENTIFIC AMERICAN titles which he has turned out bear ample witness to this, and a careful examination of these will make it clear that Mr. Backes is justified in his claim that he has done no retouching or blocking out, and in fact no trick work whatever. So far as the handling of the machine is concerned, this copy is evidently straight typewriting, and the possibilities are doubtless considerably wider than this particular group of examples shows.

A Weather-Proof Skylight Ventilator

SOMETHING different in skylights is the subject of the accompanying drawings—nothing less, in fact, than a skylight the entire area of which remains available for ventilation during any ordinary rain or snow storm. The skylight is self-opening when the control is released. This control may be by hand; or if it is desired that the skylight open as a means of release of smoke and fumes from fire, it may be held in closed position by a fusible link or an inflammable rope, to be automatically released when this gives way. The explanation that the new ventilator is designed largely for use in theaters explains what might otherwise be somewhat of a puzzle—why it is desired to give a fire exit to the outer air.

The construction is such that the device can be used as a lean-to ventilator and skylight, or placed in any other way. When closed, one sash overlaps the next by several inches, with a nosing at the top of the under sash to keep out any water that might be driven up by a rain storm.

Left: The old method, showing how much metal was wasted. Right: A hubliner cast on the box by the new process, and the mold disassembled beneath

The new outfit for casting locomotive hubliners at great saving of men and metal

THE letters, ornaments and borders in the above illustration were produced by typewriting the characters *Scientific American* - combinationally end to end or over each other. The callityped outlines took the place of as many dispensable characters on the machine. Ordinary black record ribbon was used, no carbon

sheets. All typing proceeded from left to right. There was no penwork, whitening out or soldering or mortising. No guiding device was used, and there was no shifting or reinsertion of the paper.

The original size of this callityped illustration was 8 1/5 by 7 inches. All originals can be either photographically enlarged or reduced to microscopic print.

A sample of what can be done with a typewriter equipped with a few special keys

recognize the name, callitypy, which he has given to his system. He boldly takes the bull by the horns in the matter of typewritten text, and insists that the only reason for having the lines come out with even

immediately

The automatic ventilating skylight, showing how it looks when open, and means for controlling it