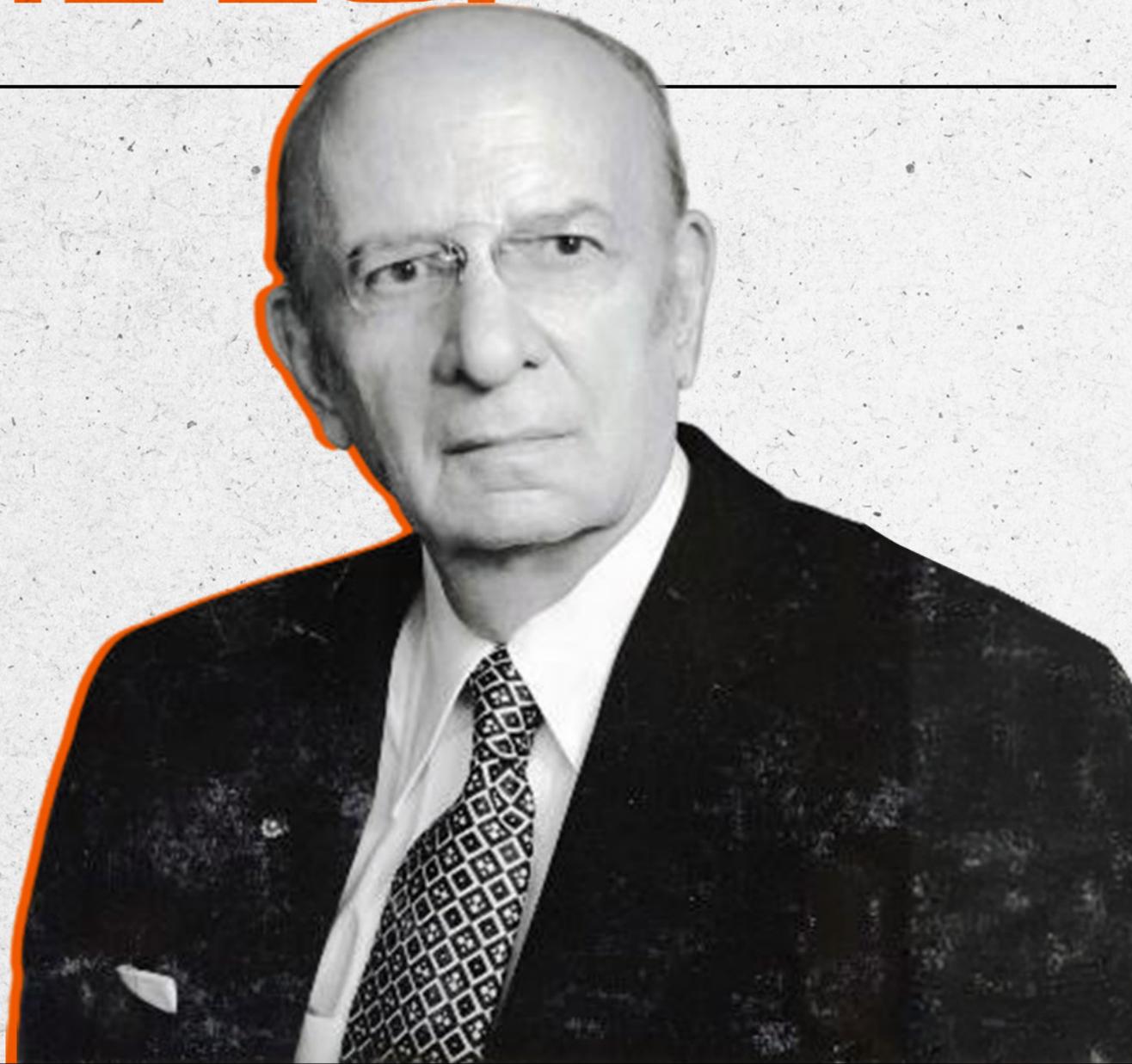


THE LEGACY OF MINGO AND THE ESP



Armais Arutunoff and the Revolution of Electric Submersible Pumps: Powering High-Volume Fluid Production

In 1916, immediately prior to the Russian Revolution, a Russian engineer developed a submersible electric motor/centrifugal pump that could be used in water wells, mines, and ships.. The inventor was Armais Sergeevich Arutunoff, born in the Caucasus Mountains in 1893. Arutunoff immigrated to the United States with his design in 1923.

This pump is a multi-stage centrifugal pump which means stacking multiple stages in series on the same shaft. Arutunoff discovered that pumps ability to lift the fluid up (This is also referred to Hydrostatic Head, or Pressure) was directly proportional to the number of stages in the pump. The has to be coupled with an electric submersible motor with enough horsepower to move the fluid. The system also requires and a bearing/seal section called a "protector" that can handle the thrust load on the pump. This entire pump assembly has a well bore diameter restraint, but not a length restraint. As long as the motor can built with enough horsepower, the pump can be a long as it needs (have enough stages) to lift the fluid to surface. A common installation today on newly drilled unconventional wells in the United States is 2000 Barrels per day (58 Gallons per Minute) setting at a depth of 8000 ft with a 200 HP motor driving 400 stages.

In 1928 Arutunoff moved to Bartlesville, where he formed Bart Manufacturing Company, and built the first practical electric submersible pumps (ESPs) for oil well applications. The and first successfully demonstrated it in a well in Burns, Kansas.

In 1930, With the help of a prominent Oklahoma oil company president Frank Phillips of Phillips Petroleum, Bart Manufacturing became REDA Pump Company; "Russian Electrical Dynamo of Arutunoff." At this time, Phillips petroleum was seeking a high volume production method to produce more total fluid efficiently and economically.



From 1930 to 1980, REDA was the only provider of the ESP's. until a few people branched off and started a company called ODI. ODI was able to get around the REDA patent by simply changing the direction of spin of the shaft. When that happened, they also decided to change the shaft settings and bolt hole dimensions to make it impossible for someone to make a REDA Component to an ODI Component.

CAMCO purchased REDA Pump Company in 1988 from TRW, Inc for \$300 Million..

Schlumberger Acquired CAMCO in 1998



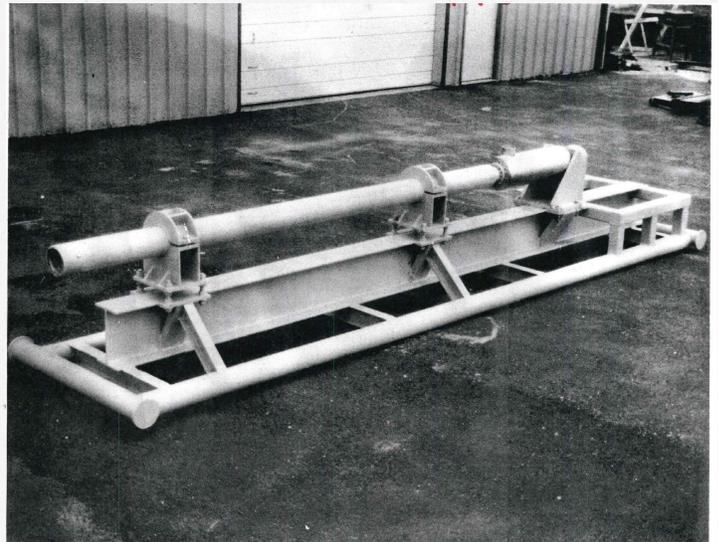
ODI turns to Centrilift

In 1981, A retired American Airlines Machinist, Ron Witten, along with Oklahoma State University graduates Ray Witten, of Centrilift and Terry Ingle, of Citi Services start a machine shop for the sole purpose of making adapter kits to fit up REDA and Centrilift (ODI) equipment; Mingo Manufacturing.

Mingo continued on to make ESP accessories, such as heads, bases; and shafts, gas separators, downhole check valves and shroud hangers for downhole motors.

As the ESP industry continued to grow exponentially with more wells being drilled, more service companies entering the market, and the well bore conditions starting to be harsher on the equipment, the industry started to experience a lot of Pump failures, when the motor and the seal were still in good working condition. It was very easy to rework the pump and replace the damaged stages, but the pump had to be tested. Testing multiple ESP Pump by connecting the ESP Motor and Seal is not feasible because the test string is too long and has to be vertical and submerged in fluid to operate and cool properly.

So, Mingo performed a test to see if the ESP pump could move fluid when it was laying on its side. This test was successful. It was found that the pump operated with the same efficiency when horizontal as it does when it is vertical. Thus, Mingo invented and created the first ESP Pump Test Bench.



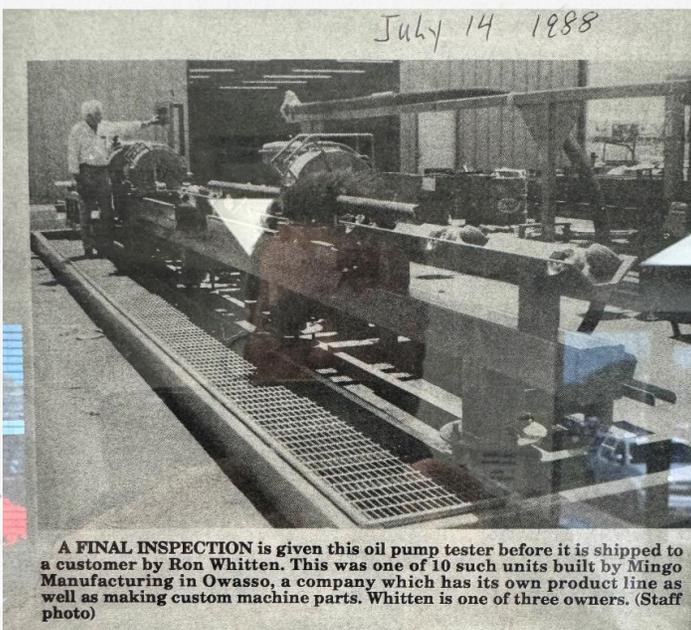
Soon after the pump test bench was invented, it was adopted worldwide as a standard for testing all ESP pumps of various sizes from 3" (338) to 8" (862) and beyond.

As the number of producing wells increased globally, the industry gained a need for high volume pumps to move fluid on surface from one well to another. Also, as time when on and fields were being depleted, the wells starting getting deeper and deeper and as they did, the amount of water that was produced with the oil started to increase exponentially as well. Due to the nature of the water, it is not safe to pour it on the ground or into lakes and rivers. The water has to be injected or pumped back into the earth through a disposal well.

In the 20th century, the primary style of pump was a positive displacement pump. Positive Displacement pumps (Piston Pumps) are very effective moving moderate rates of water at moderate pressures. As the produced water volumes increased with the number of producing wells, another pumping option was needed that was capable of much higher rates and the pressure needed to inject and dispose of the water.

After the ESP Pump test bench was developed and proven, and with the demand for water disposal at higher flow rates and pressures, came the invention of the Horizontal Pumping System or HPS. Pictured below is the first ever manufactured HPS Skid. After the invention of the Horizontal Pumping System, a partnership was established between Mingo and REDA, leading to the commencement of HPS system manufacturing at the Owasso, Oklahoma facility.

Pictured below is one of the first turn-key HPS skids made under the REDA Mingo partnership. Pictured left to right, Ron Witten, Ray Witten, Terry Ingle



A FINAL INSPECTION is given this oil pump tester before it is shipped to a customer by Ron Whitten. This was one of 10 such units built by Mingo Manufacturing in Owasso, a company which has its own product line as well as making custom machine parts. Whitten is one of three owners. (Staff photo)

