TESLA ENGINE BUILDERS ASSOCIATION

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N E W S

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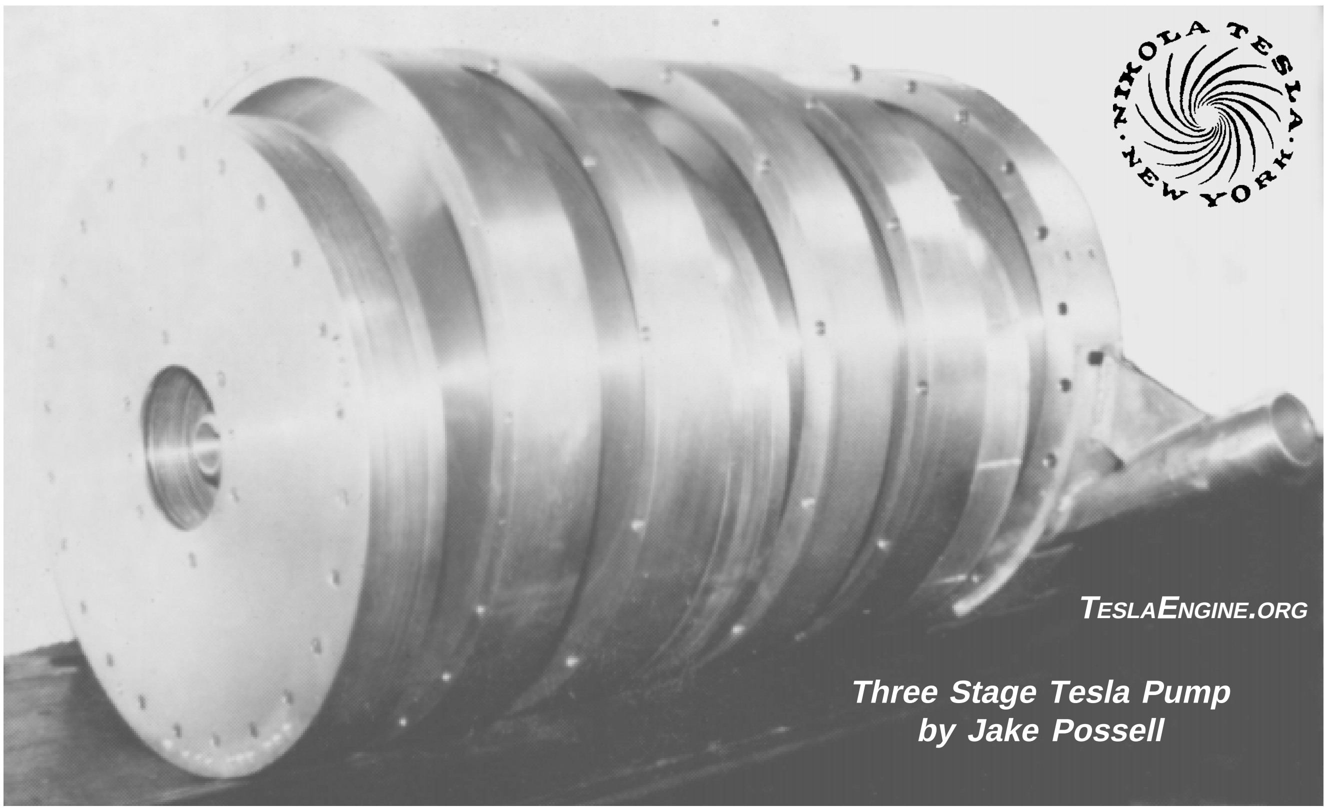
Multiple Stage Vacuum Pumping



Three Stage Tesla Pump by Jake Possell

"This is a disassembled three stage all aluminum bladeless vacuum pump. The vacuum is amplified from one stage to the next creating a very high vacuum output. This pump was installed at a dental office employing 50 dentists and serves as a vacuum source for all 50 dental offices in the building. The quality that is so unique is that contaminants do not cause havoc in this vacuum pump as they do in conventional vacuum pumps that operate with a piston or sliding vane.

To demonstrate the effectiveness of the bladeless pump, a salesman will take a hand full of long nails and allow them to be sucked into the intake of the pump. These nails go through the pump without damaging it in any way!"

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TEBA News is the official publication of the TESLA ENGINE BUILDERS ASSOCIATION (TEBA), an educational organization dedicated to Nikola Tesla and his Prime Movers. Research and dissemination of information on the history, theory, construction, and operation of Tesla Turbo Machinery, also referred to as the Tesla Engine or Tesla Turbine. Coverage is also given to Tesla's reciprocating engine referred to as the oscillating motor. Pumping applications are also considered.

Memberships includes a comprehensive manual containing CAD drawings for the 110 hp Tesla bladeless rotary engine and also makes possible research and this periodic newsletter. Please consider joining — **www.TeslaEngine.org**

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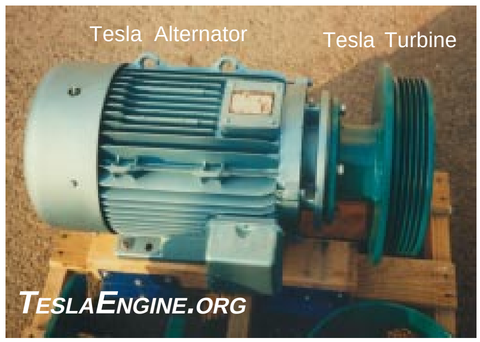

The Mechanical Universe and Beyond

by Dr. David L. Goodstein
Professor of physics California Institute of Technology

Throughout this long yarn we've been spinning, there have always been certain individuals whom we could identify as the "saints of science." These were people who were driven to scientific discovery the way moths are attracted to light. They would include Kepler, Newton, Faraday, and certainly Albert Einstein. Some of these people did very well for themselves, in fact a few became quite wealthy, but obviously it was not money that drove them to do what they did. But at the same time there's always been a different kind of genius. These were people just as clever as the others, but people who had their eyes firmly fixed on the bottom line. One of course was Thomas Edison, but there was also James Watt and Henry Ford and there were many others. Such people typically spent as much time in law courts litigating patents as they spent making their inventions. One is tempted to draw a distinction between the "saintly scientist" and the "money grubbing technologist," but of course there was an exception that proved the rule.

Incidently, I've never liked that phrase very much, "the exception that proves the rule." I think it must come from an archaic meaning of the word to "prove" which used to mean to "test." An exception tests the rule. If it's truly an exception, then the rule can't be right. Well, there was an exception who tested the rule and found it wanting, and that was Nikola Tesla.

Tesla was certainly a genius of the first magnitude.

If Michael Faraday could imagine space filled with lines of constant force, Nikola Tesla could picture multiphase generators and multiphase motors all connected with complex electrical circuits and when they were built, all of it would work perfectly, exactly as he had imagined it.

Time and again Tesla made fortunes and squandered them. But turned down soft jobs with fat salaries just so he could be left alone to think and invent. You might say that Tesla, like Devinci before him, was a true "saint of engineering." He died almost forgotten and almost penniless in New York City. But it was Nikola Tesla, at least as much as Thomas Edison, who shaped the nature of the world that we live in today.

Concluding Remarks: PBS Program #42
"Alternating Currents"

Before It Went Black:

Mechanics Illustrated: June 1957

Conquest of Space

ANTI-GRAVITY: Power of the ~~Future~~ Now!

By G. Harry Stine
Chief, Navy Range Operations: White Sands Proving Grounds

THERE is a good chance that the rocket will be obsolete for space travel within 50 years. Some of us have been concentrating on the development of the rocket as the possible power plant for outer space propulsion. We've fired a lot of them and we've proved that they will work in outer space. We've also learned a lot about what's out there by using rockets. And probably we will take the first few faltering steps into space with rocket power plants.

But recent discoveries indicate that the spaceship of the future may be powered by ant-gravity devices. These, instead of using brute force to overcome gravity, will use the force of gravity itself much as an airplane uses the air to make it fly.

Sir William Crooks, the English scientist who developed the cathode-ray tube we now use for television, made extensive investigations of levitation phenomena—a field that once belonged to vaudeville magicians. Scientists, reasoning that if they believed his reports of weird green glows in vacuum tubes they should also look into Crooks' levitation studies, have been making slow but steady progress. Others have been investigating the fields of gravitic isotopes, jet electron streams and the mechanics of the electron shells of atoms. Townsend T. Brown, an American investigator, has gone even further than that. There are rumors that Brown has developed a real ant-gravity machine. There are many firms working on the problems of anti-gravity—the Glenn L Martin Co., Bell Aircraft, General Electric, Sperry-Rand Corp. and others.

Rumors have been circulating that scientists have built disc airfoils two feet in diameter incorporating a variation of the simple two-plate electrical condenser which, charged to a potential of 50,000 volts, has achieved a speed of 17 feet per second with a total energy input of 50 watts. A three-foot diameter disc airfoil charged to 150 kilovolts turned out such an amazing performance that the whole thing was immediately classified. Flame-jet generators, making use of the electrostatic charge discovered in rocket exhausts, have been developed which will supply charges up to 15 million volts.

Several important things have been discovered with regard to gravity propulsion. For one, the propulsive force doesn't act on only one part of the ship it is pushing; it acts on all parts within the gravity field created by the gravitic drive. It probably is not limited by the speed of light. Gravity-powered vehicles have apparently changed direction, accelerated rapidly at very high g's and stopped abruptly without any heavy stresses being experienced by the measuring devices aboard the vehicle and within the gravity-propulsion field. This control is done by changing the direction, intensity and polarity of the charge on the condenser plates of the drive unit, a fairly simple task for scientists.

Sounds incredible, doesn't it? But the information comes from reliable sources. We are licking the problems of gravity. Indications are that we are on the verge of tapping a brand new group of electrical waves similar to radio waves which link electricity and gravity *(Ed: Tesla Waves!)*. Electronic engineers have taken the electrical coil and used it as the link between electricity and magnetism, thus giving us a science of electro-magnetics which in turn has given us such things as radio, television, radar and the like. Now, gravity researchers seem to think that the condenser will open up the science of electro-gravitics. Soon we may be able to eliminate gravity as a structural, aero-dynamic and medical problem.

Although we will probably use rocket power to make our first explorations into space, the chances are now pretty good that this will not always be the case. In 50 years we may travel to the moon, the planets or even the stars propelled by the harnessed forces of gravity. If this seems fantastic, remember that the rocket and the idea of a trip to the moon was fantastic 20 years ago. Fifty years ago the idea of commercial air travel was utter nonsense.

With gravitic spaceships, we may travel to the moon in less than an hour, to the planets in less than a day or to the stars themselves in a matter of months. We may be able to do it in absolute comfort without the problems of zero-gravity or high accelerations.

The idea of the rocket becoming obsolete is not a happy idea, particularly when so much work has been done on rockets. But we have worked on rockets because we believed they were the only type of power plant capable of working in outer space. If a better method comes along, why shed tears? After all, our basic goal is to travel and explore in space and it doesn't make much difference how we do it.

Ed: The entire field was ordered black in 1958 and there has not been an official word heard since! Instead the public diversion called NASA was begun in the Autumn of 1958. Perchlorates Anyone? ⊙

Tesla Engine Builders Association
TeslaEngine.org

April 30, 1984

TESLA'S TURBINE

by Tom Valentine

EXCLUSIVE TO THE SPOTLIGHT

C.R. "Jake" Possell is a doer. Where others have talked and mused, he has built hardware that works. And Possell's story is big news despite Big Brother-style suppression and unimaginable corporate and bureaucratic ignorance.

More than 20 years age, Possell investigated the "myth" of the "Tesla turbine," and his innovative genius, like that of the great Nikola Tesla, ran into a brick wall in the form of the big business/big government partnership.

However, perseverance seems to be paying off.

"The Navy has granted my company a contract," Possell told the SPOTLIGHT in an exclusive interview recently. "And now maybe we can show the world what Tesla had in mind back in 1909."

The Navy contract is for Possell's company, General Ener-Tech, to build a geothermal electrical generating station on the Navy base at Fallon, Nevada. "Geothermal" refers to hot water steam within the earth, as in geysers. "Old Faithful" at Yellowstone National Park is the most famous example of unharnessed geothermal energy.

"This project will put all my Tesla turbine and pump technology on the map, where it belongs," Possell mused.

But Big Brother's partners do not surrender their suppressions easily. The granting of the contract brought a protest from big business interests. It was argued that Possell's company was "too small" to finance and handle the contract properly. The protest placed more hurdles in General Ener-Tech's path, but perseverance is Possell's long suit, along with his superior technology.

Geothermal energy is tremendously abundant, and Possell's particular technology opens a floodgate that could very well render nuclear, coal and oil fueled electrical generation facilities much less attractive. While this is a negative for today's power structure, it could mean energy salvation for the world.

"The big oil companies know all about geothermal." Possell pointed out, "and they have moved to buy up as much of the obvious potential as they can."

Chevron, for example, has purchased thousands of the best potential geothermal locations. However, insiders among the Big Oil firms have leaked information many times that the oil moguls have long-range plans drawn up that indicate they intend to exhaust oil and coal reserves first, before allowing geothermal to expand to its true potential.

An official of Phillips Petroleum in Bartlesville, Oklahoma, who requested anonymity, told the SPOTLIGHT; "Our company has a 250-year plan, and geothermal isn't part of the program for at least 35 more years."

Possell considers geothermal nature's best source of energy. "There's more practically free energy bubbling up from within the earth than the Earth needs." He said. It's readily available around the world; and, if we had to, we could dig down and tap it just about anywhere."

The technology for generating electrical power from geothermal has been around for 90 years. The first facility (in Laradello, Italy) has been producing since before the turn of the century.

EFFICIENT AND CHEAP

"My turbine and pump technology, which was inspired by Tesla's original turbine, is patented around the world and makes geothermal electrical generation more efficient and economical than any other source," Possell added matter-of-factly.

It has been a long, arduous journey for the "bladeless turbines" first dreamed up in the ingenious mind of Tesla back in 1906.

Tesla, the "father of alternating current," was such an inventive genius that today a virtual cult has grown up around the mystery of his life and work.

There is no doubt that history books deliberately obscured his achievements, and many people today believe much of his technology has been spirited away by monopolistic powers that desire to control technology to suit their long range goals.

LOOK MA, NO BLADES

The physics of electricity was Tesla's particular realm. But, in 1906-09, he took time to apply some thought to mechanical engineering. He designed and patented the first bladeless turbine, which evolved into a device of mythic proportions. The Tesla turbine is probably the most innovative engine scheme ever to be ignored, yet virtually canonized as legendary at the same time.

"Although Tesla's original ideas were clearly delineated in his patent application," Possell explained, "his invention had become nothing more than a term paper project used by a few college professors. Students would do very good analytical work, but their hardware was poor in quality, and the models invariably failed to perform as predicted by the analytical papers."

Possell's lifelong specialty has been reducing paper ideas to practice—making drawings into viable hardware. He was a young engineer more than 20 years ago, when he decided to make a model Tesla turbine.

All conventional turbines have "buckets," which is what the fan blades are called (in reference to the water wheel). But the Tesla/Possell designs do not have buckets—they are bladeless.

USING THE DRAG

"Tesla considered the problem known as boundary layer drag," Possell explained. "When a plane goes through the atmosphere a thin layer of air sticks to the surface of the wings and body. Planes could fly 40 percent faster if this boundary layer of dragging air could be removed. Tesla, genius that he was, thought that such a phenomenon could be used by turning the unwanted concept around 180 degrees."

Tesla designed and patented a turbine that used the boundary layer drag instead of buckets — Possell brought Tesla's legendary design to life. His hardware proved that Tesla knew what he was talking about. The bladeless turbines are far less costly to make and maintainand, in many cases, are more efficient than conventional (bladed) varieties.

"The first thing anyone needs to know about modern turbine technology," Possell added, "is that the energy stems from heat, not pressure. Working with the high temperatures necessary for efficiency poses material and design problems that drive the cost up. It has taken millions of man hours and probably a trillion dollars to arrive at today's efficient jet aircraft turbines."

To explain what he meant about heat being the key rather than pressure, Possell illustrated: "If we had a hypothetical steel sphere and somehow bottled 20,000 pounds of pressure per square inch inside of it, and we had a pressure gauge attached, the gauge would drop immediately once a pinhole released the cold pressure.

"But if that same pressure was superheated, it would take a long time before the pressure gauge would start going down. The equation is 'BTUs** equal horsepower,' not 'Pressure equals horsepower'."

Possell added that a dramatic example of this fact of energy was brought home a few years ago when he served as a consultant to a firm that wanted to consider the electrical generating capacity of geopressure zones. Geopressure zones are not geothermal—there is tremendous cold pressure buildup, which may be dangerous to oil drilling equipment, but it isn't heated pressure.

"They didn't want to accept my analysis that the megawatt output of all that pressure was surprisingly low. But I was right, and the project was dropped."

So, the problems of high temperatures and turbines make such engines extremely capital intensive. No wonder, then, that the Big Brother partnerships of government and business so easily monopolized the turbine-essential industries. "However, with bladeless turbines," Possell stressed, "the engineering problems are much more easily solved.

MAJOR COST BREAKTHROUGHS

For example, without the intricacies of bucket design, materials could be used that withstand far greater temperatures, and therefore put out far greater efficiencies.

Possell accomplished this major cost breakthrough in turbines nearly three decades ago. His first models were amazingly efficient, and he obtained a military contract to develop an expendable bladeless turbine.

However, working with the military-industrial complex power brokers had certain drawbacks. Possell had observed the suppressive might of the power brokers when he witnessed the destruction of John Northrop's revolutionary flying "wing" aircraft. Suppressive, monopolistic politics, not failed technology, resulted in the destruction of flying wing technology and hastened the death of Northrop.

"I put my gas turbine technology on a back burner and turned my attention to pumps," Possell said.

Today Possell manufactures bladeless pumps that do not suffer the engineering design maladies of all other pumps. The boundary layer principle lowers costs, raises efficiency and obviates wear and tear.

"Bauxite (aluminum ore) is the toughest stuff imaginable," Possell said, "and standard pumps are worn out in a few weeks' time. One of our pumps has been moving bauxite for 10 months so far and the wear is minimal."

Enter geothermal and today's electrical generating technology—a technology for which Big Brother wants the consumer to pay more and more (SPOTLIGHT, Nov. 28).

"Since bladeless pumps avoid cavitation (wearing away of metal by the action of implosion of water entrained gases), we can pump boiling water at atmospheric pressure. No other pumps can do that. It's a vital factor in geothermal, and also in nuclear generating facilities."

Possell explained that the Three-Mile Island shutdown became a near meltdown disaster because the cooling water pumps could not continue the water circulation once the temperature rose too high.

"Even though they shut the nuclear reactor, down," he said, "the cooling water was needed to eliminate the residual heat. But the pumps couldn't handle the high-temperature water and lost their prime."

Possell added that he is working quietly at this time with nuclear authorities to provide his pump technology to the A-plant design "arsenal."

However, with geothermal coupled to Possell's bladeless technology, the radiation danger inherent in nuclear plants need no longer be an issue. Geothermal is cleaner, cheaper and abundant.

"The godfather of geothermal, John Carlo Facca, has pounded his fist for years trying to tell utilities that the energy within the Earth is virtually free," Possell added.

Essentially, the actual energy bubbling up is free, and the costs need not be astronomical to harness it.

"Tests with our bladeless turbines indicated up to 60 percent more shaft horsepower can be achieved by using a mixture of hot water and steam, coming up out of the ground. This is really amazing to many engineers, because bladed steam turbines cannot tolerate water at all.

"We can drive the dynamos directly with total effluent geothermal without the expense of cleaning up the steam,

** A British thermal unit, or BTU, is the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit, at or near 39.2 degrees F.

and we do it more efficiently."

And, he could have added, bladeless pumps and turbines may be built for about half the capital cost of the others.

Possell has explained all this to various firms, utilities and government agencies for more than 15 years. His first patents were issued in 1966 and have been continuously updated ever since. All his perseverance has been needed as he encountered negligence and apparent complicity and conflict of interest at high levels.

"I've been patient, and I'm not trying to bring the established houses down. The system isn't threatened by my technology, just streamlined," he said.

General Ener-Tech is the public company formed by Mr. Possell. The stock is sold over-the-counter. Presently there is a "stop order" on purchases of stock in California.

The fortunes of General Ener-Tech are not running as smoothly as the bladeless technology.

The SPOTLIGHT looked into the corporate situation as well as the exciting technology, especially after learning about the billion-dollar contract with the U.S. Navy; a contract that "made" the Possell technology.

The corporate picture is muddled as of this writing, and stockholders stand to lose everything if order is not restored soon. Just exactly who and what caused all the difficulty is a matter of perspective at this point.

At the crux of the matter is the geothermal generating station contract with the U.S. Navy. This contract, which has been let to General Ener-Tech, and has survived protests by jealous major corporations, calls for $100 million in construction and about 560 million per year for the next 20-30 years.

Considering that once the station is built and operating, the costs are minimal; insurance and maintenance, and the income mostly "gravy," the contract is a plum.

The SPOTLIGHT first interviewed Possell in early November 1983. At that time the "stop order" on the company stock had been in effect only a few days. It was ordered October 28, 1983 by Melinda Brun of the California Corporations Commission (CCC). She advised that General Ener-Tech was under "investigation."

MYSTERIOUS INVESTIGATION

Brun told the SPOTLIGHT that General Ener-Tech had not provided "sufficient data" of a financial nature. She declined to give the reason for the investigation in the first place.

The late C.R. 'Jake' Possell greets International Tesla Society Director/Editor and TEBA founder Jeff Hayes at the 1990 Tesla Symposium in Colorado Springs.

Whatever the reasons, Possell blamed the CCC for catalyzing the problems which have now threatened to destroy his life's work and General Ener-Tech.

"I stand to lose the most," Possell said. "I'm the largest stockholder."

Today the stock is quoted at about $1^1/_2$. At one time it had reached as high as $8^1/_2$.

The monkey wrench in the corporate works comes with the problems a tiny company with less than $10 million in assets has in financing a $100 million contract.

"We needed a joint venture partner with the capital," Possell told the SPOTLIGHT in December, when he was still chairman of the board and such a financial partner was anticipated by everyone associated with the firm.

The need for capitalizing the contract, and for clearing up the bureaucratic red tape, pressured Possell and his board members from both sides.

It was determined that new blood on the board of directors could help. A stockholder convinced Possell and his two longtime associates that he could solve the CCC investigation problems. He also said he could help arrange contract financing.

ISRAELI CONNECTIONS

A New York-based public company with heavy connections in Israel, Helio Sciences, was to be the joint venture partner. Helio Sciences promised to provide the $100 million or so in cash and share equally in the venture, Possell explained.

It seemed like a lot to surrender since the contract was solid, but Possell was in a serious pinch for cash as other promised sources of money had not materialized.

The money from Helio Sciences was to be placed in General Ener-Tech accounts on January 5. — Nothing happened.

Upset at the turn of events, and accustomed to running his company with an iron hand, Possell called a meeting of his faithful, longtime board members to decide what to do.

The two longtime associates did not show up for the meeting. Instead, they convened their own meeting and the threesome—including the new director—voted Possell out.

The man who founded the company, and whose technological genius made the company possible, was suddenly relegated to being a "consultant."

Stung, Possell at first considered a proxy fight, taking his case to the stockholders, but he reconsidered as the funds from Helio Sciences were still pending and such funding would resolve all the problems.

THE OTHER SIDE

Vice president Jack McAllister, a 10-year Possell associate and board member, said that Possell "had to learn that the company was not a one-man show." After that he refused further comment saying the SPOTLIGHT would have to speak with his associates.

One major stockholder, familiar with the company for many years, told the SPOTLIGHT that it was possible Possell's inventive mind was not good at corporate record-keeping or management, so the change in management was necessary to bring in the financing.

Possell told the SPOTLIGHT that he "hated the hassle of bureaucratic red tape and the nitpicking of accountants." Even so, the company grew steadily during the past 12 years under his management, and he did manage to obtain the difficult Navy contract, he pointed out.

In late March, following the closure of the General Ener-Tech corporate offices and research facility in San Diego, The SPOTLIGHT contacted Helio Sciences. No one, however, would return our calls as promised by the switchboard.

As of April 2, the funding had not occurred, and General Ener-Tech was relegated to merely a telephone answering service.

Brun, the CCC investigator, told The SPOTLIGHT; " I can't learn anything about Helio Sciences, either."

Possell said that he and General Ener-Tech complied with all the CCC requests for information, and the entire investigation was uncalled for.

Strangely, the state investigation did not commence until after the Navy contract was firm. There is evidence that the "Israeli connection" within the U.S. Department of Defense is well aware of the lucrative geothermal contract.

There is some speculation now that Israel will begin manufacturing the Possell-Tesla turbine/pump under license from General Ener-Tech.

At one point during the series of interviews with Possell, after he learned he had been removed form his own corporate board, the inventor said: "Can you imagine, they (the other board members) are talking about replacing my turbines with Ormat turbines from Israel."

Ormat turbines, manufactured in Israel, are represented by Helio Sciences. The plot thickens. The corporate mess is as awful as the technology is awesome. ⊙

Feasibility of the Bladeless Turbine for Application In Hawaii's Geothermal Development.

January 31, 1992

Central Pacific Plaza, 220 South King Street,
11th Floor, Honolulu, Hawaii
P.O. Box 2359, Honolulu, Hawaii 98804

Introduction

This report was prepared in response to HCR No. 272, H.D. 1, which requested that the Department of Business, Economic Development and Tourism (DBED) review available feasibility studies on the bladeless turbine technology and report its conclusions about the potential applicability of this technology to geothermal wells within the State of Hawaii.

Many unsolicited documents from bladeless turbine proponents supporting this technology have been received by DBED. In addition, DBED solicited information from other sources in order to make an informed assessment of this technology. DBED does not have the technical expertise nor the resources required to conduct a thorough and independent analysis of the concept involved.

Description of the Technology

The bladeless turbine incorporates a unique design which enables it to extract useful power from both the liquid and steam phases of saturated steam, unlike most conventional turbines which utilizes only the steam. The bladeless turbine is also known as the radial inflow turbine because the fluid enters the turbine at right angles to the shaft (axially) and exits parallel to the shaft. Proponents of this technology have claimed it to be an economical, environmentally clean, and land efficient means of producing geothermal energy under a variety of conditions.

According to a report furnished by Mr. Hal Spindel of Terrestrial Heat Power, Inc., a field test of a 250 KW mobile system using this technology was conducted in 1979 and 1980 on geothermal wells in California's Imperial Valley. Tests have also been conducted in 1976 at the Lawrence Livermore Laboratory, at a Union Oil Company geothermal well site near Brawley, California, and at the Roosevelt Hot Springs, Utah. To our knowledge there is no known commercial installation of the bladeless turbine in operation today.

Investigation of Feasibility

The following summarizes the conclusions from numerous sources of information which were gathered in investigating the feasibility of the bladeless turbine technology:

1. Four technical reports received from the U.S. Department of Energy all conclude that the bladeless turbine technology is not a viable option for geothermal application because of relatively low efficiency.

2. A 1976 test of the turbine at the Lawrence Livermore National Laboratory showed an extremely low efficiency in the performance of the test turbine. *Ed: These tests by DOE and Livermore did not operate the turbine at rated speed, which is absolutely critical to efficiency. The Tesla turbine requires 125-185 psig at the nozzle to obtain operational speeds. See TeslaEngine.org for certified test results establishing the highest efficiency of any type singe stage device.*

3. Five recognized experts in geothermal energy conversion systems contacted by telephone confirmed that the technology has not yet been proven to be commercially feasible because of low efficiency. *Ed: These "Experts" had no direct experience or knowledge of the Tesla turbine's* *operational characteristics, relying instead on #1 and #2.*

4. A report prepared by the California Energy Commission indicates that the bladeless turbine may be appropriate and cost-effective under certain conditions for small (up to 10 MW) sized power plants. It also describes numerous technical and other barriers to commercial application of this technology. *Ed: How could this be if the Tesla turbine is completely inefficient? The Tesla Turbine is unique in that it has a 90º "Torque Knee." This was not understood and was never transcended in the previously cited tests by DOE and Livermore. The Tesla turbine has been extensively documented as having the highest energy conversion of any other type of turbine when operated in a single stage.*

Discussion With Respect to Specific Characteristics of the Technology Described in H.C.R. No. 272, H.D. 1

The following responds to the specific attributes of bladeless turbine technology cited at the bottom of the first page of the House Concurrent Resolution:

1. Costs only 25 percent of the present geothermal system.

The independent reports available to DBED suggest that bladeless turbine technology might be economically competitive in only two unusual situations: "when the plant site needs large amounts of 226 degree F or hotter thermal energy" ; and "when air quality restrictions are lenient, cooling water for a condenser is unavailable, and brine production costs are low." *Ed: Tesla geothermal hardware opens up vast reserves of Salt Brine Geothermal sources. Conventional geothermal has largely been a failure due to water requirements and environmental problems, including fracturing drilling techniques. It it has also been claimed that in many cases, conventional geothermal actually requires more energy inputs than it produces.*

2. Is a completely closed system that recycles all of the steam, water and effluent back into the ground, and can generate more power per well.

The "completely closed system" concept applies primarily to the means of fluid disposal, rather than the heat conversion technology used. Injection of all spent fluids is applicable for conventional geothermal steam turbines as well as for the bladeless turbine. Available literature is not clear whether stand-alone bladeless turbines can economically generate more power per well than conventional technology. A bladeless turbine added to a system using conventional technology can theoretically increase the power output. *Ed: Conventional turbines require a "binary" system to recover salt brine sources making it uneconomic in this mode. Even conventional geothermal sources are recovered at higher efficiency using Tesla turbines. See TEBA News #19 "A Geothermal Solution."*

3. Can be used on any of the Islands, not just the Island of Hawaii.

Preliminary information indicates that the temperature of geothermal resources on other islands are significantly lower than much of the Kilauea East Rift Zone and other locations on the Island of Hawaii. The independent literature available to DBED indicates the bladeless turbine requires a resource of relatively high temperature. This information suggests that bladeless turbines would be less effective, compared to conventional technology, on islands other than Hawaii. *(Ed: Not True — The Tesla turbine is the only type that can operate efficiently using low temperature multiphase fluids as well as the only type that can operate continuously at red heat.)*

4. Requires very little land, and would require less developmental cost and impact. Since a bladeless turbine system can be installed independently at each well head, it would appear that significant savings in land requirements may be achieved. Since no actual commercial installation of the bladeless turbine has been made, it is difficult to determine the cost and impact of such installation.

5. Eliminates the need to burn polluting fossil fuel for energy needs. Use of geothermal energy does not consume fossil fuel and can replace other electric generating processes which do.

Conclusion

On the basis of the limited investigation conducted by DBED it is concluded that the bladeless turbine technology is not feasible for commercial application at the present time. To our knowledge there is no bladeless turbine in commercial use today within the geothermal industry. We do not know whether further development of what appears to be a technically workable concept will prove that the technology can become a viable option for extracting usable energy from geothermal resources in Hawaii. Our inquiry appears to indicate that it likely will not because of its very low efficiency compared to conventional systems. Only the marketplace will determine when and to what extent this technology will become commercially useful.

As stated above, DBED does not possess the expertise nor the resources required to make a more thorough and independent analysis of the bladeless turbine technology. Unless such investigation is directed by the Legislature, DBED's further involvement with this technology will be limited to following its development elsewhere with the view towards encouraging its consideration for geothermal development in Hawaii when the technology has matured.

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GEOTHERMAL TURBINE AND METHOD OF USING THE SAME

by Clarence R. Possell

Abridged From U.S. Patent 4,232,992 issued Nov. 11, 1980

A turbine and method of using the same to generate rotational power from a desired geothermal source from which a multi-phase pressurized and heated fluid is discharged, which fluid contains steam and particles of water, and may contain particles of solid material. The turbine includes a rotor plate with a number of spaced discs secured to opposite sides thereof that are rotatably supported in a housing, and the housing having two laterally spaced sets of circumferentially disposed nozzle bodies situated therein that are each adjustable to define a convergent section, a throat and a diverging section. The nozzle bodies are so adjustable that streams of fluid at maximum velocity for a multi-phase fluid having particular characteristics as to heat, pressure and water droplet content discharge tangentially onto the two sets of spaced discs to flow through the spaces therebetween in spiral paths to discharge through openings in the centers thereof. The fluid as it pursues a spiral path exerts a drag on the discs, with the fluid losing kinetic energy that is transferred to the discs, rotor plate and shaft to drive them as an integral unit. No substantial lateral force is exerted on seals in the turbine as the lateral force generated by one set of discs by pressurized fluid flowing through the spaces therebetween is cancelled out by a like and opposite force generated on the other set of discs by the fluid.

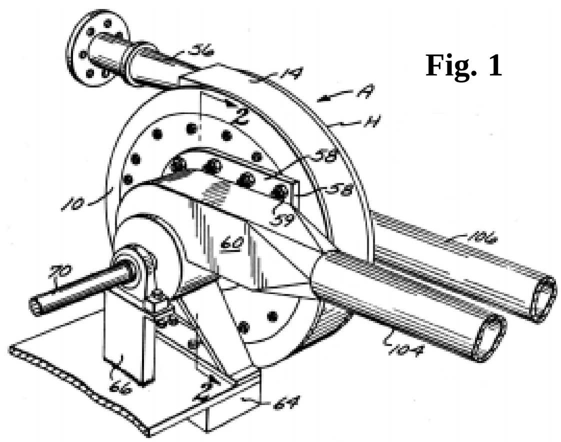


Fig. 1

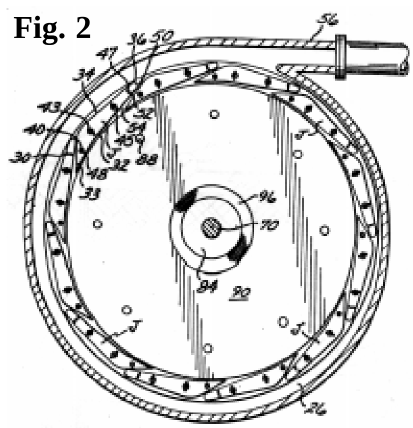


Fig. 2

BACKGROUND OF THE INVENTION
Description of the Prior Art

Prior to the present invention the use of geothermal energy has been limited to those areas that produce dry super heated steam. Such areas are extremely limited in number. In geothermal areas where dry super heated steam is available conventional turbines may be used to produce power.

In most geothermal areas the hot pressurized fluid produced from bore holes is of the multiphase type, that is, the fluid is a mixture of steam, droplets of entrained water, and also finely particled solid materials. If such hot pressurized fluid is to be used for power producing purposes with a conventional turbine the entrained droplets of water and particles of solid materials must first be removed therefrom. Removal of the droplets of water results in the loss of their heat energy as well as the kinetic energy they possess. Furthermore, the removal of the droplets of water results in loss of heat on the pressurized fluid. The use of a mixture of steam and entrained droplets of water for power producing purposes with conventional turbines results in the blades of the latter being eroded in a relatively short time.

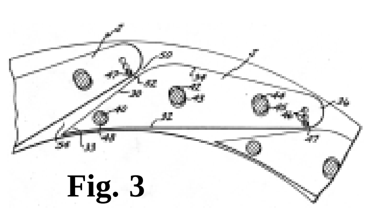


Fig. 3

From the above comments it will be apparent that the greatest amount of power could be produced if the entire effluent could be used for not only does the steam possess kinetic energy but this is equally true of the entrained droplets of water. In attempting to use hot pressurized effluent of a multiphase nature a major problem is to select a turbine nozzle that may be used effectively on the widely varying effluents one encounters not only in different geothermal areas, but from different wells in the same area.

A major object of the present invention is to provide a turbine in which first and second spaced discs on opposite sides of a circular rotor are concurrently subjected to jets of heated pressurized geothermal fluid from a number of circumferentially spaced overlapping nozzles that not only cooperate with a housing to define a circular ring-shaped space into which the effluent is discharged, but with the nozzles being of such structure as to be adjustable as to the relative dimensions of the convergent sections, the throats and the divergent sections thereof to obtain jets of pressurized fluid that are at maximum velocity when they are directed tangentally into the spaces between the discs.

Another object of the invention is to supply a turbine that has a minimum lateral force exerted on the rotor plate and first and second sets of discs due to the fluid exerting equal and opposite forces on the first and second sets of discs prior to flowing through openings in the center thereof to be returned to a bore hole that extends to the geothermal zone.

Another object of the invention is to furnish a geothermal turbine that is quiet in operation, and one that is not damaged by entrained liquid and solid particles in the effluent, for due to the boundary layer of effluent on adjoining surfaces of the discs, the liquid and solid particles do not come into contact with these surfaces as the effluent loses kinetic energy in flowing between the discs in spiral paths.

SUMMARY OF THE INVENTION

The present invention is a geothermal turbine assembly that may be adjusted to produce maximum rotational power from a particular geothermal source of a multiphase fluid that includes steam and droplets of water and in addition may contain particles of solid material. The turbine assembly includes a shaft that has first and second end portions and an intermediate portion therebetween. A circular rotor plate is mounted on the first end portion of the shaft. First and second sets of spaced discs are situated on opposite sides of the plate and secured thereto with the spacing between each two of the discs in a set being greater than the maximum dimensions of one of the solid particles that may be discharged through the turbine.

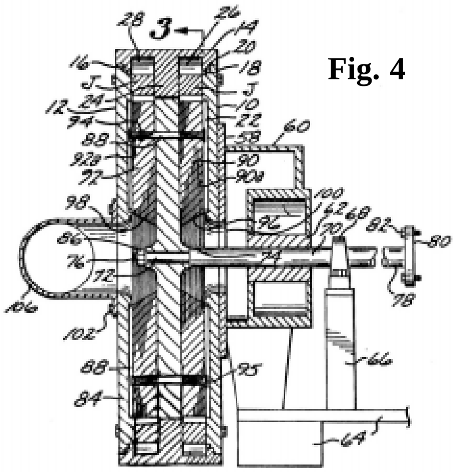


Fig. 4

The discs in the first and second sets have axially aligned centered openings.

The turbine includes a housing assembly that includes first and second laterally spaced side pieces and an end piece that extends therebetween, and cooperates with the side pieces to define a confined space in which the plate and first and second discs are disposed. A circular rib projects inwardly from the end piece to a position closely adjacent the periphery of the rotor plate, the rib, first and second side pieces, and the end piece cooperate to define first and second ring shaped spaces on the outer portion of the confined space.

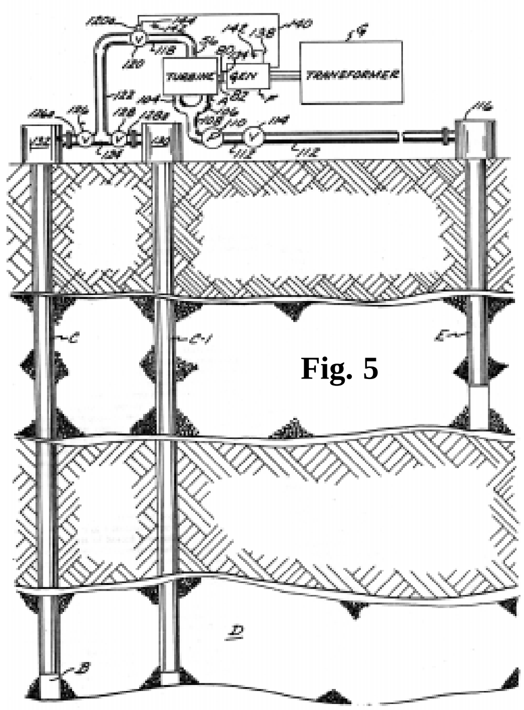


Fig. 5

The pressurized effluent is discharged concurrently into the first and second ring shaped spaces. First and second sets of elongate nozzle bodies are pivotally supported in overlapping relationship from opposite sides of the rib and inwardly from the end piece, with each pair of the nozzle bodies cooperating to define a converging space, a throat, and a diverging space therebetween. The diverging spaces in the first and second sets of nozzle bodies are in communication with the first and second ring-shaped spaces and are substantially tangentially disposed relative to the outer peripheries of the first and second sets of discs. Adjustable means are provided for holding each pair of nozzles in fixed positions relative to one another to permit the pressurized and heated fluids to discharge from the diverging sections between a pair of nozzle bodies at a maximum velocity for a geothermal effluent having a particular pressure, temperature and water droplet content.

First and second discharge openings are defined on opposite sides of the housing that are in communication with centered openings in the first and second sets of discs. Fluid discharges through the first and second discharge openings after traversing spiral paths through the spaces between the discs. Seals are provided in the turbine to prevent the pressurized fluid in the confined space discharging from the first and second discharge openings without first flowing through the spaces between the first and second sets of discs to impart kinetic energy thereto. The pressurized fluids as it flows through the spaces between the discs pursues spiral paths as it loses velocity and pressure and the loss of kinetic energy being imparted to the discs to drive the shaft, rotor plate, and first and second discs as an integral unit.

The shaft is rotatably supported by bearing means disposed exteriorly of the housing, with the shaft having a power take-off on a portion thereof adjacent the second end thereof.

Due to the incoming pressurized effluent being divided into first and second streams that flow concurrently through the first and second discs and discharge on opposite sides of the housing, the circular rotor plate is subjected to equal and opposite laterally directed forces, and no substantial longitudinal force is exerted on the shaft.

Accordingly, thrust bearings are not required in rotatably supporting the shaft.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of the geothermal turbine;

FIG. 2 is a vertical cross sectional view of the turbine taken on the line 3—3 of FIG. 4;

FIG. 3 is a fragmentary enlarged side elevational view of the adjustable nozzle bodies; and

FIG. 4 is a vertical cross sectional view of the geothermal turbine taken on the line 2—2 of FIG. 1;

FIG. 5 is a diagrammatic view of the geothermal turbine in use in producing power from a geothermal source where the effluent is of a multiphase nature and contains steam, droplets of water, and in some instances particles of entrained solids. ⊙

Ghost Plants Are Legacy of California's Geothermal Fiasco

Haste made $450 million in waste at two hurriedly built sites. Steam fields proved inadequate.

by VIRGINIA ELLIS **June 1993**

Ed: Described here is the closing of a conventional condensing geothermal plant in Northern California due to lack of power. This plant has been reopened, however, being sold and the recovery field expanded. This article highlights the problems and inefficiencies inherent with conventional geothermal recovery. Enter the Tesla Turbine. It is a paradigm change for the geothermal industry being the only turbine that can directly recover the overwhelming abundant energy of the "Salt Brine" geothermal resources. It has been estimated that the electric potential of the Saltine Sea area of Southern California alone could provide over 25 times the power requirement of the entire country! Tesla Turbines operated in this mode do not require additional water inputs or condenser being a "Total Flow" concept as described in the Possell patent.

When operated in the conventional condensing steam mode, it has been estimated that the Tesla turbine could recover approximately 60% more of the total available geothermal energy. This tremendous increase, completely changes the economics of the conventional, though still inferior, condensing steam geothermal plants! Maintenance is also drastically reduced. See TEBA News #19 for more details: "A Geothermal Solution."

COBB, California — All the signs of human activity are still there. Papers and manuals litter tables and desks. Handwritten charts cover some of the walls. Signs warn that "Ear Protection Is Required" to protect workers from the deafening noise.

Everything is there—except the people.

Echoing through the silent building are the footsteps of Glen Gordon, last manager of the state Department of Water Resources' Bottle Rock Geothermal Power Plant before it was shut down in 1990. Disappointment is etched in his face. "It was a beautiful plant," he says reverently. "Those of us who worked here were pretty proud of it."

Nestled among the lush green hills above Napa Valley, Bottle Rock and its sister plant a few miles away stand as towering monuments to government miscalculations and mistakes. Bottle Rock has not produced a kilowatt of electricity in three years. Its sister, the South Geysers Power Plant, never opened.

When the revenue bonds on the plants are finally paid in 2024, water plants are finally paid in 2024, water users will have sunk more than $450 million into the two projects, making them the state's most expensive white elephants. The customers of the Metropolitan Water District of Southern California will have shouldered 80% of the cost.

The two plants were conceived with the loftiest of goals and intentions in the 1970s when clean, cheap sources of energy were being sought to offset high-priced OPEC oil.

The state, often criticized for taking too long to act, moved with such speed on the geothermal project that it was able to move from conception to finished plant in less than a decade. Critics later complained that this was one instance when government moved too fast.

In the haste to bring the facilities on-line, government officials—especially in the case of South Geysers—too quickly accepted the word of geologists and private developers who said that steam was plentiful enough at the sites to run the facilities for 30 years.

As it turned out, there was not enough steam to run South Geysers at all. At Bottle Rock, it lasted five years.

Hidden by hills and virtually inaccessible to casual passerby, the plants are largely forgotten located near the community of Cobb, population 1,477. Many residents who own vacation cabins in nearby hamlets do not know the plants are there. Once a year they merit eight paragraphs in the Department of Water Resources 370 page annual report on the State Water Project called Bulletin 132.

This anonymity contrasts sharply with the high expectations that once surrounded them. In the heyday of the geothermal movement, the plant sites were visited frequently by top state officials—including once by Gov. Edmund G. (Jerry) Brown Jr., who brought along an entourage of reporters and photographers to record optimistic predictions of the great potential of geothermal steam.

The impetus for the Bottle Rock and South Geysers plants came in the mid-1970s when America was reeling from the shock of the OPEC oil embargo and spiraling energy costs. For California government, the need for alternative energy was particularly pressing because long-term contracts providing inexpensive electrical power for the massive State Water Project were soon to expire and officials feared large price hikes.

The water project, a critical source of water for 20 million residents, requires billions of kilowatts of electricity each year to carry water from Oroville Dam in Northern California to the end of the state's 444-mile aqueduct at Lake Perris in Riverside County.

Geothermal power seemed an ideal solution. California is one of the few places in the world with large underground steam reservoirs, areas where underground water comes in contact with molten rock near the Earth's surface. To tap the energy, wells are drilled and the steam piped to a power plant where it turns turbines that generate electricity.

The richest of California's steam reservoirs was believed to be the geysers, a geothermal area 90 miles north of San Francisco that was discovered in 1847. Commercial power production began here in 1960 and many companies, including Pacific Gas & Electric Co., had successful plants.

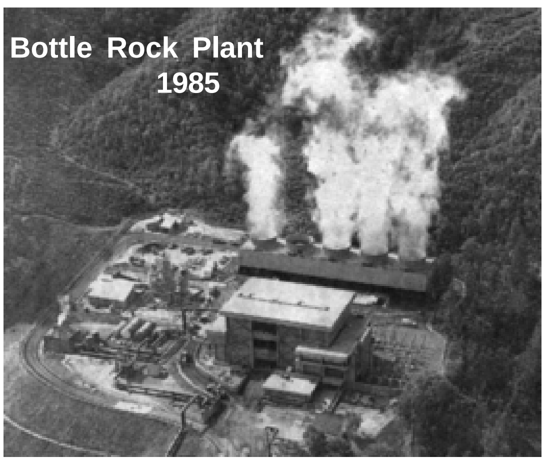
"There was this tantalizing idea that if you develop the geysers, you could find a renewable, reliable resource where the cost would be steady and you could break away from the price escalations and uncertainty of the oil market," said Richard Maullin, who served as Brown's first chairman of the state Energy Commission.

Hoping to get a least one plant on line before power contracts expired in 1983, the state quickly floated bonds to finance construction of two plants. The bonds would be paid off by customers of the State Water Project, and the projects largest customer and biggest user of energy was the MWD. The plans called for the state to construct and manage the plants, but the steam to run them would be purchased from private companies that would develop, operate and maintain adjacent steam fields.

To determine the availability of steam at the site of the plant, the state Department of Water resources hastily entered into contracts with private geologists to analyze the steam field at the Bottle Rock site. Department officials say their reports confirmed that steam would be available to run the plant at its proposed 55-megawatt capacity for 30 years.

Eugene Boudreau, a Santa Rosa geologist who has spent 10 years researching the projects in preparation for a book, maintains that is only part of the story. Although some reports were optimistic, he said others carried warnings that should have alerted officials to investigate the field further. "But the state turned a blind eye to the negative information and particularly to the lack of information," Boudreau said.

Construction started in 1981 on the $122-million Bottle Rock Plant—a facility that state officials boasted would be unlike any other at the geysers. Power plants constructed by private industry often are squat buildings of corrugated metal. The state's three-story structure of reinforced concrete had dark wood paneling in the reception area, a herringbone design etched in the concrete and reflecting glass windows on the top floor to give a panoramic view of the hills.


Bottle Rock Plant 1985

"We asked the department to consider a simple design," said Joseph Summers, an engineer who represents several water districts served by the state project. "But they wanted to build this symbolic stuff. They were hell bent on having something very elaborate that they could show off." Another official estimated that the state could have saved at least $20 million if the plant had been less ornate.

As construction of Bottle Rock got under way in Lake County, the state moved ahead with its plans to build another plant a few miles away in Sonoma County. The state relied on assurances from the private steam field operator, Geothermal Kinetics Inc., that there would be enough steam available to support the plant. A later state audit found that the Department of Water Resources insisted that it did not have time for an independent analysis, even though the agency knew PG&E was having problems "locating enough steam for one of [its] plants on property adjacent to the South Geysers property."

As it turned out, the contractor's assurances were based on the drilling of three test wells, all in the same northwest quadrant of the steam field. The wells showed the presence of steam, but they told nothing about its availability on the remainder of the property. During construction, the drilling yielded bad news. In 1985, the state decided to halt construction, determining that there was not enough steam to run the plant. By then, $55 million had been spent on construction. Today, South Geysers stands as a shell, completed on the outside but unfinished on the inside. Millions of dollars in unused equipment still sits in crates on the ground floor. Some has been sold to the Bechtel Corp. to recoup about $5 million.

Even as the state was throwing in the towel on South Geysers, it was formally opening the doors on what appeared to be its success story—the completed Bottle Rock plant. For the first year, the plant seemed to meet all expectations, pouring out electricity at the promised 55 megawatts—enough power to serve the needs of a city the size of Santa Rosa.

Then the steam field began to run into problems. First, a corrosive element in the steam caused problems with the piping. Then there was an ominous drop in pressure. Meanwhile, the price of oil had begun to drop dramatically. Suddenly power purchased from the private utilities was cheaper than that generated at the geothermal plant.

By the end of the decade, production at the plant had dropped to seven megawatts. Under pressure from water contractors, the state decided in September, 1990, that Bottle Rock should be closed and moth balled. The plant closed, having never generated enough electricity to offset the annual maintenance, operational and financing costs.

Defenders of the state's geothermal venture say the failure of the plants was hard to anticipate at a time when steam field testing procedures had not been perfected and much was still unknown about the behavior of steam reservoirs.

"In hindsight, you're looking at a program that is not successful," said John Pacheco, the department's senior engineer for water resources. "But economics played a big role and the crystal ball of the late 1970's...did not predict the drop in oil prices."

V. John White, executive director of the Center for Energy and Efficiency and Renewable Technology, a joint industry-environmental effort, said the state was an early casualty of a new industry that has learned from its mistakes. He said geothermal steam has proved to be a relatively clean form of energy and today generates 6.5% of California's electricity from plants located at the geysers Nono-Long Valley, the Imperial Valley and Coso Hot Springs in the high desert near Death Valley.

The geysers in Sonoma and Lake counties were overdeveloped and the state chose to locate its plants at the edge of the receding reservoir, most of the plants that continue to operate are in the center of the reservoir, White said.

He said that despite the state's experience, geothermal energy remains a viable alternative for government. In fact, he said, the Los Angeles Department of Water and Power plans to develop its leases at the Coso geothermal area.

As for the state, it is no longer interested in geothermal power production and would like to sell the plants, said the state's Pacheco. He said a Santa Rosa company has shown interest in reopening Bottle Rock.

Gordon, the former Bottle Rock manager who still works for the state and occasionally inspects the plant, believes that if new wells are drilled and old ones are reworked, the Bottle Rock plant could operate again. "The problem was never with the plant," he said, "and I hope it operates again someday."

For that reason, Gordon said, everything at Bottle Rock was left intact—signs still on the walls, telephones in place and manuals on the desks. All in hopes that someday somebody else would run it again. ⊙

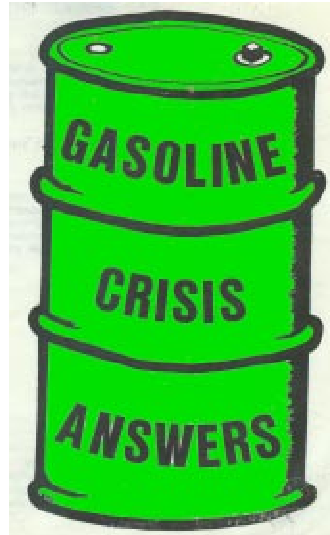
THE TURBINE CAR

Ed: Following is an extraction from the 1970's book "Gasoline Crisis Answers" attempting to explore why there was an energy crisis and possible solutions. Reproduced here is the chapter of the book exploring the "collusion" as to why we are not using the gas turbine engine in our automobiles. It contains a fairly comprehensive bibliography of media articles describing extensive efforts to develop a practical bladed gas turbine for automotive uses. It is concluded that since such extensive effort was made toward its development, its implementation must have been suppressed. This is not the case, however, with these extensive efforts being, instead, proof that the gas turbine engine was a failure at providing a practical alternative. All attempts to use the gas turbine in this mode have been a failure due to the severe limitations and complication, including efficiency, safety and cost concerns, of the bladed devices.

Jan Norby points this out in his book; "The Gas Turbine Engine." It documents, in detail, extensive attempts to employ the gas turbine engine for land vehicles (reviewed in TEBA News #7). Mr. Norby points out, in this classic work, that even if all the problems of the gas turbine for land vehicles could be resolved, its Achilles' heel is that it requires exotic metals in the fabrication of the bladed components. He concludes that the quantity of these metals required would cause the price of these commodities to rise beyond the economic use of these metals in an affordable vehicle. So no conspiracy here, only the harsh reality of physics and economics.

Now enter the Tesla Turbine. It does not require exotic metals to function efficiently and can achieve extreme mileage using dirty water injection. This use of water injection allows for adiabatic expansion at relatively low heat and drastically increases thermal efficiency. This instead of the high temperatures required for efficiency of the bladed turbine, which employes complicated blade geometries made of expensive and polluting rare earth materials and can not tolerate any solids ingestion.

For more information on the overwhelming advantages of the Tesla turbine for land vehicles, see TEBA News #23; "Tesla Turbo Electric Hybrid Design." This article describes Volvo's efforts at producing a gas turbine hybrid using all of the Tesla components, except it used a bladed gas turbine. Even so it achieved a doubling of mileage and performance. As a result of the bladed gas turbine this cutting edge project was also uneconomic but would be made practical with the Tesla Turbine Engine!



by J. E. Jackson

"This writer remembers seeing a Chrysler gas turbine car on the streets of Portland, Oregon, in the early 1960's. Actually, Chrysler Corporation made about 50 turbine cars at that time and "loaned" them out to the general public in various cities around the Country.

THE TURBINE

The turbine engine is not a new concept. They have been hard at work for many, many years. They run stand-by generators, drive Army troop trains, have powered Navy landing craft, Marine hydrofoil boats and Air Force helicopters, not to mention the fact they fly over-head every day in jet airplanes.

As far back as 1946, Captain Eddie Rickenbacker predicted that nearly all cars soon would be powered by turbines.

What happened? What advantages over the piston engine can be found in the turbine? What did Chrysler Corporation find from their tests? How would the gas turbine help us meet today's energy crisis?

TURN BACK THE CALENDAR

Let us go back to the years 1963 and 1964 and read the headlines:

"Americas First Turbine Car"
Look Magazine, June 4, 1963

"BigTest—Chrysler's Turbine Car"
Time, May 10, 1963

"Chrysler—Turboflite Experimental"
Motor Trend, May 1963

"Comeback in Detroit"
Saturday Evening Post, May 25, 1963

"Emotion — Key to Turbine"
Science Newsletter, April 11, 1964

"Gas Turbine Car Feasible"
Science Newsletter, April 4, 1964

"On the Road; Chrysler's Turbine-Powered Car"
Newsweek, December 30, 1963

"P.M. Drives Chrysler's New Gas Turbine"
Popular Mechanics, July 1963

"Test-driving a Jet; Chrysler's New Turbine Engine"
Business Week, March 28, 1964

"That's the Jet"
Newsweek, November 11 1963

"Turbine Drive" Newsweek, May 13, 1963

"Turbine in a Truck; Experimental Gas Turbine Truck"
Business Week, October 31

"Wh-o-o-o-sh, Here Comes the Turbine"
Hot Rod Magazine, July 1963

Further, the turbine car was the subject of repeated nation wide television coverage, newspaper articles...even books were written about the "turbine car."

WHAT IS THE TURBINE?

Simply stated, the turbine is an engine that sucks air through an intake "mouth" and compresses it in a chamber into which fuel is introduced and ignited by a spark. The heated expanding gases propel one turbine wheel that spins the air compressor and then speeds on to whirl another turbine that drives a shaft. See figure 1.

The turbine engine has many distinct advantages over the piston engine. It has about one-fifth as many moving parts. There is only one spark plug and it is used only for starting purposes (should never need replacing). The troublesome ignition problem found in piston engines are eliminated. There is no distributor. Also, no radiator is needed, because the engine is air cooled. Turn the key and the engine fires immediately. There is no warming period required after the car is started. Turn on the heater and you get instant heat.

The car drives similar to a conventional auto. However, those who tested the car reported that the turbine operated more smoothly than the piston engine, there was less noise and less vibration.

The turbine is a clean-burning engine. Carbon monoxide gas is practically non-existent, as the fuel is burned completely this adds almost nothing to air-pollutants. Engine oil never becomes contaminated or dirty because it doesn't come in contact with the fuel or combustion. Since there are fewer moving parts, engine oil consumption is practically eliminated. Five quarts of oil should last a life time.

The turbine engine is a light-weight engine, and should be expected to run for 300,000 miles. The engine requires very little maintenance. (This is substantiated by the low maintenance needed by the airline companies for their jets.)

Another marked advantage over the piston engine, is the fact that the turbine will deliver high power while using almost any fuel that will burn in a test tube. It will operate on diesel, unleaded, regular or premium gasoline, kerosene, peanut oil, French perfume or brandy. Actually, synthetic, non-fossil fuel or even "home made" fuel would propel the turbine car very nicely.

DOCUMENTATION: All of the facts and figures cited above are documented in the various reports, test results and articles already listed at the beginning of this section.

MOST OFTEN ASKED QUESTIONS

What about the extreme heat from a turbine's exhaust?

In 1954, George Huebner (at one time executive researcher engineer with Chrysler), "confounded the experts by developing a rotating heat exchanger to harness the heat thrown out by the exhaust. This was the key to making the engine practical and efficient enough to be worth developing." Business Week, March 28, 1964, page 76.

On page 75 in this same magazine, there is a picture of gas station attendants with hands extended at the exhaust outlet. One report states that a kitten could sleep there and not be burned.

What about the price?

"Chrysler claims that it can produce turbine engines that are competitive in price with their piston counterparts, if turned out in the same quantities." Business Week, January 6, 1962, page 37.

What was the public response to their test-driving the 50 experimental models?

When the public first learned that Chrysler was planing to loan out these cars for family driving, the company was flooded with mail, so many wanted to participate. Chrysler wanted those selected to represent the average citizen. Among those not selected were William Randolph Hearst Jr., Gen. Curtis LeMay, Ernest Borgnine and Lyndon Johnson (while he was still Vice-President).

Finally, the participants were selected on the basis of geography (one in every state), climate and road terrain.

RESULTS

The cars were reluctantly returned to Chrysler with rave notices from the borrowers:

"The first man to get a turbine car, Chicagoan Richard Viaha, told Business Week: 'I never drove anything out of Detroit like that before. It is really terrific.' And his comments are restrained, compared to some others."

Another man reports: "he can get hardly any work done at the office, everybody is so interested in the car..." Business Week, March 28, 1964, pages 75-76.

"'I just wish I could buy it after the test period is over, it's terrific,' said Mrs. Estelle Center, a housewife in Columbus, Ohio, and one of the four "typical" drivers..."Newsweek, December 30, 1963, page 50.

COMPLAINTS

Complaints have been minor ones: *(TEBA Ed: Not so minor; poor gas mileage and sluggish starts. Tesla water injected electro-turbo drive exceedes 100mpg and more than doubles 0-60!)* "Enthusiasm, says Anderson, hasn't waned, to say the least. His test mart group agrees" Business Week, March 28, 1964, page 83.

WHERE IS THE TURBINE CAR

All of us identify with a David who is up against a giant Goliath. It is easy to get some people to believe that the auto manufactures and the oil companies are like giant Goliaths who buy-up worthwhile inventions and "lock up" the design. This is done so more gas and oil can be sold or more car parts can be sold and the rich get richer. These stories are common.

Actually, from the published record there does seem to be a grain of truth to this kind of reasoning. At times there does seem to be a "collusion" between government agency officials, the automobile manufacturers and the oil companies.

However, rather than this writer offering a judgment as to the truth of these stories, let us sample the evidence — then you be the judge.

"Chrysler is careful about its claims for the future. It is uncomfortably aware of what a major shift to gas-turbine engines would do to the auto industry's vast investment in the piston engine and to the oil industry's stake in high-octane fuels, is also mindful of difficulties yet unforeseen in widespread use of the turbines. But there is plenty of evidence that the public is willing to give the new engine a try." Time, May 10, 1963, page 90.

The public liked the turbine. It was well received.

It is a proven engine. Its wide use in aviation proves that fact. The turbine was successfully adapted to a car. The written record between 1952 and 1965 proves that fact. The turbine car was ready to go. Company officials state that fact.

Yet: Chrysler is "uncomfortably aware" that:

1)...a simpler, more efficient engine would not require many parts; would require less maintenance and in the long run, less money to the auto related industry.

Also, they were aware of the fact that:

2)...this engine will operate on fuels other than gasoline...thus the oil industry's (money) stake must be considered.

Is this Time comment an isolated one? Let us dig deeper.

From this point on to the end of the chapter, notice how certain high-ranging government officials, key oil companies and the automobile manufactures are indeed closely related... as someone has said, "they are coy companions."

Since gasoline is taxed, the more gasoline burned...the more dollars flow into government coffers.

Read this documentation:

"Gasoline Racket,"

Saturday Evening Post December 26, 1931

"Gas Taxes!" Literary Digest

June 15, 1929, page 64, also February 20, 1932, page 44

":More Gas Taxes!!" Literary Digest

March 5, 1930, page 10, November 11, 1931 page 10, and February 10, 1932

"One Big Union,"

Business Week July 7, 1934 page 10

"16 Oil Companies Convicted of Fixing Gasoline Prices," Senior Scholastic

February 1938, page 15 and Business Week, January 29, 1938

"Gas Tax Injustice; Less than 5 percent Finds its Way into Street Construction and Maintenance Programs,"

August 1947, page 102

"Truth About Gas-tax Diversion"

American City, June 1949, page 5

"American Motorist: No.1 Tax Sucker"

Coronet, August 1952, pages 40-44

"Airlines Protest Added Gas Tax"

Aviation Week, July 18, 1955

"Tax Revolt at the Grass-roots"

U.S. News and World Report

April 26, 1957, page 108

"Piling it on, Double in a Decade"

Newsweek, September 7, 1959, page 34

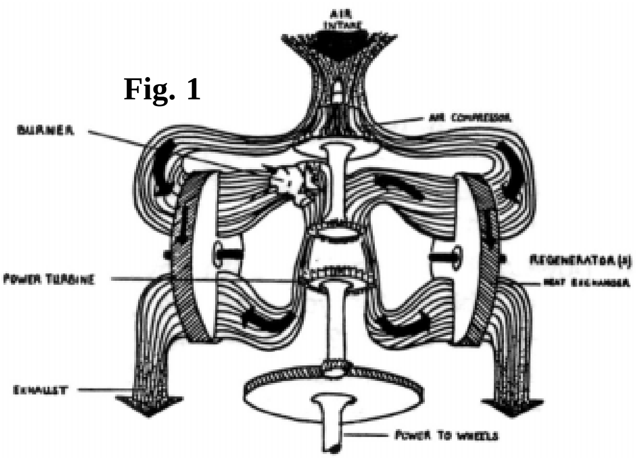
"Motorist Pay More Than Their Share of Highway Costs,"

Saturday Evening Post February 11, 1961, page 10

"(President) Ford Weighs a Hidden Tax on Gas,"

Newswek, December 30 1974, pages 48-49

Fig. 1



"Should We Sharply Increase Taxes on Gasoline?"

Senior Scholastic March 13, 1975, page 10

Telephone Call; Fall of 1977 to Local Gasoline Companies: The State and Federal excise taxes in Washington State are currently 14 cents per gallon!

In 1952, the average citizen paid the same amount in various gas and automobile taxes as he did in INCOME TAXES!

"The American Motorist: No.1 Tax Sucker." Coronet, August 1952, pages 40-41.

What do you think that figure is today?

Actually, gas and automobile "excise" taxes are simply another INCOME TAX Certainly the evidence proves that the government collects multi-millions of dollars from the gasoline tax.

NOW how does the turbine car fit into this picture?

READ THESE REPORTS

Gas turbines promise new era in power.

December 1939 Popular Science, pages 80-81

Gas turbine for airplanes.

June 13, 1942 Science news Letter, page 372

Gas turbine drives Swiss locomotive.

May 1943 Popular Science, page 114

Gas turbine: New prime mover.

June 1944 Fortune, pages 174-180

Gas turbine for autos.

June 1946 Popular Science, page 121

Readers Digest—Powdered coal feeds a turbine.

August 1946

also Scientific American

Super engine cuts gasoline bill.

August 1947 Popular Science, pages 89-91

Turbine for cars. May 17, 1948 Newsweek, page 66

Gas turbines for autos.

May 29, 1948 Business Week, page 66

Turbines designed for cars.

September 1948 — Both Popular Mechanics and Popular Science.

Baby gas turbine ready for marketing.

January 14, 1950 Business Wee, page 70

Jet on wheels.

March 20, 1950 Newsweek, page 760

Experimental gas turbine auto.

January 23, 1954 Science news Letter, page 51

First look at the gas turbine car

January 26, 1954 Look, page 15

Americas first turbo car.

February 1954 Popular Science, pages 160-161

These and 13 other reports in 1953 and 1954 indicate that the turbine car was soon to be built for marketing.

What to do until the turbine comes.

October 22, 1955 Business Week, pages 83-84

New gas turbine bus.

July 14, 1956 Science News Letter, page 21

From this point on the record makes reference to many many reports on the turbine engine written every year. We list only a few more.

You're looking at the gas turbine era!

April 1959 Popular Mechanics, pages 131-135

Chrysler's turbine.

July 1961 Popular Science, page 35

Turbine car for the masses?

January 6, 1962 Business Week, pages 36-37

Run on anything!

January 15, 1962 Newsweek, page 59

I rode cross country in the turbine auto.

March 24, 1962 Saturday Evening post pages 38-41

The years 1963 and 1964 were already referred to at the beginning of this chapter.

Car with tomorrow's engine.

April 1965 Changing Times, pages 39-42

October 1965 Popular Science, page 88

Turbine engine for cars.

February 1969 Mechanix Illustrated

(Another) Chrysler turbine car.

September 1973 Popular Science

(Another) turbine by Ford.

November—1973 Mechanix Illustrated

A CLOSER LOOK

We've already shown proof positive that other cars have been invented which do not require gasoline as a fuel. But, for now our subject is the turbine car.

Have the auto manufacturers "locked-up" this invention?

A. General motors Company had a turbine vehicle on public display as early as January 1954. See Science Digest, December 1954, pages 66-70, also April 1954.

This report asks the question: "How soon before we would expect to see the turbine car for sale?" Answer: "5 to 10 years, maybe longer."

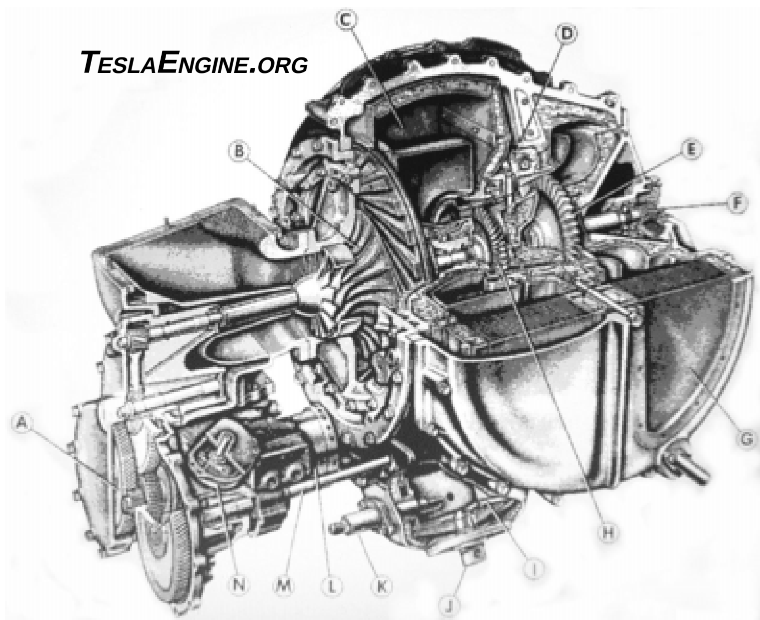
B. In 1954, Chrysler Corporation revealed their gas-turbine engine after "9 years of top secret research." See Business Week, March 29, 1954, page 67.

This report states 'that Chrysler's development may make gas turbines in cars years rather than decades away."

C. Ford Motor Company has a turbine car and a turbine truck. See Mechanix Illustrated, May 1967, page 62-65 and Business Week, October 31, 1964, page 28. See pictures of the vehicles.

When will this turbine car be ready for the public?

"Top Ford officials estimate five years before turbine trucks appear on the highway, passenger cars should follow three to five years later."



MAIN COMPONENTS OF THE TWIN-REGENERATOR GAS TURBINE:
A: Accessory Drive; **B:** Compressor; **C:** Right Regenerator Rotor; **D:** Variable Nozzle Unit; **E:** Power Turbine; **F:** Reduction Gear; **G:** Left Regenerator Rotor; **H:** Gas Generator Turbine; **I:** Burner; **J:** Fuel Nozzle; **K:** Igniter; **L:** Starter-Generator; **M:** Regenerator Drive Shaft; **N:** Ignition Unit.

Have you seen a turbine car recently?

Actually, according to written evidence, the turbine car has been ready for years.

D. "A First In Automotive History: We Drove A Turbine Car Coast-To-Coast" by George J. Huebner Jr., Executive Engineer, Research, Chrysler Corporation. Popular Mechanics, June 1956.

This article shows pictures of the car, its coast-to coast route and gives high praise for the turbine. The turbine was expected to revolutionize the auto industry within 10 years.

TIME TABLE

E. "Timetable for Next Car Engine: The Gas Turbine and its Future" Business Week, April 2, 1955, page 134

Since the turbine car would so greatly affect the auto and oil industries, the writer of this report asks the auto manufacturers and oil company officials:

"When should we expect the turbine car to be available to the public?"

THEY ESTIMATE by

1960....60,000—300,000 cars

1965....264,000—3,9000,000

1970....11,500,000—42,500,000

1975....48,000,000—62,000,000

The report goes on to say that although the auto manufacturers can now produce the turbine car it will usher in major changes....because the turbine car will run longer with less maintenance required,

Then the article points out that:

"80% of the reports submitted to the oil companies say automotive turbines are a sure-thing within 10 years."

Yet the report also points to the fact that the oil industry must face major changes when the turbine is mass produced. The turbine can operate on cheap or homemade fuels ... it doesn't need to burn gasoline.

F. Even auto parts companies began to prepare for the turbine car: "Parts Maker Prepare for Turbine"

Business Week, May 19, 1956, page 64.

CONCLUSION

1960 has come and gone.
1965 has come and gone.
1970 is history.
1975 is history.

HAVE YOU SEEN A TURBINE CAR RECENTLY? ⊙

Turbomachinery Bibliography

by Glenn A. Barlis

This is an annotated bibliography of material useful for the Turbine Engine Builder. The items are grouped by topic. Many are no longer in print but can often be found in a good university library. Used book stores and flea markets are other sources for some of the out of print items. I have listed the editions I have access to; there may be more recent editions.

Thermodynamics

There are hundreds of thermodynamic texts available. Here is one that is currently in print that has good worked examples of problems relevant to turbine engine design.

Moran, Michael J. and Howard N. Shapiro, **Fundamentals of Engineering Thermodynamics**, John Wiley and Sons, 1996.

British books often present a slightly different view from American texts of a topic. This can be useful in gaining understanding of technical topics.

Bacon, D. H., **Engineering Thermodynamics**, Butterworth and Company, 1972.

This book provides a very readable introduction to thermodynamics with a humorous approach and a de-emphasis on the math. Highly recommended.

Fenn, John B., **Engines, Energy, and Entropy**, W. H. Freeman and Company, 1982.

There are a number of books from the first half of the 20th century listed in this bibliography. They provide very readable explanations without the recent academic emphasis on fancy math.

Faires, Virgil Moring, **Theory and Practice of Heat Engines**, The MacMillan Company, 1948.

Ebaugh, Newton C., **Engineering Thermodynamics**, D. Van Nostrand, 1937.

Adams, Arthur Stanton and George Dewey Hilding, **Fundamentals of Thermodynamics**, Harper & Brothers, 1945.

A must-see site for energy and thermodynamics.
http://www.benwiens.com

Centrifugal Pumps and Compressors

Much of the engineering information on centrifugal pumps is relevant to Tesla pump design. Here is a current book that has a wealth of information and photos on pumps, bearings, seals, cases, etc.

Karassik, Igor J. and Terry McGuire, **Centrifugal Pumps**, Chapman & Hall, 1998

This is a classic in the field with a clear explanation of the concepts presented in this series and much more.

Church, Austin H., **Centrifugal Pumps and Blowers**, John Wiley and Sons, Inc., 1944.

A practical engineering manual on compressors.

Gresh, M. Theodore, **Compressor Performance**, Butterworth-Heinemann, 1991.

Fluid and Aero-Thermodynamics

These books present more technical information and are heavier into the math for fluid dynamics and thermodynamics. The first is a classic by the inventor of the jet engine.

Whittle, Sir Frank, **Gas Turbine Aero-Thermodynamics**, Pergamon Press, 1981

Cumpsty, N. A., **Compressor Aerodynamics**, Longman Scientific & Technical, 1989.

Dixon, S. L., **Fluid Mechanics, Thermodynamics of Turbomachinery**, Pergamon Press, 1978.

Lakshminarayana, Budugur, **Fluid Dynamics and Heat Transfer of Turbomachinery**, John Wiley & Sons, Inc., 1996.

A classic.

Schlichting, Hermann, **Boundary-Layer Theory**, McGraw-Hill, 1979.

The following three books are from a 12 volume set titled **High Speed Aerodynamics and Jet Propulsion** that documents the technology of jet engines. Somewhat dated but still very useful.

Hawthorne, W. R. ed., **Volume X Aerodynamics of Turbines and Compressors**, Princeton University Press, 1964.

Hawthorne, W. R. and W. T. Olson, **Volume XI Design and Performance of Gas Turbine Power Plants**, Princeton University Press, 1960.

Lancaster, O. E. ed., **Volume XII Jet Propulsion Engines**, Princeton University Press, 1959.

Gas Turbine Technology

These books present the theory of gas turbines and provide a lot of design detail.

This book gives you as close a look into the design manuals of the major manufacturers as you are likely to get.

Sawyer, John W. ed., **Gas Turbine Engineering Handbook**, Gas Turbine Publications, Inc., 1966

Among other things this book has an excellent chapter on diffusers.

Wilson, David Gordon and Theodosios Korakianitis, **The Design of High Efficiency Turbomachinery and Gas Turbines**, Prentice Hall, 1998.

This book provides a broad overview summary of turbomachines, including a brief discussion of the 'shear pump' and Tesla Turbine.

Balje, O. E., **Turbomachines**, John Wiley & Sons, 1981.

Here is an ASME publication with very detailed design information.

Walsh, Philip P. and Paul Fletcher, **Gas Turbine Performance**, Blackwell Science Ltd. And ASME Press, 1998.

I used the explanation of fluid-rotor energy transfer from this book for the explanation in part one of this series.

Shepherd, D. G., **Principles of Turbomachinery**, The MacMillan Company, 1956.

Here is a more recent volume comparable to the Shepherd text.

Harman, Richard T. C., **Gas Turbine Engineering**, John Wiley & Sons, 1981.

This book focuses on the application of the gas turbine in automobiles. It details the work of Chrysler, Ford, GM and others and includes patent details.

Norbye, Jan P., **The Gas Turbine Engine**, Chilton Book Company, 1975.

The book with everything you wanted to know about combustion for turbines.

Lefebvre, Arthur H., **Gas Turbine Combustion**, McGraw-Hill, 1976.

A couple of other introductory college texts.

Cohen, H., G. F. C. Rogers and H. I. H. Saravananuttoo, **Gas Turbine Theory**, Longman Scientific and Technical, 1990.

Logan, Earl Jr., **Turbomachinery**, Marcel Dekker, Inc., 1981.

Jet Engines and Aircraft Power Plants

These books cover the entire span of jet engine development over the last 50 years.

One of the first but still a valuable explanation of basic principles.

Zucrow, M. J., **Principles of Jet Propulsion and Gas Turbines**, John Wiley & Sons, 1948.

Finch, Volney C., **Jet Propulsion Turbojets**, The National Press, 1948.

This book highlights the transition from piston engines to jets.

Katz, Israel, **Principles of Aircraft Propulsion Machinery**, Pitman Publishing, 1949.

Casamassa, Jack V. ed., **Jet Aircraft Power Systems**, McGraw-Hill, 1950.

Durham, Franklin P., **Aircraft Jet Powerplants**, Prentice-Hall, 1951.

Hill, Philip and Carl R. Peterson, **Mechanics and Thermodynamics of Propulsion**, Addison-Wesley, 1965.

This one is still in print.

Cumpsty, Nicholas, **Jet Propulsion**, Cambridge University Press, 1997.

There are a number of books aimed at the Airframe and Power plant technician. They provide good explanation of the systems for jet engines and detailed descriptions of many commercial jet engines. The best of these is still in print.

Treager, Irwin E., **Aircraft Gas Turbine Engine Technology**, Glencoe/McGraw-Hill, 1999.

Otis, Charles E., **Aircraft Gas Turbine Powerplants**, IAP, 1989.

Casamassa, Jack V. and Ralph D. Bent, **Jet Aircraft Power Systems**, McGraw-Hill, 1957.

This last item is a military field manual that is available on the web at:

.FM 1-506 Fundamentals of Aircraft Power Systems

Steam Turbines and Technology

These books are mostly Tesla contemporaries and give insight into the state of the steam turbine technology when the Tesla patents were granted.

French, Lester G., **Steam Turbines, Practice and Theory**, Hill Publishing Company, 1907.

Croft, Terrell ed., **Practical Heat**, McGraw-Hill, 1923.

Allen, John R. and Joseph A. Bursley, **Heat Engines**, McGraw-Hill, 1931.

Kraft, E. A., **The Modern Steam Turbine**, VDI-Verlag G,M,B.H., 1931. *Finally, the classic in the field.*

Stodola, A., **Steam and Gas Turbines (in Two Volumes)**, Peter Smith, 1945.

Mechanical Engineering Laboratory Practices

These books are texts for mechanical engineering students to teach laboratory practices. They cover instrumentation and methods for dynamometers and prony brakes, pressure and flow measurements, thermometry, throttling calorimeters, etc. There appear to be few new texts on this topic and you will have to find one of the older books such as listed here for the invaluable practical details that any experimenter needs.

Ambrosious, Edgar E. and Robert D. Fellows, **Mechanical Engineering Laboratory Practice**, The Ronald Press Company, 1957.

Doolittle, Jesse Seymour, **Mechanical Engineering Laboratory**, McGraw-Hill, 1957.

Keator, Frederic W., **Mechanical Laboratory Methods**, D. Van Nostrand, 1947.

Shoop, Charles F. and George L. Tuve, **Mechanical Engineering Practice**, McGraw-Hill, 1956.

General Engineering Handbooks

These books provide the references to fundamental data and provide a concise summary of basic engineering information.

Gartmann, Hans, **De Laval Engineering Handbook**, McGraw-Hill, 1970.

Pope, J. Edward ed., **Rules of Thumb for Mechanical Engineers**, Gulf Publishing, 1996.

Bolz, Ray E. and George L. Tuve ed., **Handbook of Tables for Applied Engineering Science**, CRC Press, 1975.

Eshbach, Ovid W. and Mott Souders ed., **Handbook of Engineering Fundamentals**, John Wiley & Sons, 1975 ⊙

Tesla again offered Westinghouse the designs of his "commercially superior turbine," which he assured them would save the firm millions of dollars *(Ed: early 1922)*. But he warned that there could be no strings. He could produce the turbines at once but would not consent to agree to "any experimenting whatever." The response was tiresomely familiar. Board chairman Guy E. Tripp wrote that they could not enter such an agreement because their engineers were negative on the subject, "and of course we must be guided by the opinion of our Engineers."

From "Tesla: Man out of Time" p. 223

2,000 ARE PRESENT AT TESLA FUNERAL

GREAT IN SCIENCE ATTEND

Cathedral of St. John the Divine Is Scene of Yugoslav State Function for Scientist

Ambassador Fotich Heads the Procession of Mourners — Bishop Manning Assists

Inventors, Nobel Prize winners, leaders in the electrical arts, high officials of the Yugoslav Government and of New York, and men and women who attained distinction in many other fields paid tribute yesterday to Nikola Tesla, father of radio and of modern electrical generation and transmission systems, at an impressive funeral service in the Cathedral of St, John the Divine.

The service, conducted in Serbian by prominent priests of the Serbian Orthodox Church, was opened and closed by Bishop William T, Manning, assisted by Father Edward West, Sacrist of the Cathedral. The Serbian Orthodox Office for the Dead was said by the Very Rev. Dushan Shoukietovich, rector of the Serb Orthodox Church of St. Sava, who officiated in the name of the Serbian Orthodox Church in America.

City is Represented

More than 2,000 persons attended the service. The city was represented by Newbold Morris, President of the City Council, who headed the list of honorary pallbearers. Other honorary pallbearers included Dr. Ernest F.W. Alexanderson of the General Electric Company, inventor of the Alexanderson alternator; Professor Edwin H. Armstrong of Columbia University, inventor of frequency modulation and many other important radio devices *(Ed: Armstrong gave Tesla full credit for the basics of F.M.)*; Dr. Harvey C. Rentachler, director of the research laboratories, Westinghouse Electric and Manufacturing Company; Gano Dunn, president of the J.G. White Engineering Corporation; Colonel Henry Breckenridge, Dr. Branke Cubrilovich, Yugoslav Minister of Agriculture and Supply; Consul General D. M. Stanoyevitch of Yugoslavia and Professor William H. Barton, curator, Hayden Planetarium.

Fotich Heads Procession

The funeral service was held as an official State function of the Yugoslav Government, which was officially represented by Constantine Fotich, Yugoslav Ambassador to the United States. Dr. Fotich led the procession of mourners who passed the coffin before it was closed. Oscar Gavrilovitch, Yugoslav consul in New York, headed the list of ushers.

Many telegrams were received from officials of the United States Government, prominent scientists, literary men and many others. These included messages from Mrs. Roosevelt, on behalf of herself and the President: Viche President Henry A. Wallace, Professors Robert A. Millikan, Arthur H. Compton and James Franck, all Nobel Prize winners in physics; Professor Willliam Lyon Phelps of Yale, Jean Piccard and Major Gen. J. O. Mauborgne, U.S.A., retired.

Mrs. Roosevelt's message read: "The President and I are deeply sorry to hear of the death of Mr. Nikola Tesla. We are grateful for his contribution to science and industry and to this country."

Vice President Wallace's message read as follows:

"Nikola Tesla, Yugoslav born, so lived his life as to make it an outstanding sample of that power which makes the United States not merely an English-speaking nation but a nation with universal appeal. In Nikola Tesla's death the common man loses one of his best friends."

Scientists Pay Tribute

Drs. Millikan, Compton and Franck paid tribute to Tesla as one of the world's outstanding intellects, who paved the way for many of the important technological developments in modern times.

Among the many floral offerings was a wreath from King Peter II of Yugoslavia; the Royal Yugoslav Government, Ambassador Fotitch and many Yugoslav societies.

Chief mourner was Sava Kosanovich, nephew of Dr, Tesla and president of the Eastern and Central European Planing Board, representing Yugoslavia, Czechoslovakia, Poland and Greece.

The body was taken to Ferncliffe Cemetery, Ardsley, N.Y., where it will be in the receiving vault until plans are completed. *(Ed: New York Times Jan. 13, 1943)* ⊙