THE CURIOUS LIFE-HISTORY OF OUR BLISTER BEETLES.

Number II.

BY PROFESSOR C. V. RILEY.

It is generally stated by writers on the hive bee, that the oil beetle (*Meloe*) is one of its parasites. The possibility that our more common blister beetles were similarly parasitic on bees, taken in connection with the frequent complaints from apiarians of the wholesale death of bees from causes little understood, led me, some years since, to pay attention to the biological characteristics of the blister beetles, in the hope of ascertaining whether or not they really bear any connection with bee mortality. From these investigations, I am satisfied that *meloe* is only parasitic on the perfect hive bee, as it is on so many other winged insects that frequent flowers, and that it cannot well, in the nature of the case, breed in the cells of any social bee whose young are fed by nurses in open cells. The triungulins of our blister beetles refuse to climb on to plants furnished to them, or to fasten to bees or other hairy insects. Nor will they nourish upon honey, bee bread, or bee larvæ.

They show a proclivity for burrowing in the ground, and act quite differently from those of *meloe* or *sitaris*, which not only attach to bees in confinement, but which, in the case of *meloe*, I have known to so crowd upon mature hive bees as to worry them to death and cause extended loss in the apiary.

While analogy and the law of unity of habit in species of the same family pointed, therefore, to a parasitic life, I began to conclude, from the facts just stated, that the parasitism was of another kind, having satisfied myself by various experiments that the triungulins did not feed on roots.

Few discoveries are stumbled upon. We find, as a rule, that only which we anticipate or look for. Late last Fall, in digging up the eggs of the Rocky Mountain locust (*caloptenus spretus*) at Manhattan, Kansas, blister beetle pseudo-pupæ were not unfrequently met with. The suspicion thus raised that these insects preyed, in the preparatory states, upon locust eggs, was confirmed last Spring by finding the larvæ of different ages within the egg pods, and devouring the eggs of the locust just mentioned. From such larvæ preying on the eggs of *spretus* I have reared the unicolorous form of *epicauta cinerea*, Forster, or the marginal blister beetle; the *epicauta Pennsylvanica*, De Geer, or the black blister beetle; the *macrobasis unicolor*, Kirby, or ash-gray blister beetle; and the form of it described as *murina*, by Le Conte, or the black rat blister beetle.

Since then I have had no difficulty in tracing the larval habits and development of the two more common species around St. Louis, namely, the striped blister beetle (*epicauta vittata*, Fabr.), and the marginal blister beetle just alluded to. Careful examination of locust eggs, in the vicinity of potato fields frequented by the parents, show a varying proportion of the egg pods affected, and in some locations nearly every pod of the differential locust (*caloptenus differentialis*) will contain the *epicauta* larva. The eggs of the locust are laid in large masses of 75 to 100. The pod is but slightly bent, rather compact outside, while the eggs are

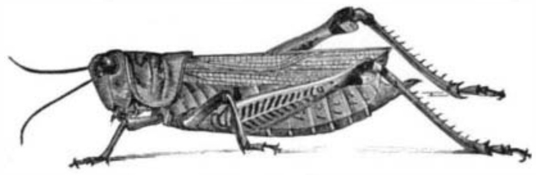


Fig. 1.—Caloptenus differentialis.

irregularly arranged and capped with but a shallow covering of mucous matter. It is the egg pod of this species which the larvæ of the two blister beetles in question prefer. The larval habits of the genus, as well as of *macrobasis* and *henous*, which I have studied, may be illustrated by reciting those of either of these species.

From July to the middle of October the eggs are being laid in the ground in loose, irregular masses of about 130 on an average. The female lays at several different intervals, producing in the aggregate probably from four to five hundred ova. She prefers for purposes of oviposition the very same warm, sunny locations chosen by the locusts, and doubtless instinctively places her eggs near those of these last, as I have on several occasions found them in close proximity.

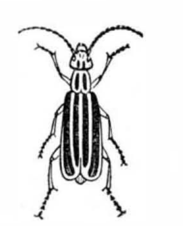


Fig. 2.—Epicauta vittata.

In the course of about ten days—more or less, according to the temperature of the ground—the first larva or triungulin hatches. These little triungulins (Fig. 4, *c*), at first feeble and per-

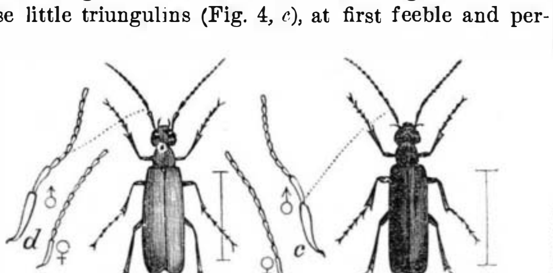


Fig. 3.—MACROBASIS UNICOLOR.—*a*, normal gray form; *b*, black (*murina*) form; *c*, *d*, male and female antennæ.

fectly white, soon assume their natural light brown color and commence to move about. At night, or during cold or wet weather, all those of a batch huddle together with little motion, but when warmed by the sun they become very active, running with their long legs over the ground, and prying with their large heads and strong jaws into every crease and crevice in the soil, into which, in due time, they burrow and hide. Under the microscope they are seen to fairly bristle with spines and spinous hairs, which all aid in burrowing. As becomes a creature of prey that must be industriously sought, they display great power of endurance, and will survive for a fortnight without food in a moderate temperature. Yet in the search for locust eggs many are, without doubt, doomed to perish, and only the more fortunate succeed in finding appropriate diet. Reaching a locust egg pod, our triungulin, by chance or instinct, or both combined, commences to burrow through the mucous neck, and makes its first repast thereon. If it has been long in search, and its jaws are well hardened, it makes quick work through this porous and cellular matter, and at once gnaws away at an egg, first devouring a portion of the shell and then sucking up the contents. Should two or more triungulins enter the same egg pod a deadly conflict sooner or later ensues, until one alone remains the victorious possessor. A second egg is attacked, and more or less complete ly exhausted of its contents, when a period of rest ensues, the triungulin skin splits along the back, and there emanates the second larva (Fig. 4, *d*), white, soft, with reduced legs, and quite different in general appearance from the first. This molt is experienced about the eighth day from the first taking of nourishment. The animal now naturally lies in a curved position. After feeding for about another week a second molt takes place, the skin, as before, splitting along the back and the new larva hunching out of it until the extremities are brought together and released almost simultaneously.

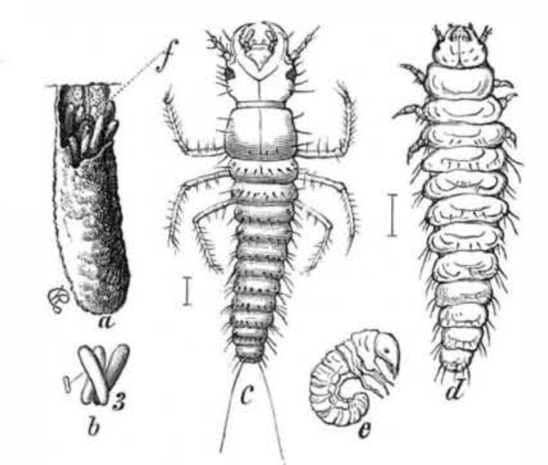


Fig. 4.—EPICAUTA.—*a*, locust egg pod, with triungulin just entering (*f*); *b*, eggs; *c*, triungulin; *d*, second larva; *e*, natural position of same.

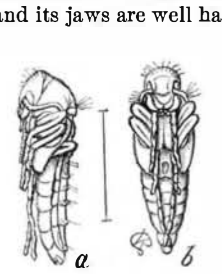


Fig. 5.—EPICAUTA.—*a*, pupa, side view; *b*, same, ventral view.

This kind of molting is exceptional among insects, the skin being ordinarily worked backward from the head. The modification at this molt is slight. A third molt ensues with but little change in the form and character of the animal. In this, the ultimate stage of the second larva (Fig. 5, *a*), the creature grows apace, its head being constantly bathed in the rich juices of the locust eggs, which it now

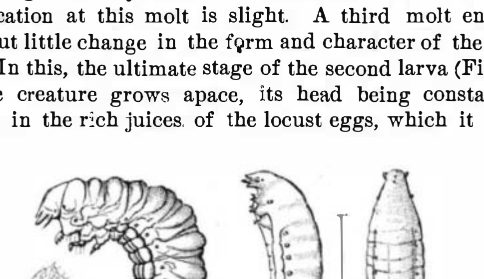


Fig. 6.—EPICAUTA.—*a*, full grown larva; *b*, setaceous points that cover the back; *c*, coarctate larva, side view; *d* same, back view.

rapidly sucks, or more or less completely devours. The color is somewhat more yellowish than it was before. In another week it forsakes the remnants of the pabular mass and burrows a short distance in the clear soil, where it forms a smooth cavity within which it lies, stretched on one side. In three days the skin splits again, but is only partially shed. The mouth parts and legs are now quite rudimentary and tuberculous, the soft skin rapidly becomes rigid and of a deeper yellow color, and we have what has been called the pseudo-pupa or coarctate larva (Fig. 5, *c*, *d*). The insect has the power of remaining in this coarctate larval condition for a long period, and generally thus hibernates.

In spring the coarctate larval skin is in its turn rent on the top of the head and thorax, and there crawls out of it the third larva, which differs in no respect from the ultimate stage of the second larva already mentioned, except in the somewhat reduced size and greater whiteness. This third larva is rather active, and burrows about in the ground; but while there seems to be no reason why it should not feed, nourishment is not at all essential, and all my specimens have, in the course of a few days, transformed to the true pupa (Fig. 6) without feeding. The pupa state lasts but five or six days.

Our blister-beetle larvæ are, therefore, partial parasites. An animal that feeds on eggs is not necessarily parasite, but the term is justly applied to such as feed within, and are confined to, the egg pod, in contradistinction to predaceous species which move from one egg pod to another. Like all parasitic insects that nourish on a limited amount of food, and possess no power to secure more, the blister beetles vary greatly in individual size in the same species, and the larvæ have the power of accommodating their life to circumstances, and of assuming the coarctate larval form earlier or later according to the size of the egg mass which they infest. In an average sized egg pod of the differential locust, however, there are more than enough eggs to nourish the largest specimens of *E. vittata*, and a few are usually left untouched. The period of growth from the first feeding to the coarctate larva averages about a month.

That the eggs may exceptionally hibernate is possible, but from their delicate nature improbable. That the triungulins frequently do so there can be no doubt, especially in specimens like the black blister beetle, which is found on the flowers of solidago, eupatorium, etc., till the end of October and continues laying till frost.

CONCLUSION.

From the foregoing history of our common blister beetles it is clear that, while they pass through the curious hypermetamorphoses so characteristic of the family, and have many other features in common, yet *epicauta* and *macrobasis* differ in many important respects from *meloe* and *sitaris*, the only genera hitherto known biologically.

To resume what is known of the larval habits of the family, we have: First, the small, smooth, unarmed, tapering triungulin of the prolific *sitaris*, with the thoracic joints subequal, with strong articulating tarsal claws on the stout-thighed but spineless legs, and, in addition, a caudal spinning apparatus. The mandibles scarcely extended beyond the labrum: the creature seeks the light, and is admirably adapted to adhering to bees but not to burrowing in the ground. The second larva is mellivorous, and the transformations from the coarctate larval stage all take place within the unrent larval skin. We have: Second, the more spinous and larger triungulin of the still more prolific *meloe*, with long caudal setæ, but otherwise closely resembling that of *sitaris* in the femoral, tarsal, and trophial characters, in the sub-equal thoracic joints, unarmed tibiæ, and in the instinctive love of light and fondness for fastening to bees. The second larva is also mellivorous, but the later transformations take place in the rent and partly shed skins of the second and coarctate larvæ. We have: Third, the larger and much more spinous triungulin of the less prolific *epicauta macrobasis* and *henous*, with unequal thoracic joints, powerful mandibles and maxillæ, shortened labrum, slender femora, well armed tibiæ, slender, spinous, less perfect tarsal claws, combined with an instinctive love of darkness and tendency to burrow and hide in the ground. The second larva takes the same food as the first, its skin is almost entirely cast from the coarctate larva, while subsequent changes are independent and entirely free of the shell of this last.

Recent Tests of the Telephone.

Some interesting trials of the articulating telephone were lately made in England through Dr. Muirhead's artificial cable. This artificial line, says the *Telegraphic Journal*, offers the closest approximation to the electrical conditions of an actual cable that has been hitherto attained. The experiments were made through a length of artificial cable of the type of the Direct United States Cable, and it was so constructed that artificial line capacity could be added to the circuit or taken away from it at will. When the capacity is taken off, the circuit is of course a mere resistance circuit; but when the capacity is put on, the circuit was equivalent to a length of submarine cable. In speaking by telephone through a hundred miles of this cable the words were comparatively loud and distinct, but the instant the capacity was put on, the voice lost both power and distinctness in a remarkable degree. It appeared only half as loud as before, and dull and smothered in tone. With a hundred and fifty miles of artificial cable, while the voice was apparently as strong as ever through the resistance circuit alone, it was completely silenced by putting on the capacity. Even with a superior telephone, the extreme limit of articulation would thus be less than two hundred miles. Theory points out, and experiment verifies the fact, that if the voice is allowed to dwell on a note for a sufficient time to establish, despite induction, a regular succession of electric waves in the cable, a faint sound will be audible. Thus, singing can be heard through a greater length of cable than talking. In articulation the changes of the voice are so hurried that time is not given the cable to establish the regular series of waves necessary to reproduce sound, so nothing is heard at all.

Novel Method of Preparing Oxygen.

The author finds that oxygen may be very readily obtained even at common temperatures by the mutual reaction of two oxygenated compounds formed of several atoms of oxygen, such as hypochlorate of lime and peroxide of barium. These facts prove, he considers, that the oxygen is produced by the neutralization of the opposite electric polarities of the oxygen in one of the compounds and that in the other.—*Sylvester Zinno, in Les Mondes.*

La Nature says that when the whale in the Westminster Aquarium, London, died, all the living eels, which had been put in the tank as food for the monster, at once attacked the body and attempted to devour it.

The Telephone in Collieries.

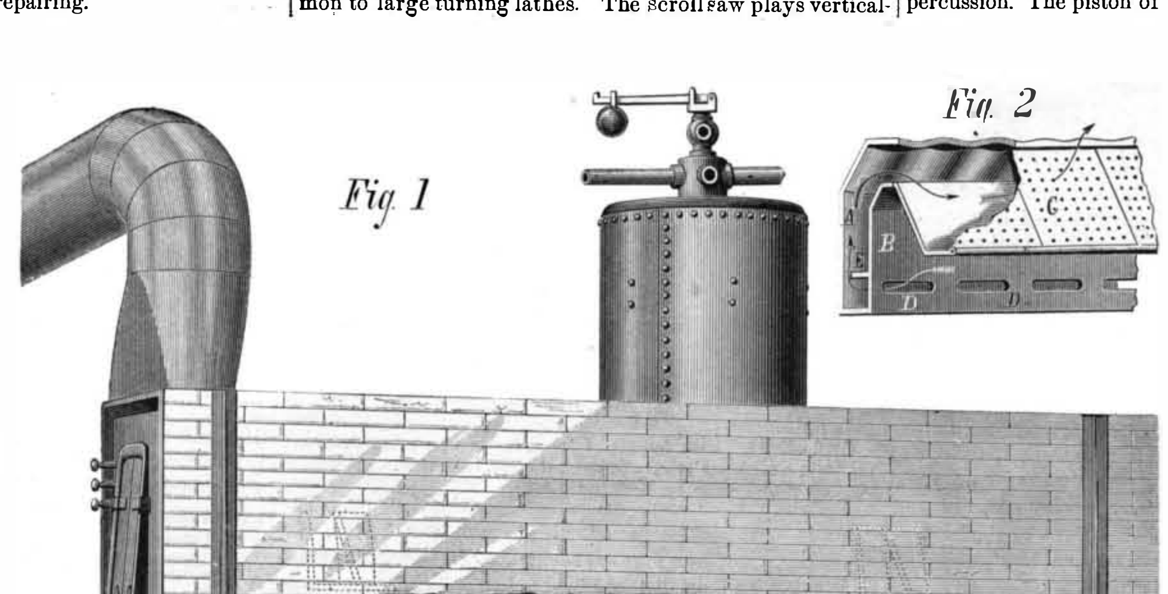
A number of gentlemen connected with the principal collieries in West Lancashire, Eng., lately assembled at Prescot Colliery, belonging to the Wigan and Whiston Coal Company, for the purpose of witnessing experiments with Professor Graham Bell's Telephone, but especially with reference to its use in the working of collieries. By an adaptation of Mr. Hall, Government Inspector of the mines of the district, one of Mr. Biram's anemometers used in collieries for testing the velocity of air passing through the workings had attached to it, instead of the regulator, a telephone, and it was to test whether the state of the ventilation could be ascertained at the surface that the experiments were made. Instead of the ordinary diaphragm, a small thin iron bar was substituted in the telephone attached to the anemometer, every tenth revolution of which caused this bar to vibrate. An anemometer thus provided was connected with the telephone placed in the colliery offices, and then taken down the shaft and fixed in the main intake—an ordinary coated electric wire, some 600 yards long, joining the two instruments. Mr. Hall and a party of underground managers had charge below ground. The vibration of the anemometer was distinctly heard by the instrument in the office, and it was found to give 28 beats to the minute, or 280 revolutions, which, multiplied by area of airway, showed the quantity of air passing. The result was considered eminently satisfactory, and was communicated to Mr. Hall. Experiments in speaking to those in the mine were then made, and Mr. Hall recognized the voices of several friends. At times word was sent from below that they could hear noises going on in the room, conversation between several of the gentlemen taking place, and this interfered with the distinctness of the messages. On the conclusion of the experiments, Sir W. Thomson, using the telephone, addressed a few words to those present, and to Mr. Hall. He expressed himself as both delighted and astonished with the result of the experiments. Never before had he heard the voice more distinct, and the experiments were very satisfactory. He explained the difference between previous telephones and Professor Bell's, and said that although he had often tested the telephone he had never before seen it made of practical use as in the present case.

THE CORRUGATED IRON AIR BRIDGE AND FUEL ECONOMIZER.

Mr. Robert K. McMurray, Chief Inspector of the Hartford Steam Boiler Inspection Company, is the inventor of the new steam boiler attachment herewith illustrated, which, it is claimed, provides an efficient means for economizing fuel, reducing the time and expense usually required for the renewal and repair of bridge walls and preventing smoke by the admission of a proper supply of heated air to the gases evolved by combustion. The principal feature of the device is that last mentioned, the inventor claiming positive advantages through the mingling of heated air instead of cold air with the gases. The bridge is also constructed so as to offer increased resistance against blows shocks, and the effects of expansion and contraction, while it may be easily removed for renewal or repairing.

The arrangement of the bridge in the furnace is shown in Fig. 1, and the device detached with portions broken away to exhibit its interior arrangement in Fig. 2. It consists of a fire plate, A, a back or base plate, B, and a dispersing plate, C. The plate, A, is corrugated in order to give it increased strength and is provided with a light bottom flange which rests upon the bridge wall and thence rises vertically for about two thirds of its height, at which point it is inclined at an angle of 45 degrees. The bottom plate, B, conforms in the relative position of three of its sides, to the plate, A, and terminates below in a horizontal foot. Both plates, A and B, are connected by bolts passing through thimbles, so as to form a hollow case. The perforated diffusing plate, C, is inserted in groves formed in the other plates. A series of air supply openings, D, are formed in the plate, B, near the base. Above them extends a deflecting flange, E. The device is so set that the lower edge of the fire plate, A, is slightly below the level of the grate bars, and its ends are closed by the side walls of the setting or by metal plates fitted therein, the latter arrangement allowing of the bridge being removed as desired by drawing it out longitudinally through the opening in the side wall.

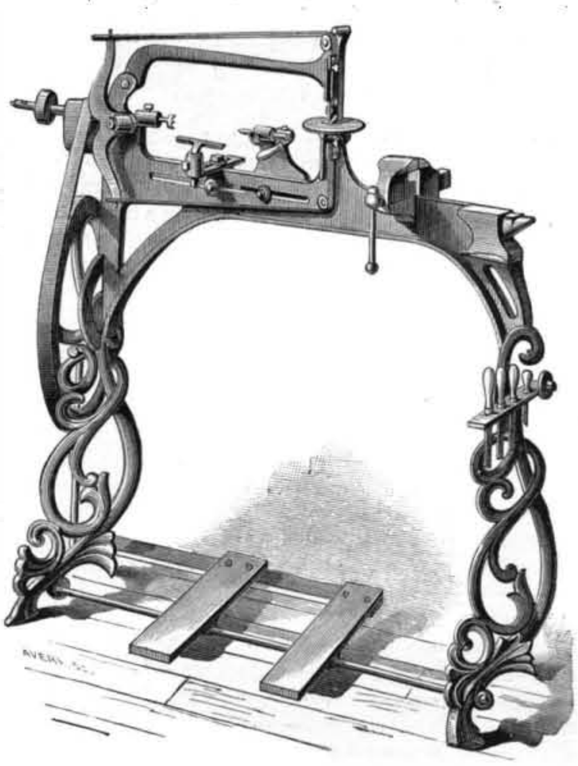
The fresh air enters the space between the back plate and fire plate through the supply openings, D, and is deflected by the flange against the heated surface of the fire plate and thence passes upward as indicated by the arrows, Fig. 2, along the space between the two plates. The air thus becomes introduced in a minutely divided condition into the combustion chamber at a temperature closely approximating that of the gases escaping from the furnace. It mingles with said gases, and is claimed to oxidize the carbonic oxide and to effect complete combustion, with a corresponding economy of fuel and prevention of smoke. The inventor informs us that the device has been well tested with uniformly successful results. Patented September 4, 1877. For further particulars, address Robert K. McMurray & Co., 285 Broadway, New York city.



THE CORRUGATED IRON AIR BRIDGE AND FUEL ECONOMIZER.

COMBINATION LATHE, SCROLL SAW, ETC.

The machine illustrated herewith is a combined foot power drill and turning lathe, scroll saw, grinding wheel, vise,



and anvil, in the construction of which many novel features are embodied. The body and legs are cast iron, the treadles wood, the belts leather, the wrench iron, the fixed screws polished iron, the set screws casehardened, the finish black japan with ornamental paintings. The lathe will turn work four inches by nine long. It is suitable to hand turning, has a press lever for drilling, and is furnished with steel spur and pointed centers. The rest has all the adjustments common to large turning lathes. The scroll saw plays vertically through the center of an iron table, which may be tipped on an angle for inlaid work. The saw is held by means of iron clamps and thumbscrews, said clamps being attached, each to the end of a leather band, which bands pass over friction pulleys and are hung to pins on the ends of the vibrating lever, which is driven by an eccentric on the lathe spindle. There are several pin holes in the upper band to adjust the strain to saws of varying lengths. An arm projecting over the table serves as a presser foot to hold the work down while sawing, and adjusts itself to varying thickness in boards. When the saw is disconnected to enter holes, said arm may be raised to admit the board, or it may be swung over to leave all clear above the lathe if desired. This machine swings fifteen inches under the arm, and the motion of the saw is in a straight line.

In carrying out this principle of operating the jig saw on a large machine, the saw is hung in sliding guides as usual, but the bands for reaching any distance on the work and the vibrating lever are the same as here shown.

It is claimed that no perceptible jar is felt in running a sixteen inch saw that will reach the center of work up to ten feet radius. This steadiness is caused by the vibrating lever being very short and well balanced, and by the cushioning effect of the inertia of the bands. The lever need not be over six inches radius to give the saw four inches stroke.

The vise and anvil are permanent attachments to the machine. The emery wheel on the spindle is heavy, and serves as a fly wheel to the lathe and saw. In the outer end of the spindle is a drill for bracket work. When desired, the manufacturer furnishes tools and extra parts with the machine, such as face plates for chucking, a drill plate, a circular saw, and table, turning gouges, chisels, etc.

Patent pending. For further particulars see Business and Personal column, or address W. X. Stevens, East Brookfield, Mass.

The Delicacy of the Telephone Circuit.

In a recent lecture before the Society of Telegraph Engineers in England, Professor Bell called attention to the remarkably slight earth connection which is needed to establish a circuit for the telephone. In describing an experiment showing this, he stated that while an assistant made connection at his end of the line by standing on a grass plot, he himself stood upon a wooden board. On trying the telephone Professor Bell was very much surprised to hear a continuous musical note uttered by his coadjutor, and on looking for the cause he found that a single blade of grass was bent over the edge of the board and that his feet touched it. The removal of the grass was followed by a cessation of sound from the telephone, but the sound became again audible whenever the Professor touched even the petal of a daisy with his foot.

Ferroux's Rock Drill at the St. Gothard Tunnel.

M. Ferroux's rock drill, which has been in operation since 1873 at the works of the St. Gothard tunnel, has recently been much simplified in the mechanism for the feed and the percussion. The piston of the percussion cylinder is formed conically at each face for the purpose of reversing it at the end of each stroke. When it arrives at the end of the stroke it strikes a small plug, which slides in a cylindrical opening and presses it inwards. This movement is simultaneously communicated by a lever to the small supply piston at the upper end of the cylinder by which the compressed air is shut off, and the exhaust opened. The percussion piston is then promptly returned to the upper end of the cylinder, where it strikes the small supply piston, and opens it for a fresh supply of compressed air, when the percussion piston makes the next down stroke. This rotation of the percussion piston and rod is effected by means of an inclined groove cut in the rod, in which a pawl is engaged. The pawl is one piece with a ratchet wheel, which turns freely with the pawl as it is swayed by the groove in the descending piston rod, but is prevented by a ratchet from returning. The ball being thus held stationary, the piston rod necessarily sways to the pawl in its turn, and makes a portion of a revolution, shifting the position of the jumper for each stroke. The weight of the new Ferroux drill is about 440 lbs. The calculated volume of air expended per stroke of the piston is 85 cubic inches.