

THE TESLA STEAM TURBINE

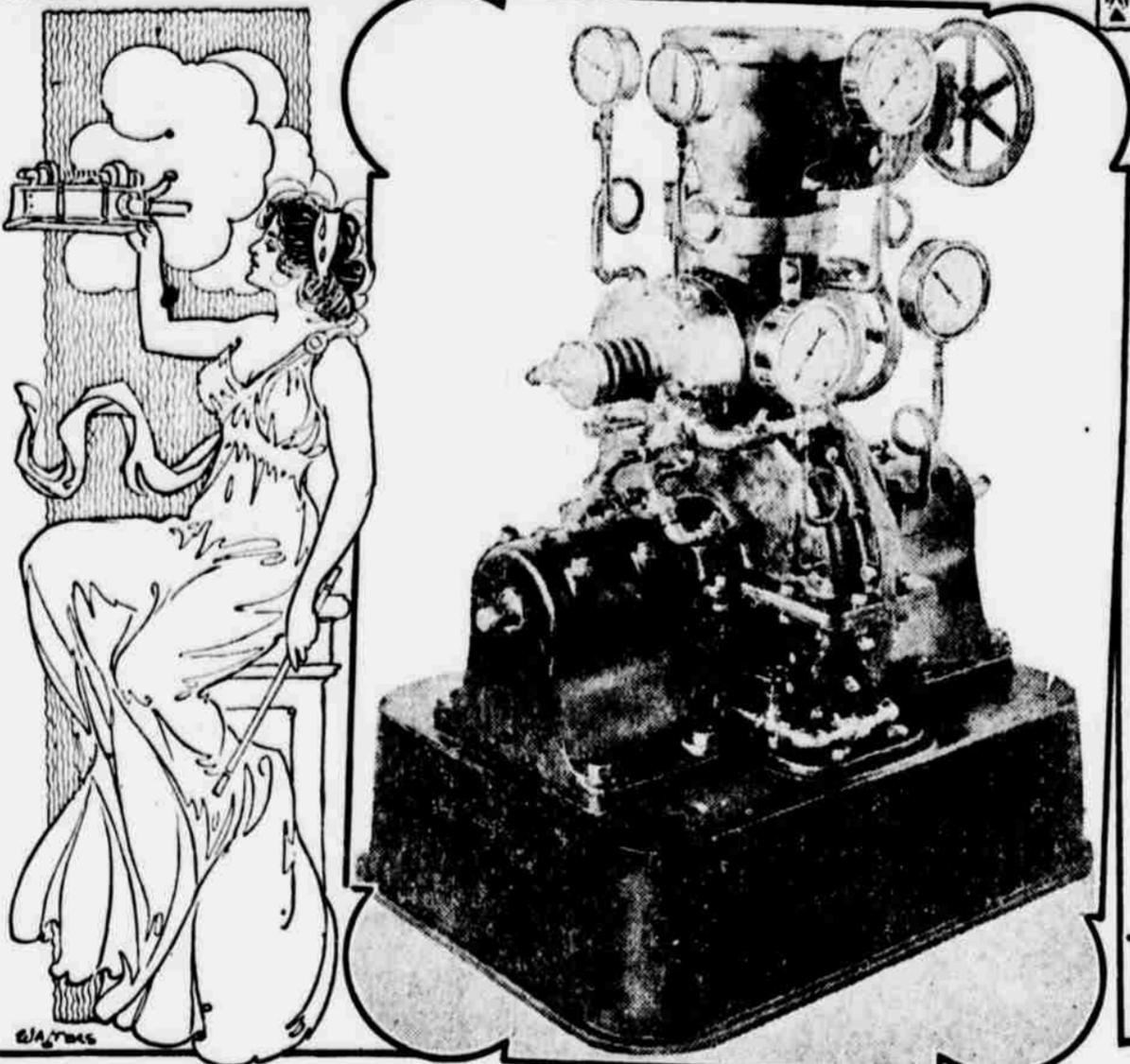
THE ROTARY HEAT MOTOR REDUCED TO ITS SIMPLEST TERMS



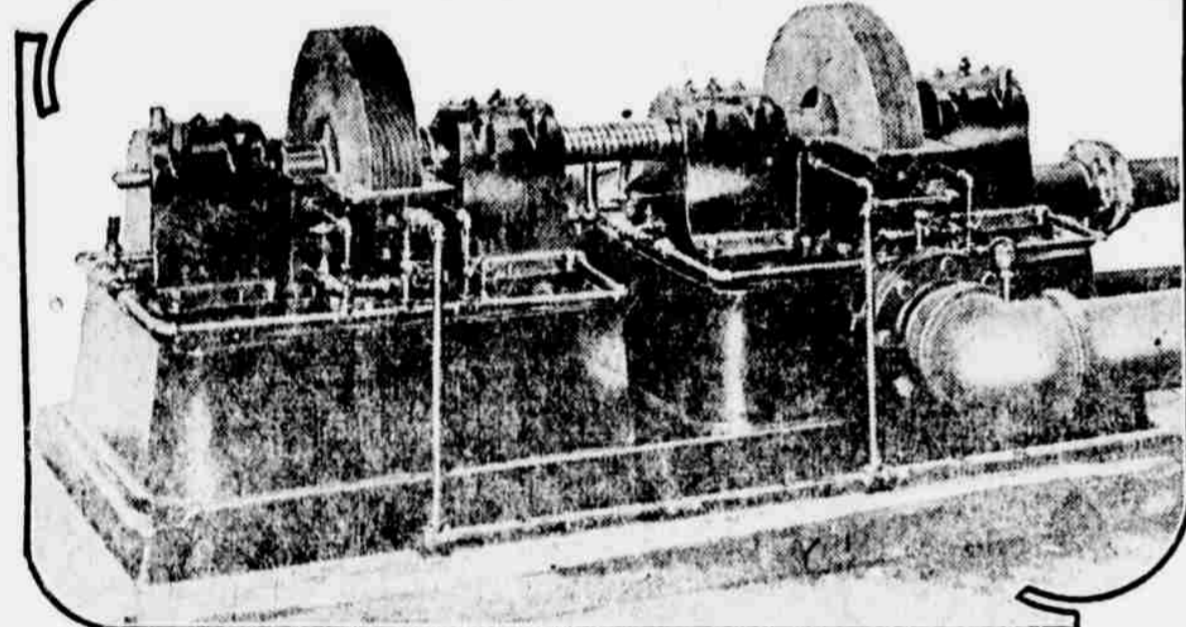
NIKOLA TESLA, whose reputation must, naturally, stand upon the contributions he made in electrical engineering when the art was yet in its comparative infancy, is by training and choice a mechanical engineer, with a strong leaning to that branch of it, which is covered by the term "steam engineering." For several years he has devoted much of his time to improvements in thermodynamic conversion and the result of his theories and practical experiments is to be found in an entirely new form of prime movers now in operation in a large plant in New York.

The basic principle which determined Tesla's investigations was the well known fact that when a fluid, steam, gas or water, is used as a vehicle of energy, the highest possible economy can be obtained only when the changes in velocity and directions of the movement of the fluid are made as gradual and easy as possible. In the present forms of turbines in which the energy is transmitted by pressure, reaction or impact, as in the De Laval, Parsons, and Curtis types, more or less sudden changes both of speed and direction are involved, with consequent shocks, vibrations and destructive eddies. Furthermore the introduction of pistons, blades, buckets, and intercepting devices of this general class into the path of the fluid involves much delicate and difficult mechanical construction which adds greatly to the cost both of production and maintenance.

The theoretically perfect turbine would be one in which the fluid was so controlled from the inlet to the exhaust that its energy was delivered to the driving shaft with the least possible losses due to the mechanical means employed. The mechanically perfect turbine would be one which combined simplicity and cheapness of construction, durability,



A 200-HORSE-POWER HIGH-PRESSURE TURBINE



THE TESLA TESTING PLANT

shaft of the driving turbine so that the center line of the silver coatings coincides with the axis of the shaft. The mirrors are so set that when there is no tension on the spring, the light beams produce a luminous spot stationary at the zero of the scale. But as soon as load is put on, the beam is deflected through an angle which indicates directly the tension. The scale and spring are so proportioned and adjusted that the horsepower can be read directly from the deflections noted. The indications of this device are very accurate and have shown that when the turbine is running at 5,000 revolutions under an inlet pressure of 125 lbs. to the square inch, and with free exhaust, 200 brake H.P. are developed. The consumption under these conditions of maximum output is 28 lbs. of saturated steam per H.P. per hour—a very high efficiency when we consider that the heat drop, measured by thermometers, is only 130 B.T.U. and that the energy transformation is effected in one stage. Since three times the number of heat units are available in a modern plant with superheat and high vacuum the above means a consumption of less than 12 lbs. per H.P. hour in such turbines adapted to take up the full drop. Under certain conditions, however, very high thermal efficiencies have been obtained which demonstrate that in large machines based on this principle, in which a very small clip can be secured, the steam consumption will be much lower and should, Mr. Tesla states approximate the theoretical minimum, thus resulting in nearly frictionless turbine transmitting almost the entire expansive energy of the steam to the shaft.

The Hounded Deer

"It doesn't make any difference now," said a hunter of long experience in the woods in an after supper talk at an Adirondack campfire, "inasmuch as the deer hound is no longer permitted to be a part of the hunt, but it is a fact that one long cherished belief of deer hunters is simply a backwoods fable. That belief is that a deer pursued by hounds when it is taken to a stream will invariably go down with the current instead of upstream, its instinct teaching it that if it goes up its scent will pass down with the water and the dogs will be enabled to follow it just as they did on dry land."

"I long ago satisfied myself that water doesn't carry the scent of a deer with it, but that on the contrary it destroys the scent."

"If the water is deep enough for the deer to swim it suits the fleeing animal best. If it is not the deer trots or lope along through it. It does not bound as on land, for it must drink, and must drink as it goes. In the bounding days the hunter who believed that the deer always went downstream and acted in accordance with that belief might recover the trail and he might not, while the hunter who knows better than to take stock in that belief would not be a great while in getting his dogs on the scent again."

"Of course I am speaking of deer that took to the mountain stream and not those that found a pond or lake more convenient, it being the nature of deer to seek water if possible, when the dogs are on their tracks. In none of the streams where deer sought to throw the dogs off the scent could a person go many rods up or down without coming to some obstruction in the course of the deer which the animal would have to get over."

"The hunter who knew would in the first place satisfy himself that the deer hadn't gone straight across the water, and would then go in one direction along the stream until he came to the first log or rock or other channel obstruction. If the deer had gone that way the obstruction in its path would be wet or top from the water that dropped from the deer as it climbed over it. If it was dry the hunter would know instantly that the quarry had not passed in that direction and the discovery of the spot where the deer had left the stream would be only a matter of time."

"But the deer doesn't have to take to water any more to elude the hounds, and it can make no difference now to old time believers in that fable how many scores of deer they have lost through that belief. Maybe there wouldn't have been so many deer in the woods today if more of the hunters contemporary with deer hounding had known better."

ease and rapidity of repairs, and a small ratio of weight and space occupied to the power delivered on the shaft. Mr. Tesla maintains that in the turbine which forms the subject of this article he has carried the steam and gas motor a long step forward toward the maximum attainable efficiency, both theoretical and mechanical. That these claims are well founded is shown by the fact that in the plant where Mr. Tesla carried out his experiments, he is securing an output of 200 H.P. from a single-stage steam turbine with atmospheric exhaust, weighing less than 2 pounds per H.P. which is contained within a space measuring 2 feet by 3 feet, by 2 feet in height and which accomplishes these results with a thermal fall of only 130 B.T.U., that is about one-third of the total drop available. Furthermore, considered from the mechanical standpoint, the turbine is astonishingly simple and economical in construction, and by the very nature of its construction should prove to possess such a durability and freedom from wear and breakdown as to place it in these respects far in advance of any type of steam or gas motor of the present day.

By reference to the accompanying photographs it will be seen that the turbine has a rotor which in the present case consists of 25 flat steel disks, one one thirty-second of an inch in thickness, of hardened and carefully tempered steel. The rotor as assembled is 3 1/2 inches wide on the face, by 18 inches in diameter and when the turbine is running at its maximum working velocity, the material is never under a tensile stress exceeding 50,000 lbs. per square inch. The rotor is mounted in a casing which is provided with two inlet nozzles for use in running direct and for reversing. Openings are cut out at the central portion of the disks and these communicate directly with exhaust ports formed in the side of the casing.

In operation, the steam or gas as the case may be, is directed on the periphery of the disks through the nozzles (which may be diverging, straight or converging) where more or less of its expansive energy is converted into velocity energy. When the machine is at rest the radial and tangential forces due to the pressure and velocity of the steam cause it to travel in a rather short curved path toward the central exhaust opening, but as the disks commence to rotate and their speed increases, the steam travels in spiral paths the length of which increases until in the case of the present turbine, the particles of the fluid complete a number of turns around the shaft before reaching the exhaust, covering in the meantime a lineal path some 12 to 16 feet in length. During its progress from inlet to exhaust, the velocity and pressure of the steam are

reduced until it leaves the exhaust at 1 or 2 pounds gage pressure. The resistance to the passage of the steam or gas between adjoining plates is approximately proportionate to the square of the relative speed, which is at maximum toward the center of the disks and is equal to the tangential velocity of the steam. Hence the resistance to radial escape is very great, being furthermore enhanced by the centrifugal force acting outwardly. One of the most desirable elements in a perfected turbine is that of reversibility and we are all familiar with the many and frequently cumbersome means which have been employed to secure this end. It will be seen that this turbine is admirably adapted for reversing since its effect can be secured by merely closing the right hand valve and opening that on the left.

It is evident that the principles of this turbine are equally applicable, by slight modifications of design, for its use as a pump and we present a photograph of a demonstration model which is in operation in Mr. Tesla's office. This little pump driven by an electric motor of 1-1/2 H.P. delivers 40 gallons per minute against a head of 9 feet. The discharge pipe leads up to a horizontal tube provided with a wire mesh for screening the water and checking the eddies. The water falls through a slot in the bottom of this tube and after passing below a baffle plate flows in a steady stream about 3/4 inch thick 18 inches in width, to a trough from which it returns to the pump. Pumps of this character show an efficiency favorably comparing with that of centrifugal pumps and they have the advantage that great heads are obtainable economically in a single stage. The runner is mounted in a two-part volute casing and except for the fact that the place of the buckets, vanes, etc., of the ordinary centrifugal pumps is taken by a set of disks, the construction is generally similar to that of pumps of the standard kind.

In conclusion it should be noted that although the experimental plant develops 200 H.P. with 125 pounds at the supply pipe and free exhaust, it could show an output of 300 H.P. with the full pressure of the supply circuit. Furthermore Mr. Tesla states that if it were compounded and the exhaust were led to a low pressure unit, carrying about three times the number of disks contained in the high pressure element, with connection to a condenser affording 28 1/2 to 29 inches of vacuum the results obtained in the present high-pressure machine indicate that the compound unit would give an output of 600 H.P. without great increase of dimensions. This estimate is very conservative.

The testing plant consists of two identical turbines, shown in the illustration, connected by a carefully calibrated tension spring, the machine to the left being the driving element, the other the brake. In the brake element the steam is delivered to the blades in a direction opposite to that of the rotation of the disks. Fastened to the shaft of the brake turbine is a hollow pulley provided with two diametrically opposite narrow slots and an incandescent lamp placed inside close to the rim. As the pulley rotates two flashes of light pass out of the same and by means of reflecting mirrors and lenses, they are carried around the plant and fall upon two rotating glass mirrors placed back to back on the

ENDED THE SPELLING LESSON

Bobby's Education, Under Aunt's Tutelage, Afterward Proceeded Under Different Lines.

Miss Thompson, whose form nature has endowed with all too ample curves, was giving her little nephew a lesson in spelling the other day. He had spelt b-e, be, and h-e, he, and now she was trying to get him to tell her what m-e spelt.

"Listen, Bobby," she said earnestly. Then closing her lips she pronounced the sound of a long m, and opening them, the sound of a long e. "What does that spell?"

Bobby looked at her and shook his head. Again she tried, and this time, while pronouncing the sounds, she vigorously tapped her own round chest with her plump forefinger.

"Mmum, ee. What letters am I saying and what do they spell?" she asked, still vigorously tapping her chest.

"I don't know what the letters are," replied Bobby, watching the plump forefinger, "but I guess they spell Fat."

Real Woman-Hater.

A will of a confirmed woman-hater, writes Virgil M. Harris in "Ancient Curios and Famous Wills," is that of a rich old bachelor who had endured much from attempts made by his family to put him under the yoke of matrimony, and who wrote: "I beg that my executors will see that I am buried where there is no woman interred, either to the right or to the left of me. Should this not be practicable in the ordinary course of things, I direct that they purchase three graves, and bury me in the middle one of the three, leaving the two others unoccupied."

No Credit Even for That.

"I am glad to say," remarked Mr. Seekton, "that I never spoke a hasty word to you."

"No, Leonidas," answered his wife, rather gently. "I'm willing to give you credit for not hurrying about anything."—Stray Stories.

WHAT EVERY FARMER SHOULD KNOW
FORMULAS how to kill and cure pork and beef. How to tan fur and leather at home. How to make all kinds of sausages. How to prepare and take of birds and fur for market. Book with 100 views with plans, how to cure and build anything out of cement on the farm. By men of life long experience. PRICE LIST FREE. W. L. KELLOGG, KEENE, N.H. (S.B.A.). Last appearance; save address.

Who Could Doubt It?

Artist (angrily)—No; I don't want a model. I only paint flowers or fruit.

Model (smilingly)—Oh, that's all right. Every one says I'm a peach.

Cole's Carbolative quickly relieves and cures burning, itching and torturing skin diseases. It instantly stops the pain of burns, chert without scars. So and by drug stores. For free sample write to J. W. Cole & Co., Black River Falls, Wis.

Every smallest stroke of virtue or of vice leaves its never-to-little scar.—Prof. James.

Work is better for most people than most people are for work.

THESE SIX LETTERS

From New England Women

Prove that Lydia E. Pinkham's Vegetable Compound Does Restore the Health of Ailing Women.

Boston, Mass.—"I was passing through the Change of Life and suffered from hemorrhages (sometimes lasting for weeks), and could get nothing to check them. I began taking Lydia E. Pinkham's Vegetable Compound (tablet form) on Tuesday, and the following Saturday morning the hemorrhages stopped. I have taken them regularly ever since and am steadily gaining."

"I certainly think that every one who is troubled as I was should give your Compound Tablets a faithful trial, and they will find relief."—Mrs. GEORGE JURY, 802 Fifth Street, South Boston, Mass.

Letter from Mrs. Julia King, Phoenix, R.I.

Phoenix, R.I.—"I worked steady in the mill from the time I was 12 years old until I had been married a year, and I think that caused my bad feelings. I had soreness in my side near my left hip that went around to my back, and sometimes I would have to lie in bed for two or three days. I was not able to do my household work."

"Lydia E. Pinkham's Vegetable Compound has helped me wonderfully in every way. You may use my letter for the good of others. I am only too glad to do anything within my power to recommend your medicine."—Mrs. JULIA KING, Box 282, Phoenix, R.I.

Letter from Mrs. Etta Donovan, Willimantic, Conn.

Willimantic, Conn.—"For five years I suffered untold agony from female troubles causing backache, irregularities, dizziness, and nervous prostration. It was impossible for me to walk up stairs without stopping on the way. I was all run down in every way."

"I tried three doctors and each told me something different. I received no benefit from any of them but seemed to suffer more. The last doctor said it was no use for me to take anything as nothing would restore me to health again. So I began taking Lydia E. Pinkham's Vegetable Compound to see what it would do, and by taking seven bottles of the Compound and other treatment you advised, I am restored to my natural health."—Mrs. ETTA DONOVAN, 703 Main Street, Willimantic, Conn.

Letter from Mrs. Winfield Dana, Augusta, Me.

Augusta, Me.—"Lydia E. Pinkham's Vegetable Compound has cured the backache, headache, and the bad pain I had in my right side, and I am perfectly well."—Mrs. WINFIELD DANA, R.F.D. No. 2, Augusta, Me.

Letter from Mrs. J. A. Thompson, Newport, Vt.

Newport, Vt.—"I thank you for the great benefit Lydia E. Pinkham's Vegetable Compound has done me. I took eight bottles and it did wonders for me, as I was a nervous wreck when I began taking it. I shall always speak a good word for it to my friends."—Mrs. JOSEPH A. THOMPSON, Box 8, Newport Center, Vermont.

Letter from Miss Grace Dodds, Bethlehem, N.H.

Bethlehem, N.H.—"By working very hard, sweeping carpets, washing, ironing, lifting heavy baskets of clothes, etc. I got all run down. I was sick in bed every month."

"This last Spring my mother got Lydia E. Pinkham's Vegetable Compound for me, and already I feel like another girl. I am regular and do not have the pains that I did, and do not have to go to bed. I will tell all my friends what the Compound is doing for me."—Miss GRACE B. DODDS, Box 133, Bethlehem, N.H.

For 30 years Lydia E. Pinkham's Vegetable Compound has been the standard remedy for female ills. No one sick with woman's ailments does justice to herself who will not try this famous medicine, made from roots and herbs, it has restored so many suffering women to health.

Write to LYDIA E. PINKHAM MEDICINE CO. (CONFIDENTIAL) LYNN, MASS., for advice. Your letter will be opened, read and answered by a woman and held in strict confidence.



Vest Pocket Telephones.

They are introducing vest pocket telephones in some of the cities of Germany. Connections are placed on walls all over town and if you happen to walk along the street and you're in a hurry to tell your wife that you will bring a friend home for dinner all you have to do is to connect your pocket instrument with the one on the wall, call the exchange, get your party and talk to your heart's content.

Trifle Wobbly.

"I am going to blow out my brains," said he.

"Well," she said after a moment's reflection, "perhaps they'll stand a little inflation, Horace. They've always struck me as being a trifle wobbly."—Harper's Weekly.

Didn't Think Much of Fred.

Louis—"They tell me she will get a million the day she marries Fred." Louise—"Well, it's worth it."—Chicago Daily News.

Dr. Pierce's Pleasant Pellets regulate and invigorate stomach, liver and bowels. Sugar-coated, tiny granules, easy to take as candy.

Look well after the cheerfulness of life, and let the dismal shift for themselves.—Louisa M. Alcott.

PILES CURED IN 6 TO 14 DAYS
Your druggist will refund money if PAGO OINTMENT fails to cure any case of Hemorrhoids, Bleeding or Protruding Piles in 6 to 14 days. See.

If a woman is a clever across the chances are that her husband will find the chorus more interesting.

Mrs. Winslow's Soothing Syrup for Children teething, softens the gums, reduces inflammation, allays pain, cures wind colic, etc. a bottle.

No, Alonzo, it isn't difficult for a woman to keep a secret—going.

IT ALWAYS DOES GOOD

No matter how long you have suffered from a weak stomach, inactive liver or constipated bowels you will find a fair trial of

Hostetter's Stomach Bitters

will result to your great benefit. It makes the appetite keen, assists digestion and improves your general health. A trial today will convince you.

GET HOSTETTER'S. AT ALL DRUGGISTS.

Pettit's Eye Salve FOR ALL SORE EYES