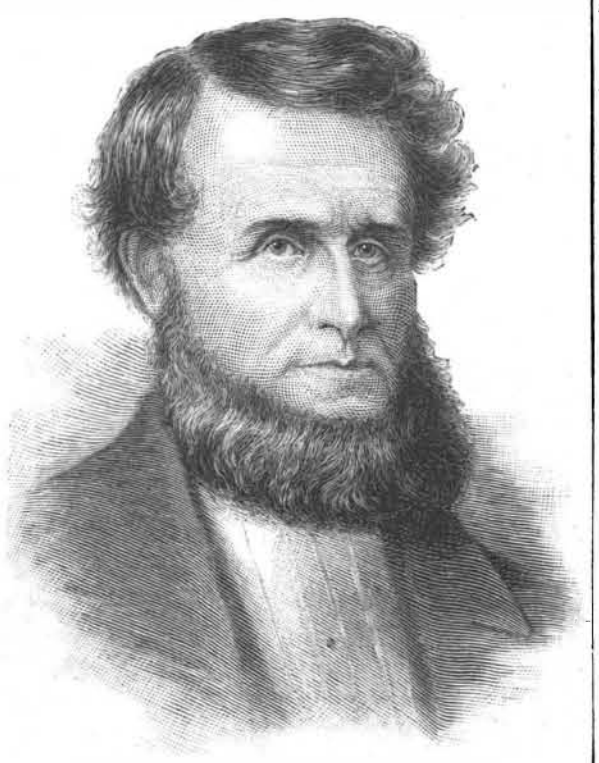
glass, and a plano-concave lens at the other end for an eyepiece, and magnifying three times. Ever since Galileo's brilliant discoveries with this "optick tube," described by Milton in his visit to Padua, the growth of the telescope has been of steady progress, in spite of the opinion of a cotemporary professor of Galileo in the University of Padua, who argued that "things invisible to the naked eye are useless and do not exist." In tracing its development briefly we find that the difficulties in obtaining good glass led Newton to construct a reflecting telescope in 1688, which magnified 39 times, the speculum or mirror being made of an alloy of copper and tin. Improvements followed which finally resulted in Herschel's finely constructed instruments, in the large six foot reflector in its gigantic frame, made by Lord Rosse, and in the celebrated reflectors of the present time. The reflecting continued to supplant the refracting telescope until about 1753, when Dolland, an English optician, showed that lenses of flint and crown glass could be combined in such a manner that their dispersive powers would neutralize each other, and this is the principle of construction of the achromatic objective now in use, consisting of an outer double convex lens of crown glass and an inner lens nearly plano-concave of flint glass.

The 12 inch refractor, which was originally made for Dr. Henry Draper's private observatory at Hastings, N. Y., by Alvan Clark & Sons, is of the finest construction. The object glass of the 6½ inch equatorial was also made by the Clarks, and is provided with a portable mounting made by Warner & Swasey. The 4 inch comet seeker, made by Alvan Clark & Sons, has a focal length of 33 inches. The rays fall on a reflecting prism, and are bent into a horizontal plane. The eye of the observer moving in azimuth while the telescope is in altitude can cover the whole sky. The motion is effected by turning a crank. This was bought on Prof. Newcomb's recommendation.

The photoheliograph is mounted south of the transit house. The transit instrument determines the axis of the photoheliograph, and this is also used as a collimator for the transit. The 6 inch Repsold meridian circle was delivered in 1884, after having been inspected by Profs. Auwers and Krueger, of Berlin. The declinograph was made under the supervision of Dr. Johann Palisa, of Vienna, to fit either a 12 inch or 6 inch equatorial. The universal instrument made by Repsold consists of a telescope containing a prism, into which the rays of light are reflected. Its aperture is 2·15 inch. The horizontal circle reads by two microscopes to 2", and the circles are 10 inches in diameter. This is a perfect geodetic instrument, and together with a 6 inch equatorial and a chronometer can be easily packed for astronomical expeditions. There are several chronometers made by Negus, and a thermometric chronometer by C. Frodsham. The most important of the minor instruments are the filar micrometer for the 36 inch telescope by Fauth & Co., the duplex micrometer by Grubb, and a star spectroscope made by Brashear from designs of Mr. Keeler. Plans for a large solar spectroscope are being worked out by Prof. Holden and Prof. Langley. The other instruments are a delicate sphereometer by Fauth & Co.; resistance coils; galvanometers; a disk photometer; spectroscopes; a lever trier of refined construction; and an engine for measuring photographs, scales, etc., made by Stackpole & Bros., from designs of Prof. Harkness.

The meteorological instruments are: Self-registering rain gauges, wind gauges, barometers, and a number of thermometers. There is a complete set of apparatus for registering earthquakes, provided by the Cambridge Scientific Instrument Co., consisting of a horizontal seismograph with clock and driving plate, the clock being started by an electric contact at the beginning of a shock, and the two rectangular components of the horizontal motion then registering on a moving plate; a vertical seismograph to register vertical motions on a dial plate; a duplex pendulum seismograph to give independent records on a dial plate, the pencil being free to move in any azimuth; and a chronograph, which is set in motion at the beginning of an earthquake and records its duration upon a clock. The staff of the observatory consists of Prof. Edward S. Holden, director and chief astronomer; Samuel W. Burnham, James E. Keeler, John M. Schaeberle, and Edward E. Barnard, assistant astronomers; and C. B. Hill, secretary, librarian, and occasional observer.

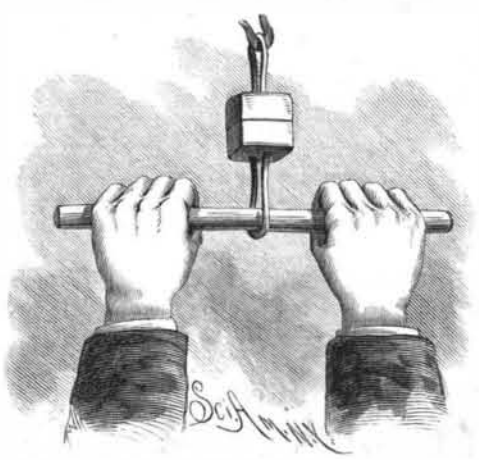
Early in 1886, Prof. Holden made contracts with the



JAMES LICK.

Southern Pacific and other railroad companies for supplying time from the observatory by automatic electric signals. This regular time service, of which Mr. Keeler has charge, has been in operation since January, 1887. A great part of the apparatus used in this service forms an integral part of the observatory's equipment. The system which has thus been introduced has been of great service to that particular section of the country, as well as to the railroad companies.

Instruments for recording earthquake shocks have been constructed by a company in San Francisco, and are sold at a very low figure. It is designed in this way that records of any seismic movements shall be procured by private individuals in different parts of the



COHESION—BLOCKS SUSTAINING DIRECT STRAIN.

State, and plates upon which the movement has been recorded may be sent to the observatory, where a record will be kept of all such data, and blue prints will be made of the diagrams and copies of this sent to the person from whom the plate has been obtained. Although this is quite independent of the regular work of the observatory, it will doubtless lead to the accumulation of data which will be most important in formulating statistics for future use.

The great telescope has been mounted for several weeks, and several satisfactory tests of its capacity have been made. It was first directed to the sky on the evening of January 3, 1888, and a few observations were then made for the partial adjustment of the object glass, but the observation was abbreviated by the skies becoming cloudy. The next observations made were on the evening of the 7th. On this occasion Saturn was observed, and Mr. Keeler, who conducted the observation, says with rapture that it was "the most glorious telescopic spectacle ever beheld." He exclaims: "Not only was he shining with the brilliancy due to the great size of the objective, but the minutest details of his surface were visible with wonderful distinctness."

The outlines of the rings were very sharply defined. The most curious feature was the structure of the outer ring; at about one-fifth of its width from its outer edge, a fine dark line was discernible, which marked the beginning of the dark shading, diminishing in intensity up to the black line. The inner ring did not shade off gradually into the gauge ring, as often represented, but the line of separation was distinct. The space between its inner edge and the planet was perfectly black.

Much of the data given in this article was procured from Prof. Holden's report in the *Sidereal Messenger* and Mr. James E. Keeler's notes on his own observations in the same journal. The observatory with its apparatus and appurtenances is to be transferred, upon its completion, to the University of California, and will in future be under the government of the regents of that institution. Prof. Holden resigned the presidency of the University in order to become director of the observatory.

COHESION OF LEAD.

T. O'CONOR SLOANE, PH.D.

It has long been known that perfectly clean surfaces of lead, when pressed together, would adhere to each other with some force. The experiment ranks as one of the classics in simple science. A very good way to show it is with bullets. Small surfaces, flat and clean, are prepared on two bullets by cutting off a little slice with a knife. When pressed together with a wrenching motion, the two will remain attached. A third bullet may now be fastened to one of the pair, and in this way a string of bullets, six or more in length, can be built up.

As the phenomenon depends on the absolute cleanness of the surfaces, and as it is a case of adherence of like to like, it is often invoked as an illustration of cohesion. Pure India rubber shows the same tendency, but in a far stronger degree relatively speaking. Whether it is true cohesion or not is uncertain, especially in the case of lead.

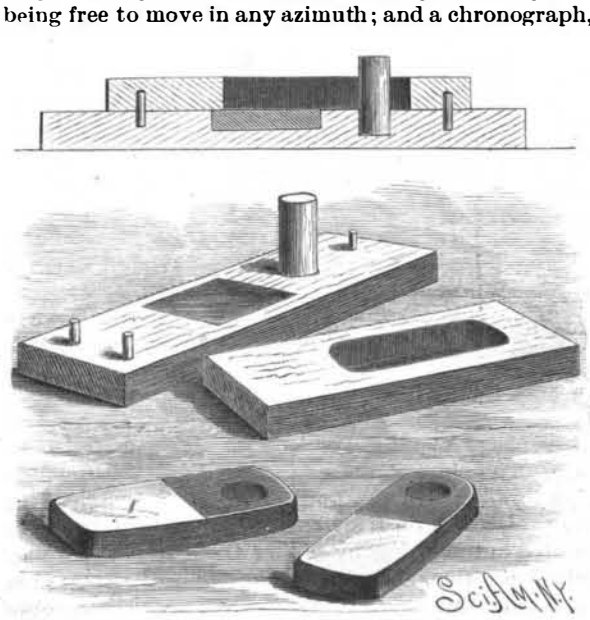
The method of obtaining this cohesion by employing mechanically prepared surfaces is a far less attractive method than the one which Faraday used in his lectures. He melted the lead and poured it out in two pieces upon a flat stone. After they had cooled, he pressed together the smooth lower surfaces of the lead, and thus obtained strong attachment. The flat plane on which the lead rested gave the essential true surface, while during the cooling it was perfectly protected from oxidation or dust. When lead is thus treated, even the upper surfaces which have been exposed to the air will answer for the experiment.

To make the phenomenon really impressive, it may be carried out on a larger scale. In the illustrations the necessary apparatus for conveniently doing this is shown. As mould for the face of the lead a polished block of metal is used. All things considered, this appears to work better than marble, which is the most available stone surface. A block of steel answers very well, and with use becomes slightly colored, as if by formation of magnetic oxide, and resists the rusting action of the atmosphere very well.

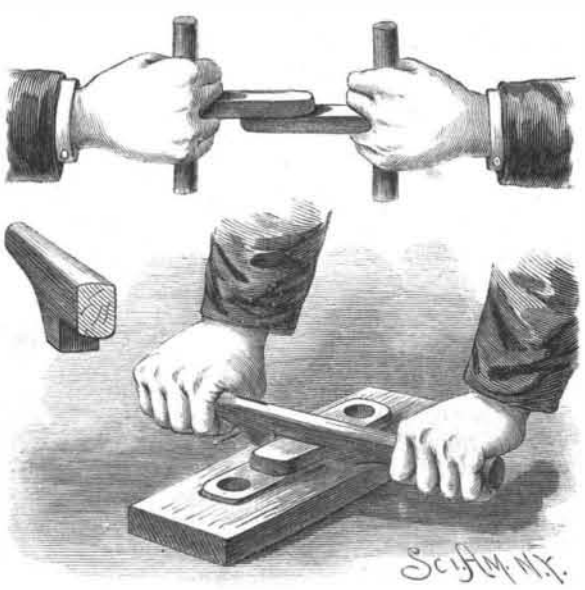
The metal block is set into a wooden base, so as to lie with its face even with the surface of the wood. Through a second piece of wood an oblong hole is cut. This should be about twice as long as it is wide. Its width should be equal to that of the metal block, or a shade less. When this is placed upon the base piece, so that the metal block lies at one of its ends and within the opening, the body of a mould is formed. Toward one end a round pin of wood is inserted. If lead is poured into the mould, it will assume an oblong form. Near one end will be a hole, and a face more or less smooth will be formed at its other end.

As regards size, a metallic block 1¼ inches square will answer for the face. The cavity of the mould should be about twice this length. A depth of from one-half to three-quarters of an inch is ample. The lead is melted and poured into the mould. As soon as solid the mould may be taken to pieces, the lead placed to one side to cool, and a second piece cast. This gives two corresponding pieces of lead.

Another piece of wood is provided, which contains a

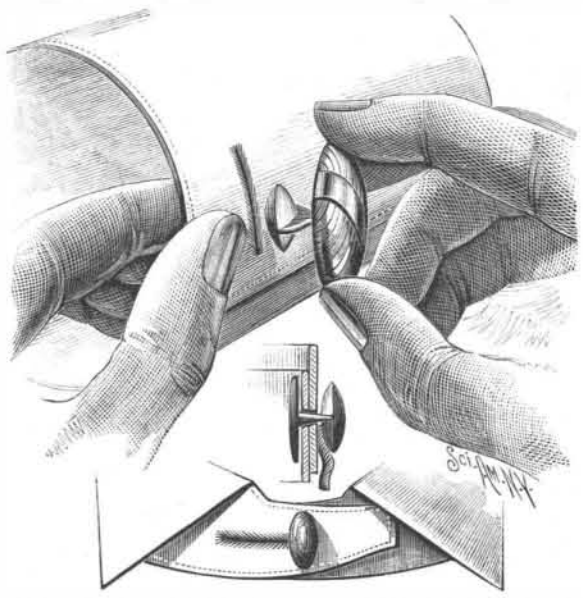


LEAD COHESION BLOCKS—THE MOULD.



COHESION—RUBBING BLOCKS TOGETHER.

shallow mortise or groove adapted to receive one of the pieces for nearly its full depth. A cross bar, with a piece cut out transversely, so as to form a notch 1¼ inches wide in the present case, is also necessary. Within the notch the wood is best rounded off. One of the pieces of lead is placed in the shallow mortise, with the smooth face uppermost. The other is placed upon



BENEDICT'S COLLAR OR CUFF BUTTON OR STUD.

it, but smooth face downward, the two clean surfaces of lead being in contact. By means of the cross bar the upper block of lead is pressed down with the full weight of the experimenter, and at the same time two or three slight twists or wrenches are given. The notch enables this to be done effectively. The latter wrenching movements are quite essential. In extent they may cover an angle of ten degrees.

The two pieces will now cohere or adhere strongly to each other. If all is properly done, they will resist a fair pull of one hundred and fifty pounds. A very slight transverse strain will immediately separate them. When pulled apart a slight roughness characterizes the points of attachment. The object of the holes is to supply places for the insertion of handles or cross bars, with which to pull them. If the experimenter is not too heavy, he can hang with his full weight suspended from them.

The stress here produced is analogous to shearing. To obtain the direct strain, two square blocks are cast upon the same metallic face, a differently shaped upper mould being used. This only requires one extra piece of board. Two square blocks of lead are made by the same process in general, and in each case a wire loop is inserted while the lead is yet soft. By using the notched bar and slotted block these are pressed together. A hole has to be made in the center of the slot for the loop of the bottom piece to pass through, and the cross bar can be passed through the loop of the upper piece.

They are pressed and twisted, as already described, and adhere about as strongly or nearly so as the others. From a pair of such pieces, 1¼ inches square, a weight of 103 pounds was suspended.

A DEVICE FOR UNLOADING AND STACKING HAY.

An invention providing means by which hay may be readily unloaded and formed in a stack is represented in the accompanying illustration, and has been patent-

HOYT'S HAY UNLOADER AND STACKER.

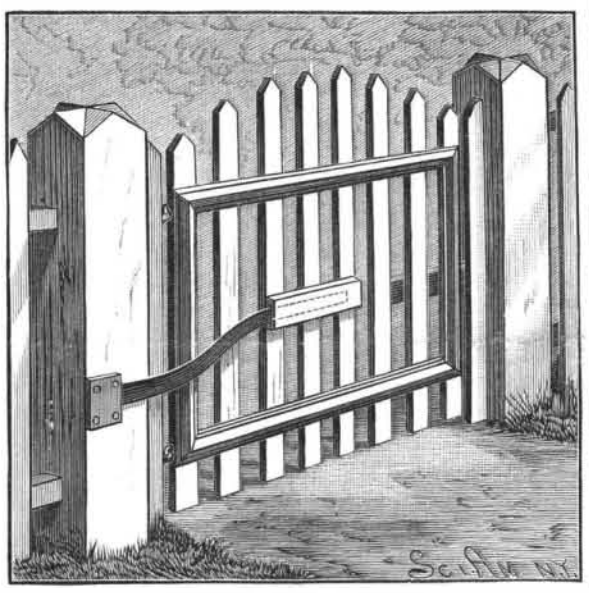
ed by Mr. Ovando Hoyt, of Ovando, Deer Lodge County, Montana Ter. The device consists of a novel construction of rack, to be placed near the spot selected for the stack, and used in connection with a pole held in perpendicular position, carrying pulleys and a hoist rope, to be drawn upon by a team of horses. The slings to be used in the wagon consist of lines secured at their outer ends to poles, which hang longitudinally over the basket sides of the wagon as it is being loaded, and the pole next the rack is provided with short chains, which are to be hooked over pins on the opposite side of the rack when the load is to be lifted. This invention is designed to facilitate the handling of a large quantity of hay at one time, without much strain upon the team, as the load is rolled from the wagon upon the slatted table of the rack, and from thence deposited on the ground or stack, the slats on one side of the rack preventing the hay from scattering beneath.

AN IMPROVED COLLAR OR CUFF BUTTON.

A special form of collar or cuff button or stud, designed to facilitate its insertion into and removal from the button hole, has been patented by Mr. Read Benedict, and is shown in the accompanying illustration. The shank is made flat upon two sides, to permit the button hole to close under the head of the button, the flat surfaces being brought parallel with the edges of the button hole, and the lower surfaces of the head of the button are curved or beveled from the flat surfaces of the shank upward to facilitate the passage of the head out of the button hole. For further particulars with reference to this invention address Messrs. Benedict Brothers, 171 Broadway, New York City.

AN IMPROVED GATE SPRING.

A gate or door spring which is easily applied and effective in operation is illustrated herewith, and has been patented by Mr. Theodore Clough, of Dobbs Ferry, N. Y. To the face of the gate is secured a housing in which there is fitted to slide the end of a plate spring, the other end of the spring being rigidly connected to the post by a plate, the arrangement being such that when the gate is swung back the spring will be drawn out of its normal position, its outer end sliding



CLOUGH'S GATE SPRING.

somewhat in the housing, and when the pressure upon the gate is relaxed the spring will act to return it to its normal position, the throw of the gate in closing being limited by a stop secured to one of the gate posts.

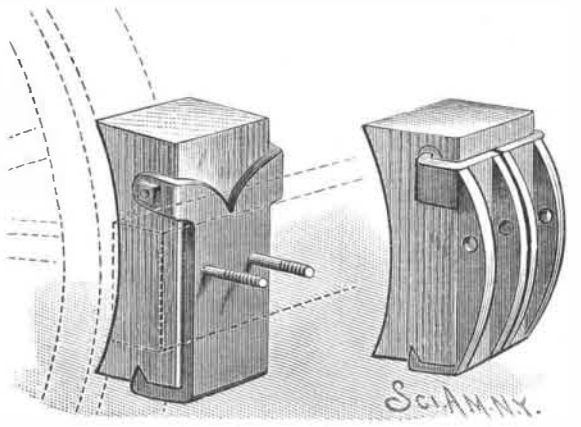
Apantlesis.

Having observed that on several occasions the upper part of an alcohol thermometer column, after having slowly risen from a considerable contraction, was colorless, and that no deposit of the coloring matter (probably cochineal) had taken place, Mallet was led to make further experiments in this direction. It seemed as if the colorless alcohol had by its expansion separated itself from a still perfect solution left behind. The solutions used were partly aqueous, partly alcoholic, of several colloid substances, starch, tannin, caramel, albumen, and gelatin. Each solution was placed in a flask of about half a liter capacity, surrounded with ice, the mouth of the flask being closed with a cork carrying a glass tube about 4 mm. in diameter and 15 or 20 cm. long, having a glass tap near its middle point.

The ice being removed, the liquid was allowed to rise in temperature until the column, originally a centimeter or two below the tap, was as much above it. The tap was now closed and the liquid above it submitted to examination in comparison with an equal volume of the original solution. In all cases the liquid above the tap contained a less amount of material in solution, in some cases very notably less; while in two or three cases there was practically none. As all the solutions were carefully filtered at the outset, there could have been no settling of particles. The conditions influencing the result seem to be: First, the proportion of the colloid solid in solution; and second, the time occupied in the rise of temperature. The author has given the name *apantlesis* to this phenomenon, signifying a draining away of some of the molecules of the solvent from those of the colloid while the solution was undergoing expansion.—*Chem. News.*

AN IMPROVED BRAKE BLOCK FOR VEHICLES.

An invention providing means whereby a brake shoe for vehicles can be easily and quickly removed when worn out, and a new one inserted, is illustrated herewith, and has been patented by Mr. George A. Posson, of Angwin, Napa County, Cal. The brake shoe may be of rubber, wood, or other suitable material, and has a metallic back formed with upper side flanges, embracing the sides of the block, and a bottom flange having upward-projecting points entering the lower end of the shoe, bolts projecting from the rear face by which the brake block is secured to the brake bar. For buggies and spring wagons, as well as for farm wagons, a modi-



POSSON'S BRAKE BLOCK.

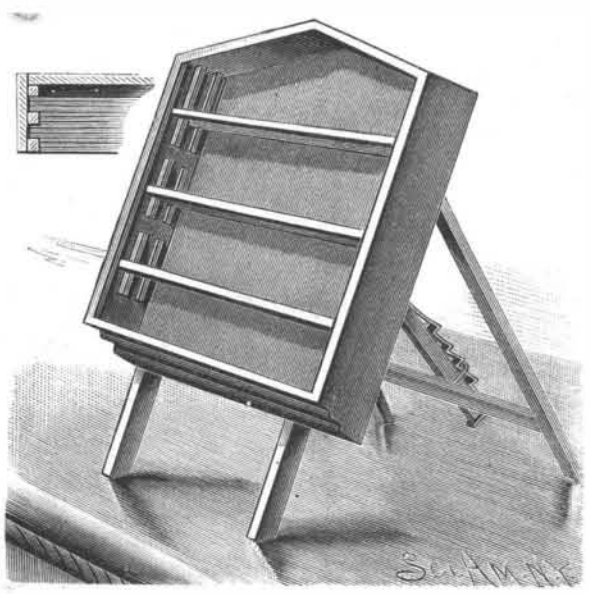
fied construction is shown in the figure to the right, in which the metallic back is made in two halves, each half having ribs fitted to the brake bar, and with apertures through which passes a bolt for holding the halves on the brake shoe and the brake block on the brake bar, the upper flanges in this case having side projections passing into apertures in the sides of the brake shoe.

An Ingenious Experiment.

Herr J. Puling, of Vienna, has devised an ingenious method of rendering visible the form of a stretched string set in vibration by having one of its extremities attached to one prong of a tuning fork, which was kept in motion electrically, and gave a definite note, the pitch of which was carefully determined. The vibrating string was lighted up by a vacuum tube connected with a Ruhmkorff coil, the rate of discharge through the tube being alterable at will, and when this is made equal to or some aliquot multiple of the number of vibrations made by the string, the latter was only illumined when occupying some one definite position, and owing to the persistence of its image on the retina, appeared as if at rest. In this way the shape of the string and the positions of the modes and vertical segments were rendered clearly visible.

AN IMPROVED STAND FOR DISPLAYING GOODS.

A frame or open casing containing removable adjustable shelves and an adjustable and folding brace support, making a stand designed to be mounted on a counter or in other suitable position for conveniently displaying goods, is illustrated herewith, and has been patented by Mr. Ralph H. Maxson, of Richburg, N. Y. The frame is adjustably held in open position by a brace bar pivoted to a strip on the back, and having a spring catch at its free end formed with shoulders



MAXSON'S STAND FOR DISPLAYING GOODS.

which engage a bent rod or loop on a cross bar of the frame. The sides of the casing are made with short strips forming grooves and spaces, and the shelves have projections on their ends whereby they may be mounted in the casing by sliding them to place in an inclined position, and sliding the projections in the grooves until a space is reached, when the shelves may be slid back in a horizontal position.