Aug. 11, 1964 G. K. HAAS ETAL 3,144,542

ELECTRICAL STOCK REMOVAL APPARATUS

Filed July 13, 1961

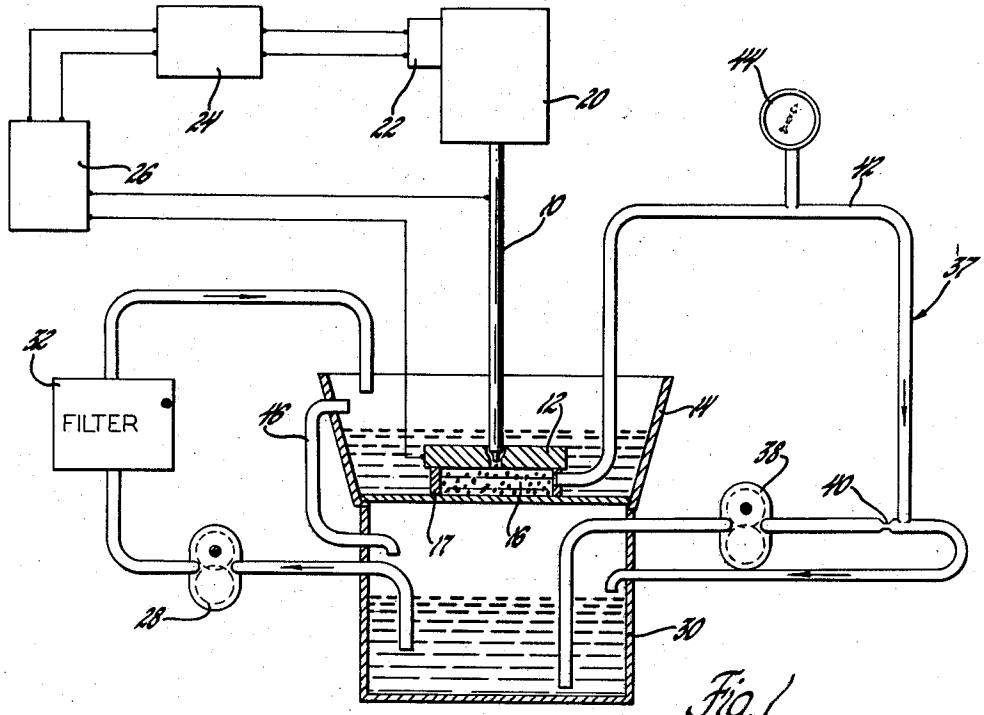


Fig. 1

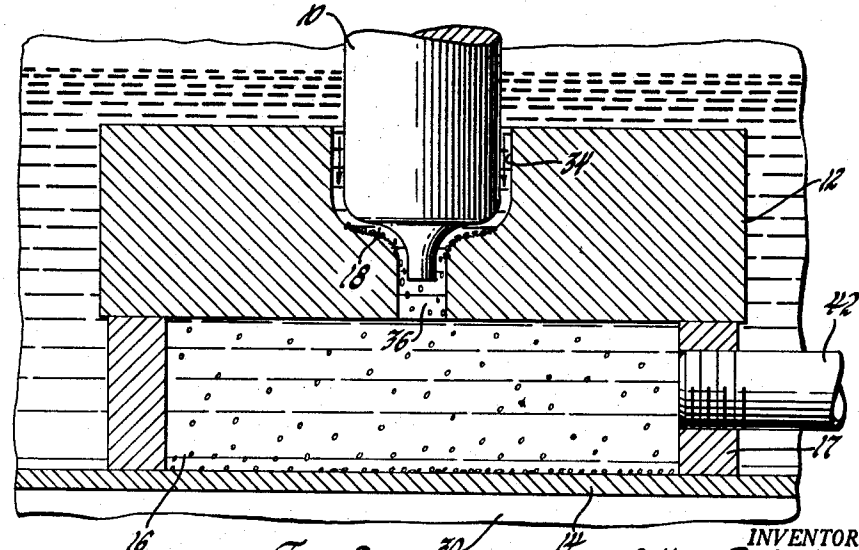


Fig. 2

INVENTORS
Arthur P. Disbrow, E
BY Gerhard K. Haas
Hugh L. Fisher
ATTORNEY

United States Patent Office 3,144,542 Patented Aug. 11, 1964

3,144,542

ELECTRICAL STOCK REMOVAL APPARATUS

Gerhard K. Haas, Berkley, and Arthur R. Disbrow, Detroit, Mich., assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed July 13, 1961, Ser. No. 123,831
4 Claims. (Cl. 219—69)

This invention relates to improvements in electrical stock removal apparatus.

As is well known in the process utilizing electrical stock removal apparatus and commonly referred to as Electric Discharge Machining, a series of time spaced electrical discharges are generated across a gap formed between cutting tool and workpiece electrodes. These electrical discharges take place in the presence of an ionizable fluid and cause particles to be eroded from the workpiece electrode in accordance with a certain scheme or pattern as determined by the configuration of the cutting tool electrode. When machining workpieces such as dies or the like having thru-openings, there is a problem of maintaining dimensional control with this process, for if the dielectric fluid containing eroded particles is allowed to flow past machined surfaces, secondary erosion results and also the finish deteriorates. As a consequence, the opening becomes tapered. To overcome this, clean dielectric fluid is caused to flow in the same direction as the stock is removed from a workpiece, e.g., the direction the cutting tool is fed into the workpiece, so that the machined surfaces are only exposed to clean dielectric fluid. This presents a problem of quickly withdrawing the contaminated dielectric fluid so that it cannot get into the machined area and so that gaseous formations developed in the fluid because of the stock removal are not permitted to remain in the gap area. These gas formations are potential hazards because they contain highly combustible and explosive gases that can be ignited by the sparks from electrical discharges. A vacuum pump has been proposed for the withdrawal of the contaminated fluid, but this usually requires both a vacuum pump and a positive displacement pump and without special provision can encourage explosions. Moreover, the apparatus to be versatile usually demands a somewhat expensive vacuum pump control for permitting the apparatus to be used over a wide range of vacuum pressures. Additionally, the commercially available vacuum pumps are limited as to the amount of vacuum that can be developed.

With the foregoing in mind, the invention contemplates electrical stock removal apparatus incorporating a novel flow system in which clean ionizable fluid is delivered to the cutting gap and then the contaminated ionizable fluid containing eroded particles and any gaseous formations developed as a result of the stock removal are quickly removed by relatively uncomplicated and simple equipment utilizing a minimum of parts.

More particularly, the invention seeks to provide a flow system of the foregoing type employing a source of pressure that is utilized to develop both a suction pressure for withdrawing the contaminated dielectric fluid from the gap area before an explosion can happen or the contaminated fluid can move out to the machined areas and a positive pressure for transferring the contaminated dielectric fluid to some desired place.

Specifically stated, the invention utilizes a positive pressure source and has in the outlet thereof provision for developing a pressure differential between the gap area and the source outlet such that contaminated dielectric fluid containing eroded particles and gaseous formations is withdrawn due to the resultant suction and delivered to a reserrvoir from which the fluid may thereafter be withdrawn and processed prior to being returned to the gap.

The foregoing and other objects and advantages of the invention will be apparent from the following description and the accompanying drawings in which:

FIGURE 1 is a schematic diagram of electrical stock removal apparatus incorporating the principles of the invention; and

FIGURE 2 is an enlarged fragmentary view of a part of the FIGURE 1 apparatus.

Referring now to the drawings in detail and particularly to FIGURE 1, the numerals 10 and 12 denote, respectively, a cutting tool and a workpiece. The workpiece 12 is fixedly mounted in a workpiece reservoir 14 containing clean dielectric fluid. The workpiece 12 in this embodiment forms the upper portion of a sealed chamber 16, the remaining part of this chamber 16 being defined by the base of the reservoir 14 and a side member 17.

The maneuvering of the cutting tool 10 and the workpiece 12 relative to each other and the generation of electrical discharges across a gap 18 (see FIGURE 2) may be accomplished in any known manner, such as described in a prior United States Patent No. 3,059,150 to Colten et al. Since this patent contains a complete disclosure, this part of the apparatus will only be briefly described. The cutting tool 10 is maneuvered relative to the workpiece 12 by a servomotor 20 of the fluid pressure operated piston type in turn controlled by a servo valve 22. If preferred, only workpiece 12 need be moved or both the cutting tool 10 and the workpiece can be maneuvered. Preferably, the disposition of the cutting tool 10 relative to the workpiece 12 is determined by the gap voltage, which reflects gap spacing. Therefore, a control circuit 24 is employed to compare the gap voltage with some reference and any difference is applied to the servo valve 22, whereupon a change in the position of the cutting tool 10 is made. The electrical discharges across the cutting gap 18 are induced by a power supply shown at 26.

Clean dielectric fluid is supplied to the workpiece reservoir 14 by a pump 28 of the positive displacement type. Pump 28 has the inlet thereof communicating with a main reservoir 30 in which a supply of dielectric fluid is maintained and has in the outlet thereof a suitable filter 32, which filters the fluid before transfer to the reservoir 14.

As best seen in FIGURE 2, the clean dielectric fluid flows to the cutting gap 18 in the direction of the arrows and therefore machined surface 34 is only exposed to clean fluid. This in itself protects the surface 34 against secondary erosion and any deterioration of the finish. In the gap 18 the clean fluid causes the eroded particles to be washed away as well as the gaseous formations that develop during the stock removal. The contaminated dielectric fluid containing the eroded particles and the gaseous formations then flows through an opening 36 and into the chamber 16, which is positioned downstream from the gap 18 and which is, as mentioned, sealed from the clean dielectric fluid. Of course, unless this chamber 16 is evacuated quickly, the gaseous formations present a safety hazard in that an explosion can take place since the sparks are constantly occurring in the gap 18.

For this reason, a withdrawal system designated generally by the numeral 37 is provided and includes a positive displacement pump 38 having the inlet thereof communicating with the main reservoir 30 and the outlet thereof discharging also into the reservoir 30 above the level of the fluid therein. The outlet of the pump 38 is provided with a suitable provision for developing a suction pressure, which in this embodiment is a restriction as a venturi type ejector denoted at 40. At the venturi ejector 40, a conduit 42 extending from the chamber 16 is connected such that the pressure on the upstream side

of the venturi ejector 40 produces a pressure differential adequate to cause discharging and continuous flow of the contaminated dielectric fluid from the chamber 16. The gaseous formations are dissipated in the main reservoir 30 where they are allowed to expand and separate from the dielectric fluid. A vacuum gage 44 may be positioned in the conduit 42 in order to permit the pressure to be visually observed.

The levels beween the main reservoir 30 and the workpiece reservoir 14 are maintained according to the requirements of a particular job by an overflow pipe 45. This pipe 46 is connected to the reservoir 14 above the normal level. The clean dielectric fluid is preferably transferred to the reservoir 14 at a faster rate than it is being returned by the pump 38 to the main reservoir 30. The clean dielectric fluid merely flows back via the overflow pipe 46 to the main reservoir 30.

From the foregoing, it will be appreciated that with this flow system, clean dielectric fluid is always supplied to the gap via the machined surfaces or in the direction stock is being removed from the workpiece 12 such that damage cannot be caused to the machined surfaces nor can secondary erosion take place due to contaminated dielectric fluid. Also significant is the mode of withdrawing the contaminated dielectric fluid so as to eliminate any possible explosion from the ignition of the highly combustibie gaseous formations. This is done by a single positive displacement pump 38 thereby rendering the system suited for many diverse applications in which a suction pump would be unable to produce the differential pressures needed. Instead of a suction pump, a positive pressure pump develops the required suction pressure thereby eliminating the need for an expensive suction pump.

The invention is to be limited only by the following claims.

We claim:

1. Apparatus for generating electrical stock removing discharges across a dielectric fluid filled gap formed between cutting tool and workpiece electrodes comprising means supplying dielectric fluid to the gap for aiding in the removal of eroded particles from the workpiece electrode, a chamber positioned downstream from the gap for collecting the contaminated dielectric fluid containing the eroded particles and gaseous formations so as to prevent the gaseous formations from accumulating in the gap, and means withdrawing the contaminated dielectric fluid from the chamber, the withdrawing means including a reservoir and a fluid pressure source arranged to circulate fluid in the reservoir, the source producing a pressure differential between the chamber and the reservoir so that the contaminated dielectric fluid is withdrawn from the chamber and delivered to the reservoir where the gaseous formations are allowed to dissipate thereby avoiding explosions thereof.

2. Apparatus for generating electrical stock removal discharges across a dielectric fluid filled gas formed between cutting tool and workpiece electrodes comprising a reservoir containing the workpiece means supplying dielectric fluid to the reservoir and accordingly to the gap for aiding in the removal of eroded particles from the workpiece electrode, a chamber positioned downstream from the gap for collecting the contaminated dielectric fluid from the gap containing the eroded particles and gaseous formations so as to isolate the gaseous formations from the dielectric fluid in the reservoir, and means withdrawing the contaminated dielectric fluid from

the chamber, the withdrawing means including a reservoir, a conduit extending from the chamber to the reservoir, a pump having the inlet and outlet thereof communicating with the reservoir, a conduit extending from the chamber to the pump outlet, pressure differential producing means situated in the pump outlet and developing a pressure differential between the chamber and the reservoir for causing the contaminated dielectric fluid to be delivered to the reservoir, the pump outlet exhausting into the reservoir at such a level that the gaseous formations are dissipated thereby avoiding an explosion thereof.

3. Apparatus for generating electrical stock removing discharges across a dielectric fluid filled gap formed between cutting tool and workpiece electrodes comprising means supplying clean dielectric fluid to the gap for aiding in removing eroded particles from the workpiece electrode, a chamber arranged downstream from the gap for collecting the contaminated dielectric fluid containing the eroded particles and gaseous formations so as to prevent the contaminated dielectric fluid from commingling with the clean dielectric fluid, and means withdrawing contaminated dielectric fluid from the chamber, the withdrawing means including a reservoir, a positive displacement pump for circulating fluid in the reservoir, the pump having in the outlet thereof a restriction, and a conduit for connecting the chamber to the pump outlet to the restriction so that a pressure differential is created for transferring the contaminated dielectric fluid to the reservoir, the pump outlet discharging into the reservoir at such a position that the gaseous formations are dissipated thereby avoiding an explosion thereof.

4. Apparatus for generating electrical stock removing discharges across a dielectric fluid filled gap formed between cutting tool and workpiece electrodes comprising a reservoir containing the workpiece, means supplying clean dielectric fluid to the reservoir and accordingly to the gap for aiding in the removal of eroded particles from the workpiece electrode, the supplying means being so arranged that dielectric fluid flows in the same direction as stock is removed from the workpiece electrode and including a supply reservoir containing dielectric fluid, a pump interconnected between the supply reservoir and the gap, and a filter for filtering the fluid delivered to the gap, a chamber positioned in the reservoir containing the workpiece downstream from the gap for collecting contaminated dielectric fluid containing eroded particles and gaseous formations so as to prevent the contaminated dielectric fluid from commingling with the clean dielectric fluid, and means withdrawing the contaminated dielectric fluid from the chamber, the withdrawing means including a positive displacement pump for circulating fluid in the reservoir and having an orifice in the outlet thereof, and a conduit for connecting the chamber to the orifice so that a suction is created in the conduit for withdrawing the contaminated dielectric fluid from the chamber and delivering the contaminated dielectric fluid to the reservoir, to the pump outlet discharging into the reservoir at such a position that the gaseous formations are separated from the contaminated fluid and dissipated thereby avoiding an explosion thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

2,526,423	Rudorff	Oct. 17, 1950
2,818,490	Dixon et al.	Dec. 31, 1957
2,981,822	Larkins	Apr. 25, 1961