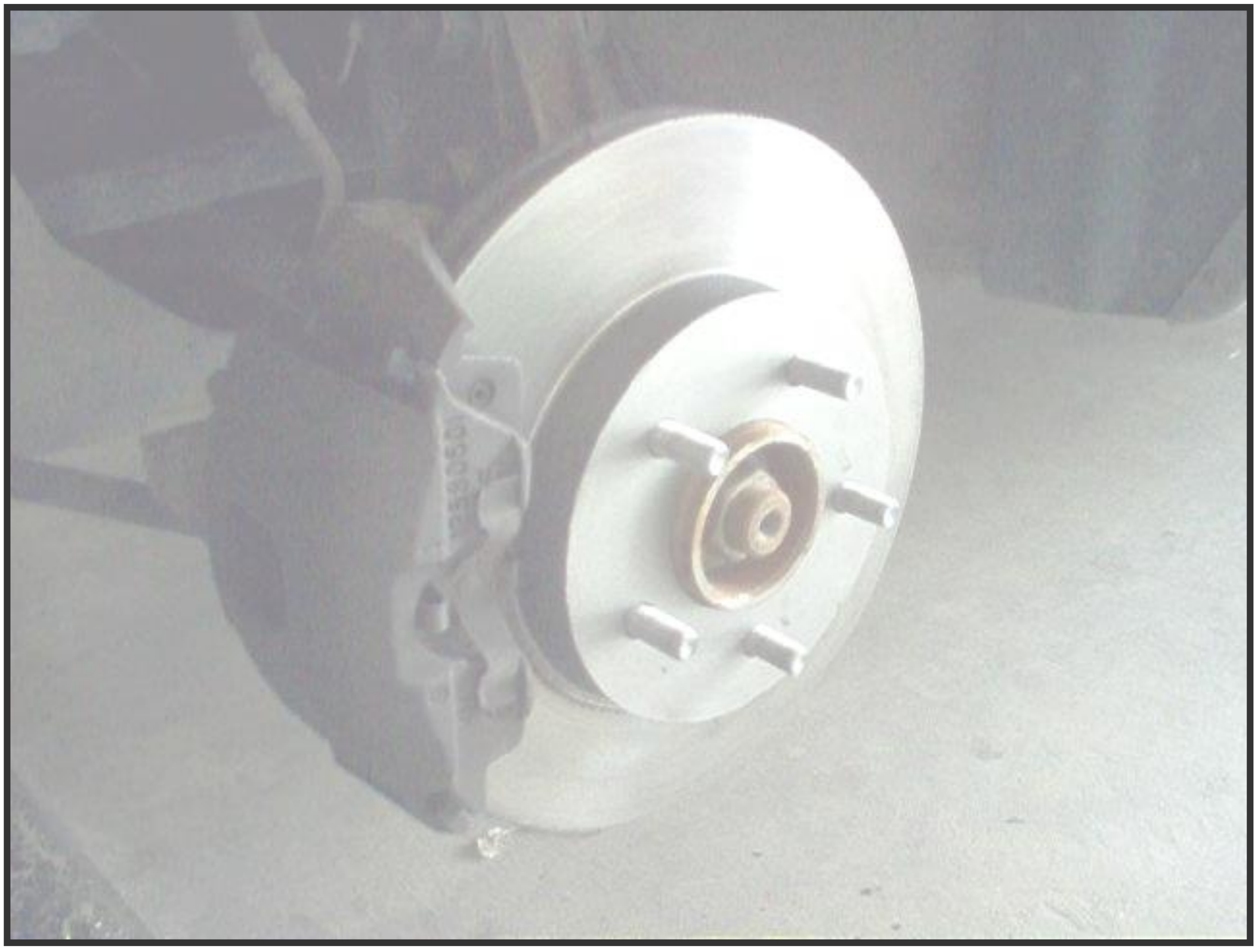
Wear^2

Intellectual Property Proposal, Patent No. 7,676,897



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2. General Company Description

Wear² is a research company formed to produce IP for the remanufacturing of automotive brake components—specifically brake rotors.

Mission Statement: Wear² promotes the advancement of mechanical wear technologies. The IP under consideration merges currently accepted cryogenic processing with common automotive remanufacturing practices. The result is a process patent that utilizes scrap brake rotors, new materials, and skilled labor to provide consumers with low cost, competitive brake component that may be marketed as an alternative to new brake rotors costing significantly more. Similar patents will follow.

Company Goals: Now that patent rights have been granted, my goal is to license the IP, sell it outright or otherwise profit from this effort and begin to invent new products and processes. I may be interested in becoming a member of a current or future company board of directors for the right entity that can realize the full potential of this invention.

Primary Proposal Objectives: For customers to find value in a unique product sold widely in the automotive and heavy trucking aftermarket. Manufacture a product that consistently exhibits better wear characteristics and structural integrity than new brake rotors.

Secondary Proposal Objectives: Leverage green aspects of reusing parts normally sold to scrap dealers (or dumped at the local landfill). Create an alternative market segment for brake rotor manufacturers by utilizing cryogenic processing, an integral process component of this IP.

Business Philosophy: The obvious reason for any business is to generate profits. In this case, the brake rotor IP will make it possible to profit from the successful invention of automotive and heavy truck remanufacturing methodologies not previously attempted.

Legal form of ownership: Sole proprietor.

3. The Reman Industry: A New Product Is Born

Currently, the only product of Wear[2] is the IP previously mentioned. The IP is a utility patent originally applied to both brake rotors and brake drums; however, early in patent negotiations I was forced to choose between rotors and drums as a product species for this process. I chose brake rotors for obvious reasons. The early development of the IP deserves a brief history.

Professional Experience. I worked for Detroit Diesel Remanufacturing West in Tooele, Utah for 9 years where I learned the remanufacturing business. Prior to being hired by Detroit Diesel, I interviewed with a small startup company by the name of Cryocon where I became aware of the advantages of cryogenic processing. Although I did not accept a full-time position with Cryocon, I stayed in contact with them, had some gauging processed by them while employed by Detroit Diesel. I purchased company stock and 4 years later I signed a contract to become an outside salesman in my spare time at the same time I continued to work full-time for Detroit Diesel.

I enjoyed working for Detroit Diesel first as a quality engineer and later as a product development manager setting up new production lines. I was born with an affinity for all things mechanical, and the core salvage aspect of the business quickly interested me. As a factory remanufacturer, Detroit Diesel Remanufacturing cleans and restores core parts to new condition, made possible through the use of innovative core repair procedures. Individual parts are assembled into high quality reman products such as cylinder heads, water pumps, oil pumps, balance shafts, superchargers, turbochargers, mechanical/electronic unit injectors and complete diesel engines.

Sometime during the first few weeks of employment I was shown a repair process that impressed me more than any other process in the facility. The plant manager showed me a series of four experienced (read "used core") turbine shafts removed from the exhaust side of several turbochargers. The first shaft was caked with carbon, grease, dirt and rust. The fins were bent and worn from catastrophic failure and the bearing journals were pitted and worn much too small for assembly clearances to be maintained. The last three parts had been cleaned and prepared for the remanufacturing process. The second shaft showed how all damage to the fins and journals was machined away. The third shaft was the same as the second except that all welding processes were complete. Each fin had welded fins built up in the exact curvature of the proper airfoil and shaft journals had been metal sprayed in excess of the original shaft dimensions. On the fourth and final shaft of the series, excess material was machined away precisely back to the original shaft tolerances with the correct surface finish. The thought of using this particular core astounded me. The reason it impressed me so much was because I knew something of the critical nature of parts in a turbocharger assembly as it cycles thermally from cold to extremely hot operating conditions. It is particularly impressive when one considers that turbochargers typically rotate in the 8,000 to 60,000 revolutions per minute. Assembled part clearances must be maintained at 0.0004″ meaning that many individual part tolerances must be machined within a 0.0002″ tolerance. This salvage process provides key savings that allows Detroit Diesel to run a profitable reman turbocharger business. It began by remanufacturing Garrett (later Honeywell) turbochargers and is now branching out to other makes to capitalize on this core competency. Turbocharger remanufacturing makes up over 50% of profits at the remanufacturing center I worked at just outside Salt Lake City, Utah.

As a side note, during my career at Detroit Diesel I became familiar with literally hundreds of other core salvage processes which included: metal spraying cylinder head cam bores and engine blocks followed by machining to original tolerances; designing and manufacturing repair sleeves of all kinds used for pressing onto worn shafts or into core castings; and updating older castings to incorporate newer factory design features. I might say here parenthetically that brake rotor technology is far less sophisticated than that associated with engines and engine components. Each reman component production line at Detroit Diesel is the result of years of engineering development. Processes are constantly being reinvented, and I saw these high quality products hold up extremely well in the heavy truck aftermarket. As one might imagine, there are many remanufacturing companies and each accomplishes reman component repairs in their own ways. They are successful in varying degrees, but they all enjoy the cost advantage of beginning their manufacturing processes with used cores at considerable raw material savings.

Now fast forward four years. To say that I had limited success in outside sales for Cryocon is slightly understated. I had very limited success selling services to the hundreds of companies I contacted. If I learned anything as I spoke with businesses about processing their parts and tooling, it was that decision makers were very closed-minded about the potential benefits of cryogenic processing. They cited examples from traditional metallurgy—especially heat treating disciplines that have been practiced for years—but they would not test a single part or tool to find out if cryogenic processing improved wear characteristics as claimed. During this time, Cryocon and most cryogenic processing companies were successfully treating new brake rotors and a variety of other products. One key market segment in which cryogenic treating has enjoyed particular success is in the tooling industry. Cutting tool, knife and instrument sharpening intervals are reduced sharply. Other products that benefit from cryogenic processing include firearms, musical instruments and even some textiles. Again, the IP in question only applies to used brake rotors.

My lack of success as a sales representative combined with my reman experience led me to think about remanufacturing core brake rotors and brake drums and treating them cryogenically. I reasoned that the ability to capitalize on used cores and follow proven reman techniques would be much less costly than purchasing new rotors. Used rotors could be treated cryogenically as easily as new. Cryocon was setting up an e-commerce website where customers could order new treated rotors for nearly any vehicle. They were also working with local automotive dealerships that were beginning to sell cryogenically treated rotors as a dealer add-on. I knew Cryocon could benefit by selling treated remanufactured brake rotors and brake drums at a competetive price point. I surmised that if I were to patent the process I would be in a much better position to benefit financially from my efforts as an inventor through licensing fees than I ever would as an outside sales rep trying to sell a treating service.

This brief history illustrates how the idea for the IP came into being. As I previously mentioned, the time came after applying for this patent to choose a product species—either brake drums or rotors. The decision to base the IP on brake rotors was based on the increasing use of brake rotors over drums in the automotive and commercial vehicle industries. Technically, brake drums may be processed in a similar way as brake rotors; however, the process may not enjoy the same level of patent protection. However, reman/cryo treated brake drum products may still infringe on the brake rotor IP. Even if a company was successful in getting around the patent sufficiently to produce a line of reman brake drums in this way, one can see that their efforts would be severely limited in this market segment as there are far more brake rotors than brake drums currently in service. The commercial truck industry is definitely behind in this trend, but rotor use is increasing year after year in that market segment as well.

Reman Part Aftermarket. The remanufacturing industry as a whole was valued at $10 billion dollars in 2007 and the automotive remanufacturing segment alone is projected to reach $105 billion by 2015. The brake manufacturing industry will be a $28.5 billion dollar industry by 2018 according to current estimates. Virtually all heavy truck manufacturers have reman divisions and automotive companies may follow given the current economic climate and the need to be competitive to stay in business. As the reman brake rotor concept proves successful, the owner or combined licensees of this patent will enjoy exclusive manufacturing rights. All other companies desiring to offer reman brake rotors will have to become licensed or cease and desist production of all products with a portent for IP infringement.

Reman parts have been available for many years, attested to by the existence of trade groups, councils, associations and institutes such as APRA (Automotive Parts Remanufacturers Association), HDRG (Heavy Duty Remanufacturing Group), TRI (The Remanufacturing Institute), NCR[3] (National Center For Remanufacturing and Resource Recovery), ERC (Engine Repower Council), AAIA (Automotive Aftermarket Industry Association), ITPA (International Truck Parts Association), MACS (Mobile Air Conditioning Society), GAAS (Global Automotive Aftermarket Symposium), MEMA (Motor & Equipment Manufacturers Association), NARSA (National Automotive Radiator Service Association) and SEMA (Specialty Equipment Market Association) who all have remanufacturing ties, to name just a few. Trade shows are also prevalent for the remanufactured components industry. Consider Big R, ReMaTec, HDAW (Heavy Duty Aftermarket Week), MATS (Mid-America Trucking Show) and others.

Summary. The purpose of this section is to show how the IP can be adapted to an existing company with brake rotor manufacturing experience. Again, it is thought that such a company would benefit most in the short term by using existing or by obtaining cryo processing equipment along with core recovery procedures to drive sales in a new reman brake rotor market segment. Again, the IP could be purchased outright or a license fee agreement could be negotiated. Depending on the scope and abilities of the licensee, exclusive rights may also be negotiated for a specified period of time. If the IP is purchased, ownership transfers to the new owner. IP protection provides significant benefits in an entirely new market segment within the remanufactured component industry, not to mention automotive and commercial truck aftermarkets.

4. Prototype Summary

This section describes the development of the first brake rotor prototypes as outlined in the IP (see uspto.gov patent no. 7,676,897). Chronologically, the initial provisional patent application came first. However, a summary of the prototype here will help with a better understanding of product intent, sequence of events and technical aspects of patent approval.

Following the first patent examiner rejection some 14 months after the application was filed, I determined that working prototypes would be critical in persuading the examiner that the invention was patent-worthy. Previous to this time I thought that since my internet and patent searches did not reveal a brake rotor remanufacturer of any kind, a patent would be granted right away without any problems. This certainly was not the case, and working prototypes seemed like the best way to show the viability of the process. In the end, it was the test results of the prototype rotors that persuaded the examiner to grant the patent.

Prototype Manufacturing. Prototypes were made from a set of brake rotors removed from a personal vehicle I was driving at the time. Both were worn beyond the minimum installation thickness specification of 0.912”. This particular vehicle was a 1995 Dodge Intrepid. In this case, the rotors were last serviced at a thickness slightly greater than the minimum spec and had worn slightly thinner than the discard specification of 0.882”. As one might imagine, the prototype rotors ended life in a somewhat greasy and very rusty condition.

By way of process summary, all rotor surfaces were sandblasted first. This was followed by a thorough grit blasting of the wear surfaces. This was done using an irregular-shaped steel grit blast media, from which the resulting surface is known to produce the best adhesion for the metal spray process. Prime Machine in Salt Lake City, sprayed a .070” thickness of Praxair Alcro (an iron chrome aluminum alloy with the following composition: Fe 23.5 Cr 5.3 Al .65 Si) on all wear surfaces. This alloy was chosen because I knew it to be compatible with other cast iron components. Further IP research and development will likely result in the discovery of other alloys that will be a better fit for the application and allow for even greater performance gains than the original material.

Because I was unsure of the effects of cryogenic processing with respect to final machining, I had the prototypes rough ground .020” thicker than the original equipment (OE) finish machining specification before sending them out for cryo treating. The rough grinding operations were performed by Superior Grinding in Salt Lake City. My thought was that if cryo treating relieved any stresses from the metal spray process as claimed, slight warping would result and the prototypes may not have parallel wear surfaces. This proved not to be the case as there was no warping observed whatsoever. Next, the prototypes were sent to 300 Below, Inc. in Decatur, Illinois, for cryogenic treating as Cryocon was now out of business. Once returned, I took the treated rotors back to Superior Grinding where they verified that the wear surfaces were parallel to each other as well as the brake rotor "hat" (raised mounting surface). Through this process I learned that the rough grinding step could be eliminated when future products were manufactured; however, in this case finish grinding had to be performed to reach the OE finish spec of 0.948 – 0.950". Inspection using a micrometer and test gauge showed that all surfaces were within this spec and parallel within 0.0004".

Vehicle Installation. Interestingly, during the approximate12 months it took to complete the prototypes my Dodge Intrepid was hit by a drunk driver while parked at my home and totaled. I purchased a 1993 Chrysler Concorde for my son to drive while commuting back and forth to college as it utilized the same brake rotor. The prototypes were installed on the front of the subject vehicle and I made sure the rotor runout was within the 0.003" specification measured from a fixed point relative to both sides of the rotor wear surfaces with the rotor turning on the wheel hub of the vehicle. The actual runout measurement was 0.001" at room temperature following a test run after the rotors and brake pads were installed and "worn in" together. The pads were a high grade semi-metallic. The prototypes ran on the car for 23,000 miles.

On-Vehicle Test Results. The prototypes were removed from the vehicle and an aftermarket set of rotors was installed at 23,000 miles due to failure of the driver's side rotor. There was no indication that anything related to the remanufacture of the rotors was responsible for the failure. Quite to the contrary, the driver side rotor had been exposed to extremely high temperatures and suffered deep grooving from metal to metal contact with the rivets in the brake pad. This rotor held up extremely well with no indication of any separation of the metal sprayed/finish machined layer from the substrate (core rotor). The rotor did not actually fail, but suffered only deep grooving (0.030 - 0.040" deep) which rendered it useless for further on-vehicle testing. The passenger side rotor and pad exhibited very little wear at 23,000 miles as rotor thickness measured 0.934 – 0.938" (.010 - .016" wear). The brake pads on the passenger side still had 2/3 of their service life left resulting in a pad to rotor wear ratio of 22:1. The runout of both rotors prior to being removed was still 0.001". As a side note, the aftermarket rotors I installed after the prototypes began to show more uneven wear on the driver side again. Further investigation revealed that the cause of the "failure" was the driver side front caliper.

Before the decision was made to replace both prototypes, an attempt was made to have the rotors turned on a brake lathe so I could install new brake pads and continue accumulating mileage. Two things influenced my decision to remove them. First, removing them would give me the opportunity to begin both destructive and non-destructive testing in order to better address examiner rejections. Second, when I took the prototypes to the local auto parts store to have them turned down to an acceptable thickness with the wear surfaces machined completely flat again, the clerk refused to ruin any more inserts in the process of trying. These rotors were so tough and wear-resistant that he changed the cutting insert on the brake lathe 3 times in an effort to remove material. He returned the rotors to me with a puzzled look on his face and said he had never had that problem before. The cutting insert would only bounce along over the top of the wear surface as it deflected over the entire cutter path. I was elated to hear this report as it confirmed the effectiveness of the IP. I briefly explained to the clerk that these were experimental rotors. He didn't look any less puzzled when I left.

The prototype rotors were subsequently taken to a local metallurgist who removed a section of one rotor and provided micrographs and analysis of the cross-section . I thought there might be some unexpected results at the boundary between the metal spray overlay and substrate boundary in the report, but its appearance was as expected. The metallurgist cut the section at one location on one of the prototypes where the metal spray had separated slightly and allowed some rust to form between the metal spray and substrate. This was the only defect of its kind and was obviously a problem with the metal spray process. Detection of such a defect is routine with today's quality control techniques. In other words, if this were being produced in a high volume manufacturing environment this particular brake rotor problem would have been easily detected long before it ever reached a customer to be installed on a vehicle. The analysis done by the metallurgist contained a few clues as to what materials to try on our next prototypes.

The testing that was most persuasive to the patent examiner was the pull testing performed by Flame-spray Industries, Inc. in Port Washington, New York. Detroit Diesel used this company to verify metal spray results on several projects I was familiar with, so it was natural for me to send the brake rotor prototypes to them to perform a series of pull tests to obtain adhesion data.

In short, a “dolly” is glued to the metal spray surface and an apparatus is connected to the dolly and adhesion strength is measured. The dolly is continuously pulled until a failure occurs, which will be one of 4 types: glue failure (the dolly pulls away from the metal spray surface), adhesive failure (the metal spray layer pulls away from the substrate at the boundary), cohesive failure (the metal spray layer adheres to the substrate and the substrate pulls apart at varying depths, or a combination of any two. Two samples were tested in addition to the brake rotor prototypes to try to assess the effectiveness of the cryo processing step as well as grit blasting prior to metal spraying. These results were inconclusive for the purposes of this section. The pull test results on the prototype rotors confirmed that in 18 of the pulls performed, 10 were either cohesive failures or a combination of cohesive and other failures. There were 4 adhesive failures at relatively high forces. The engineers at Flame-spray Industries were not concerned with these failures due to compressive forces on brake rotors when in service. Finally, there were 4 glue failures which was a high number but the engineers worked directly with the glue manufacturer and both concluded that these results were due to a bad batch of glue. Overall, pull test results were highly favorable and was the primary evidence that the patent produced non-obvious results.

Secondary evidence considered by the patent examiner was contained in a letter written by Robin Rhodes, CEO of Nitrofreeze, LLC. Mr. Rhodes provided expert opinion that companies in the cryogenic processing industry universally do not treat used rotors. They only process new brake rotors, thus establishing the uniqueness of this exclusive IP.

5. Business Opportunities

IP Benefits. The benefits of this IP are listed here:

1. "Green" solution eliminates material scrap
2. Preserves original engineering/manufacturing resources
3. Products better than new due to increased wear characteristics
4. Improved quality over typically inferior offshore castings
5. Improved price over high quality domestic rotors and drums
6. Any cores may be utilized
7. Benefits of combined metal spray *and* cryogenic processing
8. Unlimited component service lives as opposed to single conventional
9. Materials development is real strength of patent
10. Excellent market potential given automotive and commercial truck aftermarkets
11. Not previously considered due to industry steeped in traditional casting methods
12. Unexpected prototype results positive, especially considering different materials
13. Potential for metal spray of hundreds of materials including ceramics
14. IP creates competitive advantage
15. Techniques are license-friendly
16. Remanufactured parts are not as heavily regulated as OEM

Summary--Combined Venture Possibilities. In short, opportunities to take advantage of this IP are many and varied. The preferred relationship would be to sell this IP outright and work together in the future to develop future IP based on process refinement and materials R&D. As an inventor, it is a personal goal to see this IP utilized at first and then universally accepted. It is hoped that these ideas are intriguing to a brake rotor manufacturer so that initial operations and its benefits will begin to be realized. Negotiations big or small will result in a future business relationship that will be mutually beneficial.