eye of the seat projection. The seat and saddletree are thus simply and firmly connected together.

Ole H. Larson, of Fort Dodge, Iowa, has patented a Ventilating Beer Faucet. A flexible tube with split bulb, and connected with the outside air, forms part of the faucet, and is forced into the liquid where the bulb floats on the surface, thus admitting of a free passage of air. It is an ingenious and good device.

Mr. William A. Cates, of Union, Oregon, has devised an ingenious clock, the dial of which is so subdivided as to indicate the 24 hours of the day. It is arranged with a revolving face plate having a map of the earth on a polar projection, the face plate being placed on the hub of the hour hand. A loosely moving and graduated index hand is placed on the hub of the hour wheel, for indicating the time and geographical position of any place on the earth.

Mr. Daniel G. Beers, of Sandy Hook, Conn., is the inventor of an improved clothes wringer so constructed as to allow the rollers to spread while operating upon large or thick fabrics without throwing the gear wheels out of engagement.

Zelotes McKinler & Virgil True, of Laclede, Mo., have patented a Gas Stove, which is designed to provide an economical form of cooking stove especially adapted to small families and for summer use. It generates its own gas from a burner, without the use of a wick, by volatilizing, through the heat of the burner, a limited quantity of the volatile oil admitted to the burner from a reservoir placed above the same. The improvements consist in the particular construction and arrangement of the pipes with respect to the reservoir and the supports or stoves for the cooking utensils.

John Miller, of Petersburgh, Pa., and William B. Miller, of Altoona, Pa., have patented a Shaft Tug, an improvement upon that form of shaft tug which is provided with an internal protector to receive the wear of the shaft; and it consists in the peculiar construction and arrangement of the parts whereby the protector may be taken out and replaced, when worn, without deranging or destroying the tug strap.

A Pill Machine invented by Dr. John Hill of South Norwalk, Conn., consists of a series of blades fixed to a vibrating bar, and adapted for dividing the rolls of pill mass upon a tablet, in combination with pivoted clearers which separate the mass from the cutters. The bits of pill mass are then rolled into pills in the ordinary way.

John W. Drake of Tolono, Ill., has invented an improved lamp shade and reflector, which by an efficient arrangement of conical sections and reflectors throws a strong light through the opening of the shade.

On the base of a buckle patented by T. L. Wiswell, of Olathe, Kan., is formed a hook. The end of the strap passes through the buckle, enters the hook and rests upon the ring it holds, so that it is impossible to detach the hook without loosening the strap. It is strong and the buckle does not need to be sewed on.

An air feeder for stoves has been invented by G. C. Palm, of Andersonburg, Penn., which supplies the air for combustion from outside the house. An air trough beneath the floor leading out to the outer air is connected with an air box under the stove. This box is provided with partitions, dampers, doors and two outlet pipes. One outlet pipe is connected with a sunken air chamber under the stove and the other with the bottom of the hearth. The former supplies heated air to a heater above the stove and the latter furnishes the draft.

Communications.

The Law of the Pressure of Saturated Steam with Relation to Temperature.

To the Editor of the Scientific American:

The exact law of the connection between the pressure and temperature of saturated steam has hitherto eluded discovery, notwithstanding the numerous and admirable investigations and experiments instituted on the important subject; and the respective values relied upon for practical purposes have been derived from empirical formulæ more or less simple or complex in proportion as less or greater exactness is required. I think that I have discovered the true nature of the relation in question, a result which I have obtained with the aid and on the ground of the views and conclusions set forth in my recently published pamphlet, "Nature of the Physical Forces" (Rosnan & Co., San Francisco, Cal.). The following is a brief statement of the principal facts involved.

The unit of weight of a given volume of a gas is, according to my deductions, and in conformity with the kinetic theory, equal to the square root of the weight of volume. Multiples of volume, as 2...3...4, etc., therefore involve an increase of the unit of weight at the rate of the square roots of the numbers, respectively by 1·4142....1·732....2, etc. If the number of volumes is increased, while the space occupied by them remains that of one volume, the force of expansion, which is equivalent to pressure, will increase in proportion to the weight of the number of volumes; the units of weight increasing only at the rate of the square roots of these numbers. The increase of volumes of steam in a steam boiler, consequent on the continued application of heat, is of this nature; and the pressure being at 100° C., that of 1 volume, whose weight is equal to that of a column of mercury 760 mm. high and = 1 atmosphere, is at 120° C. = 1491 mm., or nearly 2 atmospheres, at 135° C. = 3 atmospheres, etc., the units of weight being $\sqrt{760} = 27·568$ for 1 atmosphere; $\sqrt{2 \times 760}$, or $1·41 \times 27·568$ for 2 atmospheres; $\sqrt{3 \times 760}$, or $1·73 \times 27·568$ for 3 atmospheres, etc.

The power by which additional volumes are constantly forced into the same space is increase of temperature, and it remains to be shown that the units of heat actually increase at the same rate as the units of weight of the volumes of steam, and thus to illustrate in the most striking manner the truth of the mechanical equivalence of heat.

The temperatures really increase at the rate indicated; in order to render this manifest, it is only necessary to divide the squares of temperature expressed in degrees of the centigrade scale, by 10,000. In the following, the quotients thus obtained are compared with the square roots of the units of the pressure corresponding to the temperature according to Regnault. The first column contains the temperatures; the second the units of pressure in atmospheres; the third the squares of temperature divided by 10,000; the fourth the roots of units of pressure.

100° C.	1·000	1·0000	1·0000	195° C.	13·84	3·8025	3·7198
120° C.	1·962	1·44	1·4000	200° C.	15·38	4·0000	3·9211
135° C.	3·097	1·8225	1·7579	205° C.	17·00	4·2025	4·1231
145° C	4·11	2·1025	2·0259	210° C.	18·85	4·4100	4·3414
160° C.	6·12	2·5600	2·4729	215° C.	20·8	4·6225	4·5604
165° C.	6·94	2·7225	2·6339	220° C.	22·88	4·8400	4·7831
170° C.	7·844	2·89	2·7998	225° C.	25·00	5·0625	5·0000
175° C.	8·83	3·0625	2·9708	230° C.	27·5	5·2900	5·2438
185° C.	11·12	3·4225	3·3343				

The values of the units of temperatures corresponding to the square roots of the units of pressure are slightly but uniformly in excess of the values of the latter, which discrepancy will be accounted for presently; of the existence of the exact relation there can be no doubt; and this very simple relation expressed in general terms is as follows:

The temperatures are as the square roots of the number of units of pressure; the pressure is proportional to the total weight of volumes, which is equal to the square of the square root of the number of volumes multiplied by the unit of weight; and the square of the temperature (t) divided by 10000, is the square root of the number of compressed volumes, or $p = \left(\frac{t^2}{10000}\right)^2 \times 760$; and inversely, the square root of the number (n) of units of pressure, multiplied by 10000, is the square whose root represents the temperature at the pressure of n units, or $t = \sqrt{\sqrt{n} \times 10000}$.

A comparison of the values of t and p calculated from these formulæ, with the values actually found by experiment, will show if and to what degree the theory is in agreement with facts.

The first column of the following table exhibits the temperatures, from which the pressures of the second column have been calculated, and *vice versa*; the figures of the third column are the actual pressures, according to Regnault; the fourth shows the difference:

100° C.	760 mm.	760 mm.	
120° C.	1530 mm.	1491·28 mm.	38·72
135° C.	2523·2 mm.	2353·73 mm.	169·47
145° C.	3359·2 mm.	3125·55 mm.	233·65
160° C.	4980·73 mm.	4651·62 mm.	329·11
165° C.	5633·12 mm.	5274·54 mm.	358·58
170° C.	6347·59 mm.	5961·66 mm.	386
175° C.	7127·96 mm.	6717·43 mm.	410·53
185° C.	8899·66 mm.	8453·23 mm.	446·43
195° C.	10988·84 mm.	10519·63 mm.	469·2
200° C.	12160 mm.	11688·96 mm.	471
205° C.	13421·45 mm.	12955·66 mm.	465·79
210° C.	14780·546 mm.	14324·80 mm.	455·75
215° C.	16239·3 mm.	15801·33 mm.	438
220° C.	17803·156 mm.	17390·36 mm.	413
225° C.	19477·87 mm.	19097·04 mm.	380·83
230° C.	21267·916 mm.	20926·4 mm.	341·516

The figures show, as already stated, that the actual pressures are lower than those calculated from the temperatures; there has been a loss of temperature which has to be accounted for, if the doctrine of the mechanical equivalence of heat is to be rigorously true. The loss seems to be strongly confirmatory of the correctness of the law, as above enunciated; for when the pressure of the steam is indicated by the gauge, a certain amount of the expansive energy has already been consumed in the heating and expansion of the boiler, and the work thus performed is not included in the registered tension. The discrepancies, therefore, enter as a necessary factor for the determination of the values. The loss, as will be seen, increases gradually till at about 14 atmospheres it reaches a maximum, and, after remaining nearly stationary between 14 and 17 atmospheres, gradually diminishes. This seems to be in perfect agreement with the behavior of metals under strain, their power of resistance increasing gradually up to a maximum with the increase of the straining forces. Special investigations, however, are necessary to show that the discrepancies are solely due to this cause.

San Francisco, Cal., December, 1877. E. VOGEL.

The Telephone's Freaks Again.

To the Editor of the Scientific American:

We have just completed a line eleven miles long, from this place to Cape Girardeau, through a hilly, heavily timbered country, and are using the Bell telephone. At Cape Girardeau our wire passes in on the north side of a window and the wire of the Western Union Telegraph Company passes through the window on the south side, and that is as near as they come together any place on the line. If we listen in the telephone at Jackson we can hear every click made by the W. U. instrument, which is in the same room with the telephone, but in no way connected by wires. The telegraph instrument is secured to a small table and the telephone is fastened on a railing two feet distant.

Jackson, Mo. T. F. WHEELER.

Trueing a Crank Pin.

To the Editor of the Scientific American:

A quicker way of doing the job than that described by J. R., in issue of December 16, is this:

Set the crank shaft perfectly level; place the crank in a horizontal position, and apply a good level to the crank pin bearing. If you have no short level, true up parallel the edges of a strip of wood or metal, a trifle shorter than the crank pin bearing, and wide enough to clear the outside collar of the same; hollow out one of the edges, so that on placing the strip upon the bearing only the ends will touch; put the level on top, file away the high end of the pin till the parallel strip rests level, and by aid of a straight edge carefully file a flat place across the pin. This operation is repeated with the crank in vertical position, and, if you choose, with the same standing at an angle of 45°, both forward and back. With a pair of callipers find the smallest diameter across the flat places, and file the pin opposite to them to that diameter. Use the brasses or a template, the brasses being too large, in filing between the flat places to indicate the high spots, until you have the pin true and round.

I have followed this practice for a good many years with good success, both as to time required to do the work and the truth of it. JAMES LOCHER.

Two Brilliant Meteors.

To the Editor of the Scientific American:

After reading Dr. James' communication to your valuable paper of the 29th inst., I think it very probable that the meteorites in question were distinct, and the dates of observation correct. Within an hour of the time of falling I made a note of the occurrence, from which I wrote my communication to you. Besides, the meteor observed by Dr. James had "a slight deviation to the East," while the one seen by myself had an inclination of 65° to the West.

In regard to the cause of the green color, it may be proper to state that the fact that Dr. Smith, Pugh, Forchhammer, Bergemann and others have observed a fraction of 1 per cent (from 0·03 per cent to 0·45 per cent) of Cu and P, in various meteorites, may lead us to ascribe the phenomenon in question to those elements, although the amount observed be not sufficient to cause the appearance.

Racine, Wis. R. C. HINDLEY.

PRACTICAL MECHANISM.

BY JOSHUA ROSE, M.E.

NEW SERIES—No. XXXVI.

GEAR WHEEL TEETH.

The designations of the various parts of a gear tooth may be understood from Fig. 256, in which A represents the face of a tooth, B the flank, C the point, D the root, E the depth, length, or height, F the breadth, G the thickness, and P P the pitch circle or pitch line, these last two terms being synonymous. When, however, this line is spoken of in con-

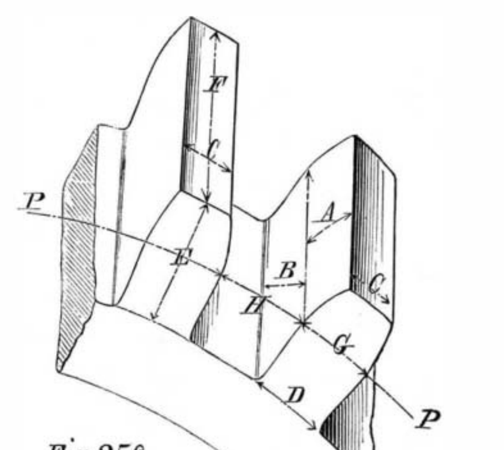

Fig. 256.

nection with a tooth it is termed the pitch line, but with the whole wheel, the pitch circle. The thickness of the tooth is always measured along the pitch line. The distance from the center of one tooth to the center of the next, measured along the pitch line, is termed the pitch, either of the wheel or of the teeth, as the case may be. The distance between one tooth and the next one measured on the pitch line, as at H, is called a space, and is equal to the thickness of the tooth and whatever clearance is allowed. (Clearance will be explained hereafter.)

The pitch of the teeth may be measured in two ways, one around the circumference of the pitch circle and the other straight across. It is evident that the first is an arc and the other a chord, hence the designations arc pitch and chordial pitch. Suppose that in Fig. 257 P P represents a portion of a pitch circle, and A, B, C, D the centers of teeth, then the distance between two of these centers, measured across E, is the chordial pitch, while that measured around the curvature of P P is the arc pitch. In a wheel having teeth it would be somewhat difficult to practically measure the arc pitch; hence when in the workshop the simple term "pitch" is used, it is understood to imply the chordial pitch, which can