Aug. 14, 1962 C. B. SADTLER 3,049,058

MACHINE FOR TAPERING WIRE

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Fig. 1



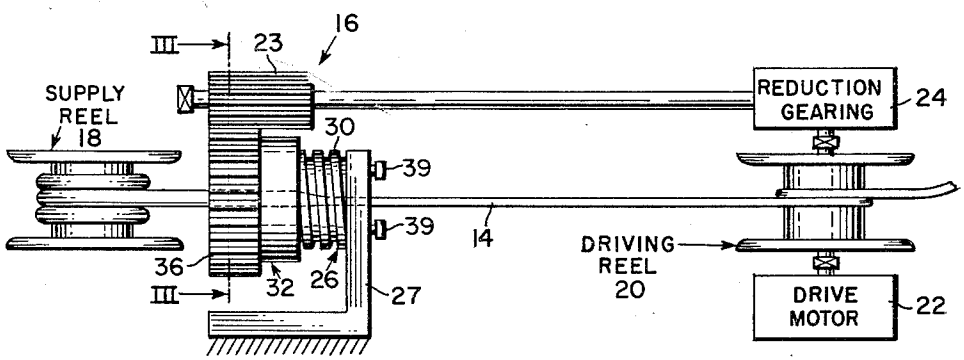


Fig. 2

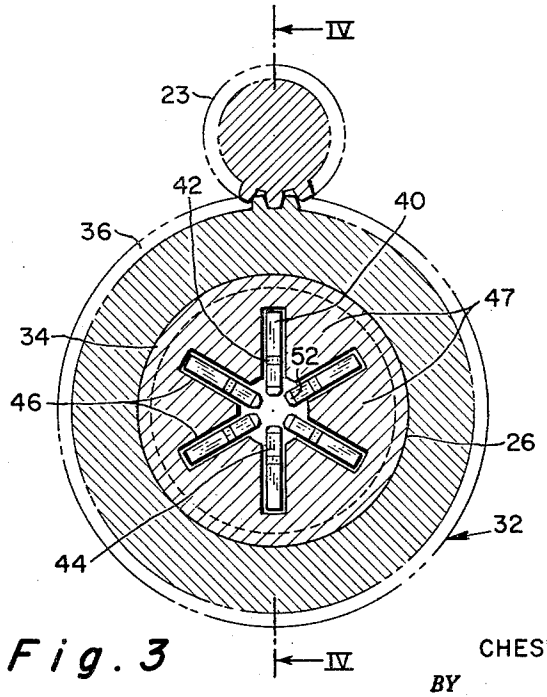


Fig. 3

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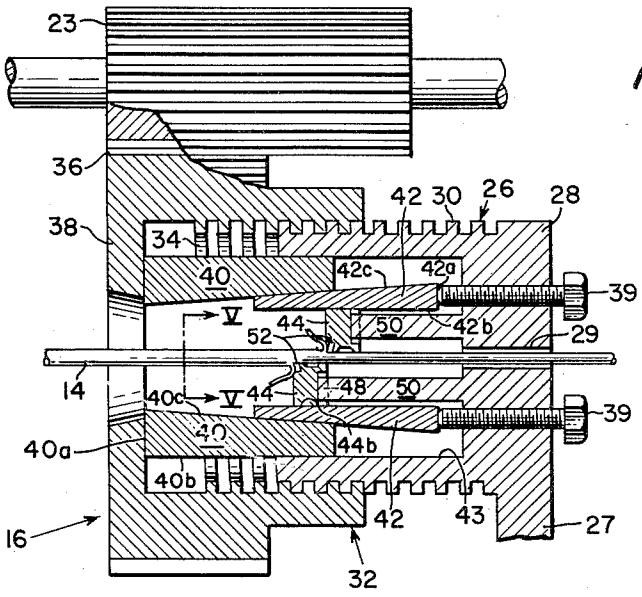


Fig. 4

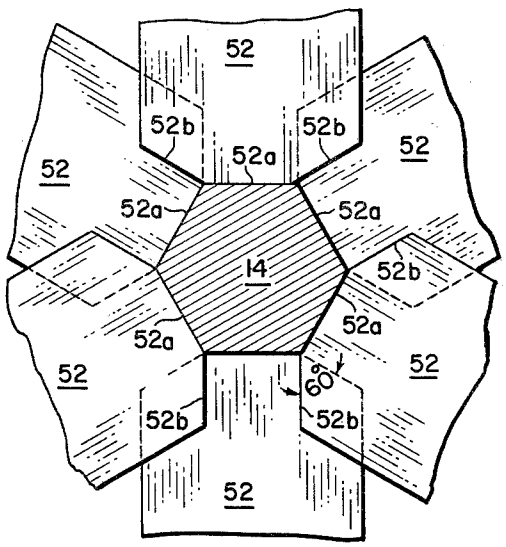


Fig. 5

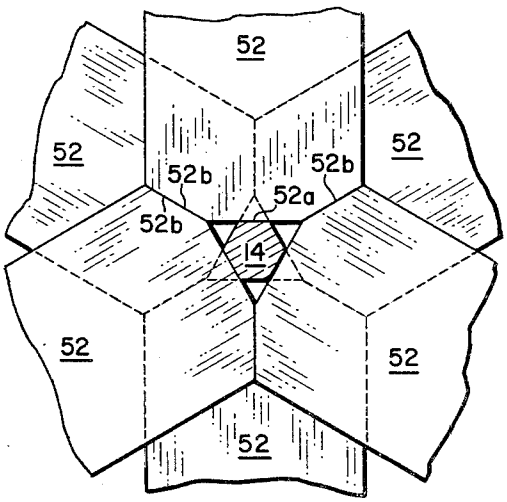


Fig. 6

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3,049,058

MACHINE FOR TAPERING WIRE

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7 Claims. (Cl. 90—24)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to metal-working machines, and more particularly to a cutting machine for tapering a long length of monofilament wire, such as may be employed in the towing of aerial targets.

Two general types of aerial targets are used for anti-aircraft practice, namely, captive aerial targets and self-propelled aerial targets or drones. Captive-flight aerial targets, of concern in this invention, are usually towed by a mother aircraft by means of a tow line. With the advent of supersonic missiles and suitable targets therefore, as a matter of safety, it is necessary to increase substantially the length of the towing line, in the order of 40,000–50,000 feet in length. With extremely long uniform diameter tow lines now in use as much as 85 percent of the aerodynamic drag may be attributed to the tow line, with only 15 percent of the drag being caused by the target. To reduce this excessive drag created by a uniform diameter tow line, it has been suggested that the towing line be tapered throughout its length, gradually tapering from a maximum diameter to a point adjacent the towing aircraft to the minimum diameter at the towed target. Tapering the tow line uniformly distributes the stress throughout the entire length of the tow line and reduces the drag caused by the tow line per se.

The instant invention provides a machine for cutting a uniform diameter, monofilament wire into a gradually tapered wire of the same length. The machine comprises two or more sets of cutters disposed in transverse planes longitudinally spaced along the longitudinal axis of the wire to be trimmed. Each cutter set includes a plurality of circumferentially spaced blades radially movable in contact with the wire. The cutters of one set are alternatively disposed with relation to the cutters of another set so that each cutter acts on a different portion of the wire periphery, while all cutters jointly circumscribe the wire periphery. Means are provided for gradually moving all the blades radially inwardly as the wire is passed through the cutter sets.

A principal object of this invention is to provide a cutting machine for tapering a long length of monofilament wire in a simple and inexpensive manner and a corollary object is to enable the wire to be tapered in a gradual and continuous operation.

Another object is to provide a cutting machine for tapering such a wire wherein blade movement radially the wire is dependent on the rate of wire movement longitudinally passing through the cutting machine.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a diagrammatic view of a typical aircraft towing an aerial target by means of a long tow line;

FIG. 2 is a diagrammatic side elevation of a cutting machine having two cutter sets in which blade movement radially the wire is dependent on the rate of wire movement passing through the machine;

FIG. 3 is an enlarged transverse section taken along line III—III of FIG. 2 with the tow wire normally extending axially the machine being omitted for clarity;

FIG. 4 is a longitudinal section taken along line IV—IV of FIG. 3;

FIG. 5 is a magnified partial view of the blades of both cutter sets in an outermost and initial position producing a hexagonal cross-section wire taken along line V—V of FIG. 4, and

FIG. 6 is a similar view as FIG. 5 at the innermost and final position of the cutting blades.

Referring to the drawing where like reference numerals refer to similar parts throughout the figures there is shown in FIG. 1 an aircraft 10 towing an aerial target 12 by means of a tow line 14. When towing supersonic targets, the length of the tow line may be in the order of 40,000 to 50,000 feet in length to insure a safe towing distance. This invention pertains to a machine for manufacturing such a tow line, namely a cutting machine 16 which tapers the wire to minimize the aerodynamic drag caused by the line when towing the target.

The manufacturing process for tapering the wire is illustrated in FIG. 2 wherein tow wire 14 is unwound from a supply reel 18 by a driving reel 20 after passing through the cutting machine 16 wherein the wire is tapered. The tapered wire can be accumulated in any suitable manner after passing over the driving reel. Reel 20 is driven by a motor 22 that may also be utilized to drive cutting machine 16 by a pinion gear 23 through a conventional reduction gearing 24 in any suitable manner. Instead of tapering the wire in linear relation to the rate of wire movement through the machine, a non-linear cutting action can be provided by utilizing a cam or the like.

Cutting machine 16 comprises an internal housing 26 secured in a fixed position by a stand 27 integral with an end shoulder 28. The shoulder has a central longitudinal aperture 29 through which is threaded the tapered wire 14 as it passes through the machine between the supply and driving reels. Internal housing 26 has integral external threads 30 for rotatably supporting an external housing 32 internally threaded at 34 to receive housing 26. External housing 32 has an integral external gear 36 in driven relation to pinion gear 23, the latter gear being of a length to drive external housing throughout its longitudinal travel on the internal housing. External housing has an annular shoulder 38 which cooperates with internal housing shoulder 28 and adjustment screws 39 to confine therebetween a plurality of pairs of mating cam wedges 40 and 42 disposed within bore 43 of the internal housing. Each pair of wedges functions to radially actuate a corresponding cutter 44.

In the illustrated embodiment, wire 14 is provided with a hexagonal cross-sectional configuration, and, accordingly, six pairs of wedges are used, one pair for each cutter and one cutter for each respective surface portion of the hexagonal wire. The pairs of wedges are uniformly spaced around the periphery of internal housing 26 each pair being slidably confined in a respective longitudinal slot 46 formed by ribs 47 extending radially the housing (FIG. 3). As each pair of wedges and the associated cutter are identical, a description of one of the duplicate components will suffice for all.

Referring to FIGS. 3 and 4, each outer wedge 40 has a flat end 40*a* which presents a bearing surface to shoulder 38 which rotates with respect thereto; a longitudinal side 40*b* arcuate to slidably engage bore 43 of housing 26; and a flat opposite sloping side 40*c*. Complementary inner wedge 42 has a flat oppositely sloping side 42*c* slidably engaging side 40*c*, and an end 42*a* bearing against screw 39 threadedly mounted in shoulder 38 for initial adjustment of the wedges. Flat side 42*b*, parallel to side 40*b*, abuts against an outer flat bearing surface 44*b*

of corresponding cutter 44. Movement of the outer wedge 40 toward inner wedge 42 on the sloping surfaces 40*c* and 42*c*, respectively, causes a radially inward thrust of the corresponding cutter against the wire work piece 14, the wedges being guided in slots 46.

As shown in FIGS. 3 and 4, the six cutters 44 are arranged in two sets of three cutters each, each set being disposed in adjacent planes transverse to wire 14, one set being forward of the other. Each cutter is supported for radial movement by a slotted connection 48 formed in a longitudinally extending finger 50 integral with inner housing shoulder 38. The fingers for the forward set of cutters are longer than those of the closer positioned set and project through the space between the cutters of the latter set. Each cutter 44 may consist of the entire blade or, as illustrated, a replaceable blade 52 may be mounted in the inner face cutter which in such case may function as a blade holder.

The radial limits of the cutting action in tapering wire 14 are shown in FIGS. 5 and 6. In FIG. 5 blades 52 of both cutter sets are shown in the initial outermost position wherein the full width of each blade edge 52*a*, which is shown as a straight edge, engages wire 14, and the lateral edges 52*b* of adjacent blades in each set are spaced apart. The final cutting stage is shown in FIG. 6 wherein only an intermediate portion of the blade edge 52*a* engage the reduced wire 14 and adjacent edges 52*b* abut. The total reduction in the diameter of hexagonal wire 14 during the tapering operation is apparent from a comparison of FIGS. 5 and 6, this reduction occurring gradually and continuously throughout the length of wire involved. Throughout the cutting action, the blades of both cutter sets collectively circumscribe the entire periphery of the wire, the cutters of the forward and aft sets removing the same amount of wire during each cut but on different and alternative portions of the wire. To facilitate chips removal, the longitudinal axis of the machine 16 may be shifted 90° to that shown in the drawings in a vertical arrangement so that the metal chips from the two sets of cutters can fall downward by gravity through the opening defined by shoulder 38.

The operation of cutting machine 16 is as follows. With wire 14 threaded through the machine, the initial position of wedges 42 and the associate cutters 44 are set by adjustment screws 39. As the wire is pulled through the machine, in the embodiment disclosed, the blades are moved against the wire toward its axis at the same rate. This occurs by rotation of external housing 32 over 30 forcing wedges 40 over wedges 42 increasing the effective height of the wedges. As wedges 40 are confined within the bore of housing 26, the resultant radial force is directed against cutters 44 which move the blades against the wire periphery. Although the cutters in both sets are moved the same amount and in unison, by making alternative cuts immediate adjacent portions of the wire can not be cut by the same set that can cause interference, and complicate both tool design and chip removal. The cutting action proceeds gradually until the desired final diameter of the wire is achieved, the cutters 44 being designed to provide a mechanical stop at that point. The decrease in wire diameter throughout the tapering process is obvious from a comparison of FIGS. 5 and 6.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A cutting machine for gradually tapering a long length of wire into a polygonal cross-section with adjacent sides of the wire having the same angular relation throughout the tapered length comprising a rotatable housing having a central opening along a longitudinal axis through which the wire is threaded, a plurality of sets of cutters arranged within the housing in parallel planes transverse to the longitudinal axis, said cutters having straight cutting edges, the cutters in each set being circumferentially spaced apart and movable in a radial direction to bear against the wire, each of said sets of cutters being longitudinally spaced along said longitudinal axis with respect to the adjacent set of cutters so as to engage distinctly different portions of the wire periphery, all of said cutters uniformly spaced entirely around the wire, and means supported in the housing for gradually and simultaneously moving said cutters radially inwardly as the wire passes through the machine, said last mentioned means being actuated by the rotatable housing.

2. The cutting machine of claim 1 wherein said housing is driven at a speed proportional to the rate of movement of the wire passing through the housing.

3. A cutting machine for gradually tapering a long length of wire into a polygonal cross-section with adjacent sides of the wire having the same angular relation throughout the tapered length comprising a rotatable housing having a central opening along a longitudinal axis through which the wire is threaded, a plurality of sets of cutters arranged within the housing in parallel planes transverse to the longitudinal axis, said cutters having straight cutting edges, the cutters in each set being circumferentially spaced apart and movable in a radial direction to bear against the wire, each of said sets of cutters being longitudinally spaced along said longitudinal axis with respect to the adjacent set of cutters so as to engage distinctly different portions of the wire periphery, all of said cutters uniformly spaced entirely around the wire, a pair of cooperating wedges slidably confined in the housing for gradually and simultaneously moving each of said cutters radially inwardly as the wire passes through the machine, and means for drawing said wedge surfaces together to effect radial movement of the respective cutters during wire movement.

4. The cutting machine of claim 3 wherein means are provided for adjusting the initial relationship of the wedges independent of said last named means.

5. A cutting machine for gradually tapering a long length of wire into a polygonal cross-section with adjacent sides of the wire having the same angular relation throughout the tapered length comprising a housing having a central opening along a longitudinal axis through which the wire is threaded, said housing including inner and outer sleeve portions threadedly mounted together, opposite outer end portions of the sleeves having shoulders, one of said sleeves being rotatable with respect to a fixed sleeve, a plurality of sets of cutters arranged within the housing in parallel planes transverse to the longitudinal axis, the cutters in each set being circumferentially spaced apart and movable in a radial direction to bear against the wire, radial guide means for said cutters, said cutters having straight cutting edges, each of said sets of cutters being longitudinally spaced along said longitudinal axis with respect to the cutters in an adjacent set so as to engage different intermediate surface portions of the wire periphery, all of said cutters uniformly spaced entirely around the wire, a pair of cooperating wedges supported in the housing between said shoulders for gradually moving each of said cutters radially inwardly as the wire passes through the machine, means for advancing the movable sleeve to draw said wedges together and effect radial movement of the respective cutters.

6. The cutting machine of claim 5 wherein the guide means for said cutters comprises longitudinal slots formed inside the fixed sleeve, said wedges being slidably disposed within said slots.

7. A cutting machine for gradually tapering a long length of wire into a polygonal cross-section comprising a housing having a central opening along a longitudinal axis through which the wire is threaded, said housing including inner and outer sleeve portions threadedly mount-

ed together, opposite outer end portions having annular shoulders, said outer sleeve having external gear teeth being mounted for rotation over the inner sleeve, said inner sleeve being fixed, said inner sleeve having longitudinal circumferentially spaced slots formed on the inside thereof, a plurality of sets of cutters disposed in said slots and radially guided for movement against the wire, said cutters having straight cutting edges, said cutter sets arranged in parallel planes transverse to the longitudinal axis, cutters in each of said sets being circumferentially spaced about said longitudinal axis, each set of said cutters being longitudinally spaced along said longitudinal axis with respect to the respective cutters in an adjacent set so as to engage different intermediate surface portions of the wire periphery, all of said cutters uniformly spaced entirely around the wire, a pair of cooperating wedges disposed in each slot between the inner

sleeve and the respective cutter for gradually moving each of said cutters radially against corresponding surface portions of the wire, outer ends of the wedges being confined between and bearing against the sleeve shoulders, said outer sleeve being rotatable to advance over the inner sleeve and draw said wedges together and effect radial movement of the respective cutters.

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