Nov. 24, 1959 L. E. FIELDS ET AL 2,914,643

WIRE FEEDER MECHANISM

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Fig. 1.

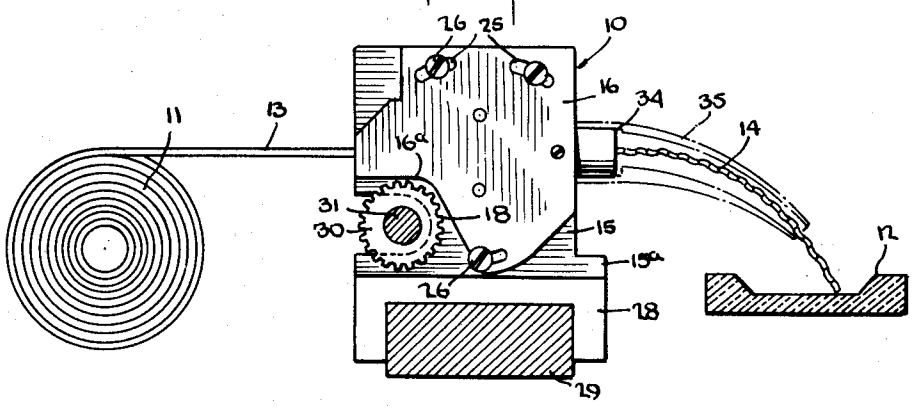


Fig. 2.

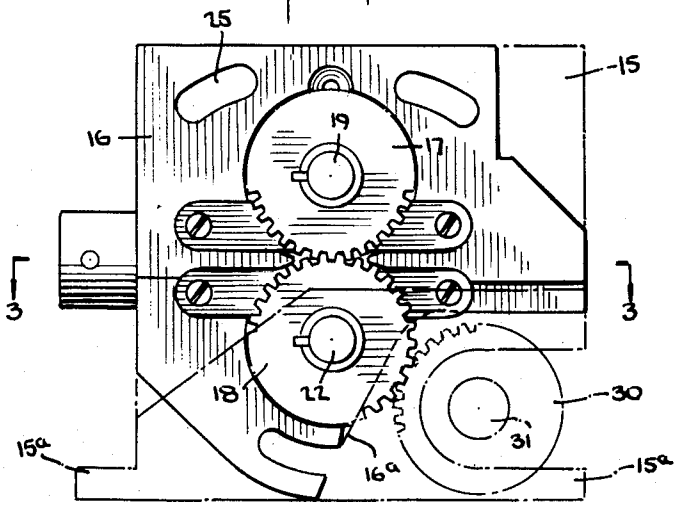
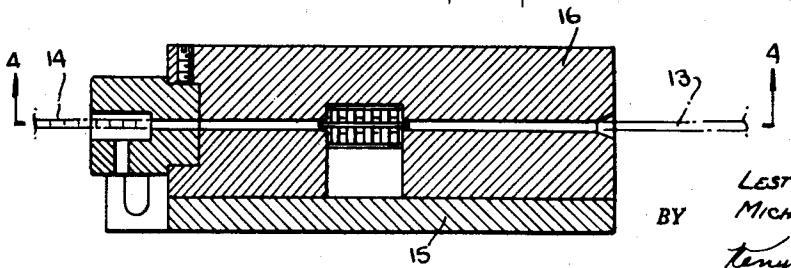


Fig. 3.



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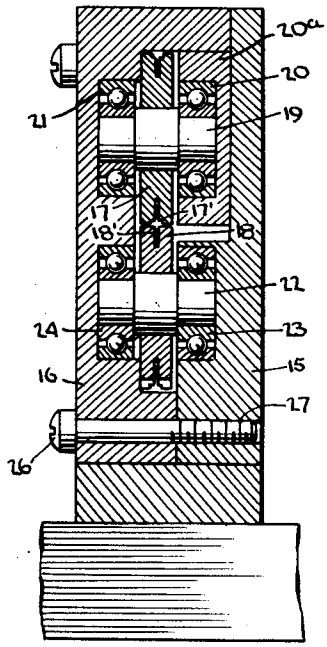

Fig. 5.

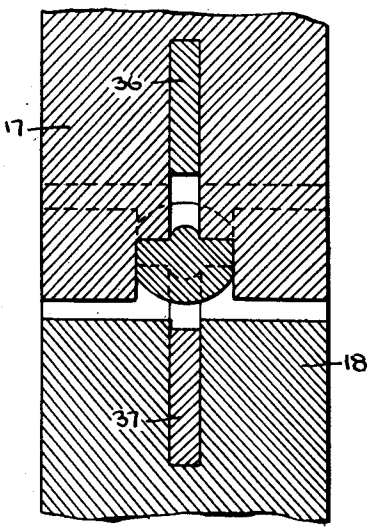

Fig. 6.

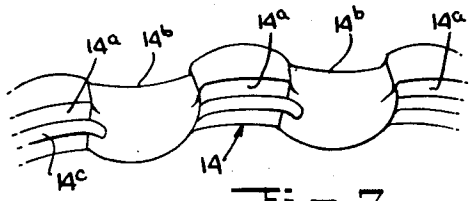

Fig. 7.

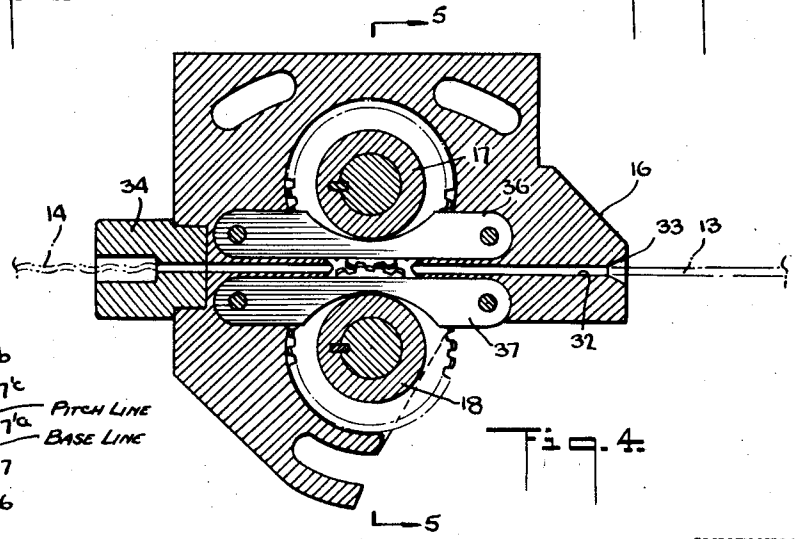

Fig. 4.

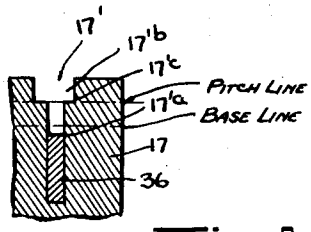

Fig. 8.

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WIRE FEEDER MECHANISM

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Application April 29, 1957, Serial No. 655,579

8 Claims. (Cl. 219—19)

The present invention relates generally to apparatus for the vacuum evaporation of metallic wire continuously fed to a heating element, and more particularly to an improved feeder mechanism adapted to supply wire to a crucible in a consistent and positive manner.

In the vacuum evaporation technique, an extremely thin film of metal is applied to a surface or substratum by condensing metal vapor thereon. While a number of metals may be evaporated for application to surfaces, aluminum is at present of greatest value from the commercial standpoint. Other metals of importance are gold, silver and copper, as well as various alloys of aluminum. The time necessary to evacuate the coating chamber to the requisite degree of low pressure is considerable, hence continuous operation of the metal-evaporation system is essential. This is usually accomplished by a feeder mechanism for replenishing the metal as it is evaporated.

In one known form of vacuum metalizing apparatus, the metal is evaporated in a continuous type process wherein a web of paper or plastic material to be coated is unrolled in a vacuum chamber as metal is continuously fed onto heater elements. The metal is in the form of wire wound on spools which are free to unwind, a spool being provided for each heater. The wire is drawn from the spool by a feeder mechanism constituted by a pair of cooperating rollers, the wire being directed into the rollers through a guide tube and being fed thereout through a nozzle pointed toward the heater.

The heater element is generally in the form of an elongated crucible and the feeder mechanism is arranged to reciprocate along a path parallel thereto to feed the wire along the center of the crucible. In this manner the metal vapor from the crucible is not concentrated in a single area but is spread out uniformly to afford better vapor distribution relative to the web being coated.

For most effective vaporization it is essential that the tip of the wire which impinges on the active area of the crucible be in alignment with the center thereof. This is ordinarily accomplished by orienting the wire feeding nozzle so as to project the wire toward the target area on the crucible. Best results are had by placing the nozzle in close proximity to the crucible. But since metal vapor from the crucible will condense about the mouth of the nozzle, with conventional feeder mechanisms it is necessary to keep the nozzle at some distance from the crucible. Otherwise the mouth of the nozzle will become clogged by reason of metal condensed thereon, such clogging tending to interfere with the continuous movement of wire.

In practice it is necessary to clean the nozzle after each run to clear the mouth of metal deposited thereon. Moreover, since the wire is relatively soft and deformable, by spacing the nozzle away from the crucible, the angular position of the wire is not consistently maintained, whatever the orientation of the nozzle. Thus misalignment is experienced and the wire is displaced from its proper position in the cavity of the crucible.

Another disadvantage of conventional roll feeders is that in the event the wire fed thereby meets resistance either at the nozzle or at the target area, the resultant back-up of wire causes the wire to wrap around the rollers, thereby jamming the mechanism. As a consequence, it becomes necessary to stop the operation to free the rollers and to adjust the position of the wire feed. This involves the re-evacuation of the vacuum chamber and results in substantial losses in time and in productive output.

In view of the foregoing, the principal object of the present invention is to provide an improved wire feeding mechanism which overcomes the drawbacks characteristic of prior art devices and which is capable of feeding wire in a positive manner.

More particularly, it is an object of the invention to provide a wire feeder mechanism adapted to corrugate the surface of wire fed therethrough, whereby the wire when ejected through the mouth of the nozzle has an abrasive action on the inner wall of the nozzle serving to prevent clogging. An advantage of the arrangement is that since the feeder is self-cleaning, the nozzle may be brought into closer proximity to the crucible for a more effective feeding action.

Another object of the invention is to provide a feeder mechanism which acts to impress serrations on the surface of the relatively soft wire fed therethrough, thereby rigidifying the wire so as to maintain a pre-set alignment with a crucible.

Another feature of the invention lies in the fact that the serrations indent the wire at uniformly spaced position thereon, such that when the tip of the wire make contact with the crucible and is rendered molten, the wire gives way at the boundary indentation to form a globule or pellet of metal. With continuous feeding of the wire and the concurrent reciprocation of the feeder mechanism, pellets of metal are in effect uniformly deposited across the crucible and are quickly evaporated. This uniform evaporation produced by fragmentation of the wire is in contradistinction to the random action encountered in feeding untreated wire into the crucible by conventional mechanisms whereby uneven pools of metal are formed which give rise in some instances to hot spots and slag.

Yet another object of the invention is to provide a wire feeder mechanism including cooperating gears in an enclosed housing in conjunction with doctor blades such that the wire fed therethrough is prevented from wrapping about the gears and jamming of the feed mechanism is precluded.

A feeder mechanism in accordance with the invention includes a pair of intermeshing spur gears having circumferential grooves formed therein at corresponding positions to define an opening. Guide means are provided to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves being relative to the diameter of said wire whereby said wire is notched by said teeth to form a serrated surface.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description to be read in conjunction with the accompanying drawing wherein:

Fig. 1 is a front elevational view of a wire feeder mechanism in accordance with the invention, as it appears when mounted in a vacuum chamber.

Fig. 2 is a rear elevational view of the feeder mechanism, one bearing block thereof being shown in phan-

tom to expose the components mounted on the other bearing block.

Fig. 3 is a sectional view taken along the horizontal plane indicated by lines 3—3 in Fig. 2.

Fig. 4 is a sectional view taken along the vertical plane indicated by lines 4—4 in Fig. 3.

Fig. 5 is a transverse sectional view in the vertical plane taken along lines 5—5 in Fig. 4.

Fig. 6 is an enlarged detail in section showing the intermeshing gear teeth and the wire compressed therebetween.

Fig. 7 is a perspective view showing the configuration of the wire after it emerges from the feeder mechanism.

Fig. 8 is a segment of one feeding gear showing the shape of the circumferential groove therein.

Referring now to the drawings, and more particularly to Fig. 1, supported within a vacuum chamber is a wire feeder mechanism, generally designated by numeral **10**. The mechanism acts to unwind wire from a reel **11** and to feed it into the cavity of a crucible **12**. Within the vacuum chamber there is provided a carrier structure for supporting and unrolling the web of material to be coated, the chamber being held at a pressure in the micron range by means of a vacuum pumping system. The crucible is heated electrically to a temperature sufficient to vaporize the wire fed therein at the pressure existing in the chamber. The web carrier, the chamber, the vacuum system therefor and the crucible form no part of the present invention but represent the environment within which the feeder operates.

The wire **13** from reel **11**, before it enters the feeder mechanism **10**, is of uniform circular cross-section, but when it emerges therefrom, it is continuously serrated as shown separately by sample **14** in Fig. 7. The serrations are created by indentations which alternate from one side to the other of the wire to form teeth, one set of indentations being represented in Fig. 7 by numeral **14***a* and the other set by numeral **14***b*. Extending longitudinally along each indentation is a central rib **14***c*, only the ribs on indentations **14***a* being visible in Fig. 7.

The juncture or boundary line between successive teeth on the wire constitute relatively weak discontinuities in the wire structure such that when the wire impinges on the heated crucible and is rendered molten, it gives way at the juncture. As the wire feeds continuously into the crucible and is caused simultaneously to scan across the surface of the cavity, successive pellets of molten wire are deposited and vaporized, each pellet representing a uniform charge of metal.

The rib **14***c* acts to stiffen or rigidify the wire which for example in the case of aluminum is otherwise relatively soft and easily deformed. The ribs therefore act to maintain the preset orientation of the wire as it leaves the feeder mechanism. The manner in which the teeth and ribs are formed will become apparent hereinafter from the description of the wire feeder.

As best seen in Fig. 5, the wire feeder mechanism **10** includes a fixed bearing block **15** and an adjustable bearing block **16** for rotatably supporting and enclosing a pair of intermeshing upper and lower spur gears **17** and **18** in a vertical plane. Gear **17** is keyed to a spindle **19** whose ends are journaled in ball-bearings **20** and **21** supported within the blocks, bearings **20** being contained within a cylindrical cap **20***a*. Gear **18** is keyed to a spindle **22** whose ends are journaled in ball-bearings **23** and **24** supported in the blocks. The gears are accommodated within suitable recesses in the adjustable block **16** and are enclosed when block **16** is attached to block **15**.

The adjustable block **16** is provided with arcuate slots **25** at three triangularly spaced positions, through which are insertable screws **26** receivable in threaded bores **27** in the fixed block **15**. The arrangement is such as to permit an angular adjustment of the block **16** relative to block **15**. In this way the direction of the wire feed may be adjusted within certain limits determined by the shape of the slots.

The adjustable block **16** is provided with a cut-away portion **16***a*, partially to expose the lower gear **18** in order to permit its engagement with a drive gear. As shown in Fig. 1, the base of the fixed block **15** is provided with laterally extending feet **15***a* whereby the feeder mechanism may be mounted on a saddle member **28** supported on a reciprocating bar **29** which moves in a direction parallel to the length of the crucible **12**. The feeder mechanism gears are driven by means of a drive gear **30** rotatably supported on a shaft **31** and engaging the lower gear **18**.

Cut centrally into gears **17** and **18** are circumferential grooves **17′** and **18′** respectively. Each groove, as shown separately in Fig. 8, in connection with channel **17′** consists of a relatively deep and narrow channel **17′***a* and a shallow and broad channel **17′***b* concentric therewith to define an annular shoulder **17′***c*. The broad channel **17′***b* terminates approximately at the pitch circle of the gear, whereas the narrow channel extends below the base circle of the gear.

Extending through the block **16** in alignment with the opening formed by the grooves **17′** and **18′** in the spur gears is a wire passage **32**, the passage beginning with a conical opening **33** and terminating in a coupling tube **34** for supporting a nozzle **35** (note Fig. 1) through which the serrated wire is projected onto the crucible. Cooperatively arranged with respect to the gears **17** and **18** on either side of the passage **32** are stripper blades **36** and **37**, the edges of the blades being relieved whereby the blades nest within the deep channels in the circumferential grooves in the manner shown in Figs. 6 and 8. The strippers act to prevent the wire from wrapping about the gears.

As shown in Fig. 6, the cross-sectional area of the wire fed through the gears is greater than the opening formed by the cooperating channels in the gears, such that the wire is compressed between the intermeshing teeth of the gears and is continuously notched to assume the shape shown in Fig. 7. The ribs are formed by compression of the wire into the channels **17′***a* and **18′***a* partially occupied by the stripper blades.

In practice, the grooves **17′** and **18′** are preferably dimensioned relative to the diameter of the wire to produce a depth of indentation in the order of 30 to 40% of the wire diameter. In this manner positive drive and fragmentation of the wire is achieved without loss of continuity.

It will be appreciated that since the guide passage **32** for directing the incoming wire through the opening formed by the circumferential grooves in the cooperating spur gears is cut in the adjustable bearing block **16**, an angular adjustment of this block with respect to stationary block **15** in no way alters the position of the wire relative to the gears.

While there has been shown what at present is considered to be a preferred embodiment of the invention, it is to be understood that many changes and modifications may be made therein without departing from the essential spirit of the invention. It is intended, therefore, in the accompanying claims to cover all such changes and modifications as fall within the true spirit of the invention.

What is claimed is:

1. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system, said mechanism comprising a pair of intermeshing spur gears having circumferential grooves formed therein at corresponding positions to define an opening, and guide means to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves being such relative to the diameter of said wire whereby said wire is notched by said teeth to form a serrated surface, and a nozzle disposed in

registration with said guide means for directing said serrated wire onto said heater element.

2. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system comprising a pair of intermeshing spur gears having circumferential grooves formed therein at corresponding positions to define an opening, guide means to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves being such relative to the diameter of said wire whereby said wire is notched by said teeth to form a serrated surface, a stripper blade extending through each groove to prevent said wire from wrapping about said teeth, and a nozzle disposed in registration with said guide for directing said serrated wire onto said heater element.

3. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system comprising a pair of intermeshing spur gears having circumferential grooves formed therein at corresponding positions to define an opening, guide means to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves being such relative to the diameter of said wire whereby said wire is notched by said teeth to form a serrated surface, said grooves each being formed by a relatively broad annular channel terminating approximately at the pitch circle of the gear and a relatively narrow annular channel extending below the base circle of the gear, and a nozzle disposed in registration with said guide for directing said serrated wire onto said heater element

4. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system comprising a first and fixed bearing block, a second bearing block attachable to said first block and angularly adjustable relative thereto, a pair of spur gears in intermeshing relationship rotatably supported between said blocks, said gears having circumferential grooves formed centrally therein to define an opening, a guide passage in said second block to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves defining an opening which cross-sectional area is smaller than that of said wire whereby said wire is notched by said gear teeth to form a serrated surface, and a nozzle disposed in registration with said guide for directing said serrated wire onto said heater element.

5. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system comprising a first and fixed bearing block, a second bearing block attachable to said first block and angularly adjustable relative thereto, a pair of spur gears in intermeshing relationship rotatably supported between said blocks, said gears having circumferential grooves formed centrally therein to define an opening, a guide passage in said second block to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves defining an opening which cross-sectional area is smaller than that of said wire whereby said wire is notched by said gear teeth to form a serrated surface, said first block having recesses therein to accommodate said gears whereby when said first

block is attached to said second block said gears are enclosed, and a nozzle disposed in registration with said guide for directing said serrated wire onto said heater element.

6. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system comprising a pair of intermeshing spur gears having circumferential grooves formed therein at corresponding positions to define an opening, guide means to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, the dimensions of said grooves being such relative to the diameter of said wire whereby said wire is notched by said teeth to form a serrated surface, said grooves each being formed by a relatively broad annular channel terminating approximately at the pitch circle of the gear and a relatively narrow annular channel extending below the base circle of the gear, and stripper blades extending through said narrow channels of said grooves partially to occupy same whereby ribs are formed in said serrated wire to rigidify same, and a nozzle disposed in registration with said guide for directing said serrated wire onto said heater element.

7. A wire feeder mechanism for directing wire onto a heater element in a vacuum evaporation system comprising a first and fixed bearing block, a second bearing block attachable to said first block and angularly adjustable relative thereto, a pair of spur gears in intermeshing relationship rotatably supported between said blocks, said gears having circumferential grooves formed centrally therein to define an opening, a guide passage in said second block to direct a wire through said opening to be engaged and driven positively by the teeth of said gears, said grooves each being formed by a relatively broad annular channel terminating approximately at the pitch circle of the gear and a relatively narrow annular channel extending below the base circle of the gear, and stripper blades extending through said narrow channels partially to occupy same whereby the wire is prevented from wrapping around said gear and ribs are formed in said serrated wire to rigidify same, and a nozzle disposed in registration with said guide for directing said serrated wire onto said heater element.

8. A wire feeding mechanism for directing wire onto a heater element in a vacuum evaporation system including an output nozzle and intermeshing gears for driving a wire of uniform section positively and for concurrently notching the surface thereof to provide serrations having an abrasive action on the inner wall of said nozzle thereby to prevent clogging.

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