uniformly and rapidly, by having two short pieces of ¾ inch india rubber hose attached to the bottom of the can, the other end of the hose terminating in a tin rose, similar to that on watering pots. The liquid should be well stirred at each filling of the can, and it should be frequently and violently shaken during the time of applying it. An active man can apply the poison to four acres of potatoes in a day with ease, and two applications, at proper intervals, will save the crop.

The cost is estimated as follows: Hauling water, mixing, and applying the liquid, 30 cents per lb., two applications, 60 cents; 2 gallons molasses, 60 cents; 2 lbs. Paris green, $1.40; total, $2.60.

THE POWER OF SMALL ENGINES.

One of the most frequently recurring questions, asked by our correspondents, relates to the power that can be obtained from an engine of given dimensions, with a specified steam pressure and number of revolutions per minute. As we have frequently explained, questions of this sort can only be determined definitely by means of tests. The rules, ordinarily found in works on the steam engine, for calculating the horse power of an engine, give results that rarely accord with those obtained in practice. Indeed, it is impossible to lay down rules that will apply to all cases, the construction and performance of different engines being so varied. We feel, however, that we must do something to satisfy the many readers who want information about the small engines which they are building or using. We have therefore compiled a table, from the best data at our own command, by which the performance of small engines of good design can be approximately estimated. We have also added some examples to illustrate the use of the table. It is designed for engines with cylinders up 6 inches in diameter, and for piston speeds up to 400 feet a minute: the connection of the engine with the boiler being supposed to be tolerably direct, the ports and pipes being of sufficient size, and the steam valve closing when the piston has made ⅞ of the stroke. Even with all these suppositions, which probably represent the average conditions of small engines, the table will give results that are too large in some cases and too small in others, for the very reason that it does represent average conditions. With these explanations, we will proceed to illustrate its use.

1. To find the area of a piston, knowing its diameter: Multiply the square of the diameter by 0·7854. Example: The diameter of a piston is 3 inches. What is its area? The square of 3 is 9. Multiplying 9 by 0·7854, we obtain 7·0686, as the area of the piston in square inches. It may be well to observe that, whether the piston has either a flat, rounded, or raised end, its effective area is to be calculated from the diameter, as explained above.

2. To find the speed of a piston in feet per minute, when the length of stroke and the number of revolutions per minute are known: Multiply twice the length of stroke, in inches, by the number of revolutions per minute, and divide by 12. Example: An engine has a stroke of 3 inches, and makes 300 revolutions a minute. What is the piston speed? Twice the length of stroke is 6 inches. Multiplying by 300, and dividing by 12, we obtain 150, as the piston speed in feet per minute.

3. To find the horse power of an engine, when the diameter of the cylinder, the length of stroke, the number of revolutions per minute, and the pressure of steam in the boiler are known: Find the area of the piston, in square inches, and the piston speed, in feet per minute. Find the number in the table, the nearest to the given steam pressure and calculated piston speed, and multiply it by the area of the piston. Example: An engine has a cylinder 2 inches in diameter and with a length of stroke of 2 inches. It makes 400 revolutions a minute, with a boiler pressure of 50 lbs. per square inch. What is the horse power? Square of diameter of piston 4 × 0·7854 = 3·1416, area of piston, in square inches. Twice the length of stroke 4 × 400 = 1600 ÷ 12 = 133⅓, speed of piston in feet per minute. Nearest piston speed in table is 130, and the number in table corresponding to piston speed of 100 feet per minute and boiler pressure of 50 lbs. is 0·074; add the number corresponding to piston speed of 30 feet per minute, 0·022; this will give the number corresponding to piston speed of 130 feet per minute, 0 096. Multiplying this by area of piston, 3·1416, we obtain, horse power, 0·3 +.

The power so calculated is that available for useful work, such as would be developed on a friction brake, in an experiment made by the method explained on page 273 of our volume XXXI.

If any of our readers test their engines in this manner, we would be glad to receive the results of their experiments, which will be useful in enabling us to correct the table, if necessary.

4. To find the diameter of cylinder for an engine to develope a given horse power, when the piston speed, in feet per minute, and the pressure of steam in the boiler are known: Find, in the table, the number nearest to the given piston speed and pressure of steam. Divide the required horse power by 0·7854 times this number, and take the square root of the quotient. Example: An engine is to develope 2 horse power, with a piston speed of 150 feet a minute, and a boiler pressure of 100 lbs. per square inch. What should be the diameter of the cylinder? The number in table, for piston speed of 100 feet, is 0·161, and for 50 feet 0·081, giving a total of 150 feet = 0·242. Multiply this by 0·7854, and we have a result of 0·1900668. Divide the horse power by the figure 0·1900668, and the quotient is 10·5226 +. The square root of 10·5226 is 3·24 +, or about 3¼ inches, the required diameter of cylinder.

5. To find the length of stroke, in inches, when the piston speed, in feet per minute, and the number of revolutions per minute, are known. Multiply the piston speed by 6, and divide by the number of revolutions per minute. Example: The piston speed of an engine is 200 feet per minute, and the number of revolutions per minute is 300. What is the length of stroke? Multiplying 200 by 6, and dividing the product, 1200, by 200, we obtain 4 inches, as the length of stroke.

In this article. we have presented the subject as plainly as possible, so that it can be used by all who have queries on power developed by small engines.

EFFECTIVE HORSE POWER OF AN ENGINE WITH A PISTON ONE SQUARE INCH IN AREA, FOR DIFFERENT STEAM PRESSURES AND PISTON SPEEDS.

Pressure.*	Horse power corresponding to piston speed (in feet per minute) of											
	10	20	30	40	50	60	70	80	90	100	200	300	400
10	·0005	·0010	·0015	·0020	·0025	·0030	·0035	·0040	·0045	·0050	·0099	·0149	·0199
15	·001	·003	·004	·005	·007	·008	·010	·011	·012	·014	·027	·041	·055
20	·002	·004	·007	·009	·011	·013	·016	·018	·020	·022	·045	·067	·089
25	·003	·006	·009	·012	·015	·019	·022	·025	·028	·031	·062	·093	·124
30	·004	·008	·012	·016	·020	·024	·028	·032	·036	·010	·079	·119	·158
35	·005	·010	·015	·019	·024	·029	·034	·039	044	·048	·097	·145	·194
40	·006	·011	·017	·023	·029	·034	·040	·046	·051	·057	·114	·171	·228
45	·007	013	·020	·026	·033	·039	·016	·053	·059	·066	·131	·197	·263
50	·0074	·015	·022	·030	·037	·045	·052	·059	·067	·074	·148	·223	·297
55	·008	·017	·025	·033	·042	·050	·058	·067	·075	·083	·166	·250	·333
60	·009	·018	·028	·037	·046	·055	·064	·073	·083	·092	·184	·275	·367
65	·010	·020	·030	·040	·050	·060	·070	·080	·090	·100	·201	·301	·402
70	·011	·022	·033	·014	·055	·065	·076	·087	·098	·109	·218	·327	·436
75	·012	·024	·035	·047	·059	·071	·083	·094	·106	·118	·236	·354	·472
80	·013	·025	·038	·051	·063	·076	·089	·101	·114	·127	·253	·380	·506
85	·0135	·027	·041	·054	·068	·081	·095	·108	·122	·135	·270	·406	·541
90	·014	·029	·043	·058	·072	·086	·101	·115	·129	·144	·288	·432	·575
95	·015	·031	·046	·061	·076	·092	·107	·122	·137	·153	·306	·458	·611
100	·016	·032	·048	·065	·081	·098	·113	·129	·145	·161	·323	·484	·645
105	·017	·034	·051	·068	·085	·102	·119	·136	·153	·170	·340	·510	·680
110	·018	·036	·054	·071	·089	·107	·125	·143	·161	·179	·357	·536	·715
115	·019	·038	·055	·074	·093	·112	·130	·149	·168	·187	·373	·560	·746
120	·0196	·039	·059	·078	·098	·118	·137	·157	·177	·196	·392	·588	·785
125	·020	·041	061	·082	·102	·123	·143	·164	·184	·205	·410	·614	·819
180	·021	·043	·064	·085	·107	·128	·149	·171	·192	·213	·427	·640	·854
135	·022	·044	·067	·089	·111	·133	·156	·178	·200	·222	·445	·667	·889
140	·023	·046	·069	·092	·115	·139	·162	·185	·208	·231	·462	·693	·924
145	·024	·048	·072	·096	·120	·144	·168	·192	·216	·210	·479	·719	·958
150	·025	·050	·074	·099	·124	·149	·174	·199	·223	·248	·496	·745	·993

* In boiler, by gage.

THE KEELY MOTOR DECEPTION.

We publish on another page a communication from the counsellor of the Keely Motor Company, Mr. Collier, and his colleagues, in reply to an article on the above subject given in our paper of June 26. We devote this space, first, because the parties interested, feeling personally aggrieved by our remarks, have requested, as a matter of fair play, an opportunity for reply; and second, because we have hopes that some of our readers may be led thereby to study out the probable processes by which these gentlemen have been precipitated into this delusion. Such studies may result in useful suggestions or new knowledge. It is not often that the active participants in delusions like this are willing to come forward and chronicle themselves in the broad and public manner that these persons have done. The mental or psychological phenomena will, we think, be found interesting subjects for investigation.

An example somewhat similar to this Keely motor business occurred in London, in 1871, when Dr. William Crookes, the well known scientist, published his astonishing account of the spirit motor of Home, in which the spring gage was made to move by the simple pointing at it of the operator's finger. The truth of this performance was attested by Dr. Crookes, who himself prepared the apparatus, by Dr. William Huggins, by Edward William Cox, a distinguished lawyer, and by numerous other witnesses of undoubted reliability. Dr. Crookes and others were convinced by this exhibition that a new force, which he termed psychic force, had been discovered; but Dr. Huggins, while attesting that the gage moved (in fact, the movement was made to record itself on paper), declined to express an opinion as to how the movement was produced. An account of these performances, with an engraving of the arrangement of levers and gage used, was published in the SCIENTIFIC AMERICAN, page 99, August 12, 1871.

This motor of Dr. Crookes appears to surpass the Keely device in some respects. The power is workable at a low pressure, involves but little expense for apparatus, requires no blowing of air from the lungs, uses no hydrant pressure, and its success does not depend upon "cold vapor."

No one, we believe, has ever questioned the honesty of Dr. Crookes, or supposed for a moment that he had, personally, any hand in giving motion to the gage. The more reasonable supposition is that somebody, in some manner unobserved by those present, applied the necessary force to the instrument.

The human senses are but weak instruments at best, easily played upon and deceived; and those who have most highly prided themselves upon the possession of superior perceptions, by which they were confident of their ability to detect the unreal from the real, have become lamentable examples of the ease with which the mind of man can be entrapped and led astray by mere appearances.

In matters of Science and Mechanics, especially in those branches pertaining to the correlation of forces, it is only by the application of the most careful methods, coupled with the searching tests of mathematics, that reliable knowledge can be acquired and delusive conclusions avoided.

As in the present example of the Keely motor, so in the case of the Paine electro-motor in 1871; the originator of the deception made the most solemn assertions that the machine which he then had in operation derived its sole power from the four small battery cups, which the witnesses saw standing on a shelf at the side of the apartment. The machine was tested, with brakes, as to power, by well known practical electricians of this city, whose names are now before us, who reported large gains of power and detected no fraud. Their experiments were corroborated by many other intelligent witnesses. Special exhibitions were given to capitalists, who pronounced the show wonderful.

We expressed the opinion that the whole thing was a deception, warning the public against investing means in the motor shares. We reproduced the well known mathematics of electric action, we showed the exact amount of force derivable, under the most favorable circumstances, from the consumption of a given amount of zinc and acid, as determined, after exhaustive experience, by the most eminent savans; and from these teachings, we pointed out the necessary falsity of the statements made in behalf of the new motor. Paine, in reply to our strictures, reaffirmed all that he had before claimed for his motor, which he now alleged was far below the actual truth; he said that he was then engaged in building a great and powerful engine which would be ready in ninety days, which would develop 500 horse power from a single cup, completely annihilate the figures given by us, and show to the world that people who, like the editor of the SCIENTIFIC AMERICAN, undertook to doubt or criticise the performances of a machine they had never seen and were practically unacquainted with, were jackasses, or "a fool," as our friend Mr. Collier suggests others might properly say.

"I am familiar," said Paine, "with the experiments of Grove, Carpenter, Mayer, Faraday, Liebig, and a host of others, relative to the doctrines of correlation and conservation of forces. Therefore, I am no tyro, but the peer of any authority you may quote; and as such I unqualifiedly assert that, instead of the miserably small result of 67,000 foot pounds from three grains of zinc (as stated in the SCIENTIFIC AMERICAN) we should realize 67,000,000 foot pounds. The forces developed by the action of a single Bunsen quart cell, if utilized and converted into power, would drive the largest ship afloat with a velocity only limited by the strength of the ship's frame; and you and I will live to see the day, if our lives are lengthened to the usual term, when this statement will be verified, and that, too, without involving the question of perpetual motion."

This sort of talk prevailed with the capitalists; they swallowed the bait, paid in their money, took their shares—"without being urged"—and that was the end of the five hundred horse power, no perpetual motion, one cup, engine, and motor.

The Keely motor deception in all its aspects up to this date is but a repetition of the Paine affair. The originator is very honest; all the people who assist at the deception believe in him and in his machine. They know not precisely how the thing is done, or by what laws it is governed, but they know that it *is* done; and any suggestion to the contrary they seem to consider as a reflection on their personal intelligence and honor.

The Keely performance is as follows:

Keely blows from his lungs, for a period of 30 seconds, into a nozzle upon the generator. He connects the same nozzle, by means of a small rubber tube, with the hydrant, and lets in five gallons of water under a pressure of 26½ lbs. to the inch, then shuts off the water. He opens the valve of a pipe of $\frac{1}{16}$ of an inch bore, between the generator and a gage or pressure indicator; and lo! the gage indicates 10,000 lbs. to the square inch.

Such, in sum and substance, is the Keely motor, as set forth by the learned counsel of the company and corroborated by various mechanical experts, in the statements they have now freshly prepared for the especial benefit and enlightenment of the readers of the SCIENTIFIC AMERICAN: corroborated also by scores of other intelligent persons, so Mr. Collier assures us.

The majority of our readers will doubtless conclude with us that, on the showing of the parties themselves, the whole thing must be classed as a second rate juggle—a mechanical Katie King arrangement, too contemptible for serious consideration.

In our article of June 25, we assumed that the chief purpose of the deception was to wriggle money out of silly people. It appears, from the confession with which Mr. Collier has favored us, that the very first practical use he made of the pretended invention was to obtain money from New York capitalists; that the second use was to procure money from the same source; the third the same, and so on, until the treasury is considered full enough for the time being. We attribute to Mr. Collier no dishonorable motives or methods in financing his company; but we think he confirms our statement as to the uses of the alleged invention. In connection with the letters from the various parties, given elsewhere, some further comments will be found.

Synthesis of Therpylene.

Some time ago M. Berthelot published investigations in which he showed that the essence of turpentine, represented by the formula $C_{20}H_{16}$, resulted from the condensation of a special carburet, $C_{10}H_8$. This last, termed therpylene, no one has ever seen until the present time, when M. Bouchardat announces that he has produced it by synthesis.

MONDAY, the day following July 4 (which this year comes on Sunday), will be, as usual, observed as a holiday in this city. Pressmen, as well as men in other occupations, will suspend work on Monday; therefore if subscribers to the SCIENTIFIC AMERICAN fail to get this issue of the paper till a day or two later than usual, they will know the reason.

THE body of an American, John Blackford by name, has recently been found in a large ice block in the vicinity of Mont Blanc, after several days of thaw. The unfortunate tourist had tried three years ago to ascend Mont Blanc without a guide, and had not since been heard of. Features and clothes are perfectly preserved.