April 2, 1940. F. D. MORAN 2,196,076

APPARATUS FOR MAKING METAL SPONGE

Filed June 22, 1937 3 Sheets-Sheet 1

Fig. 1

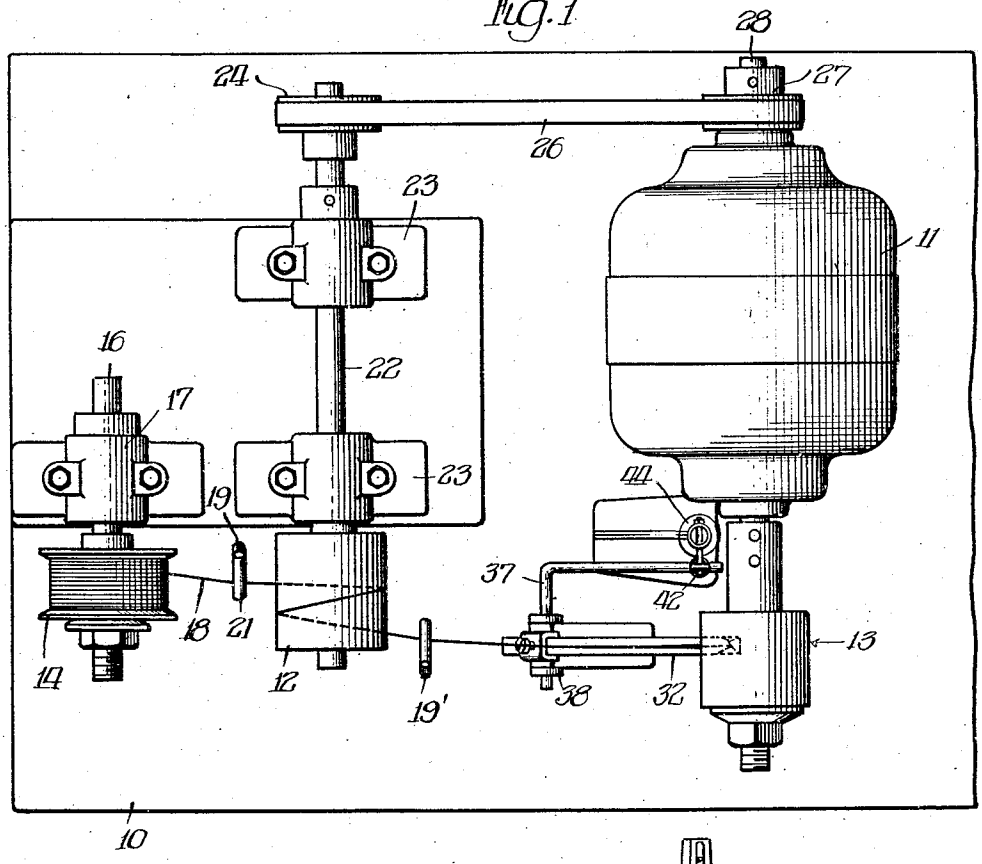
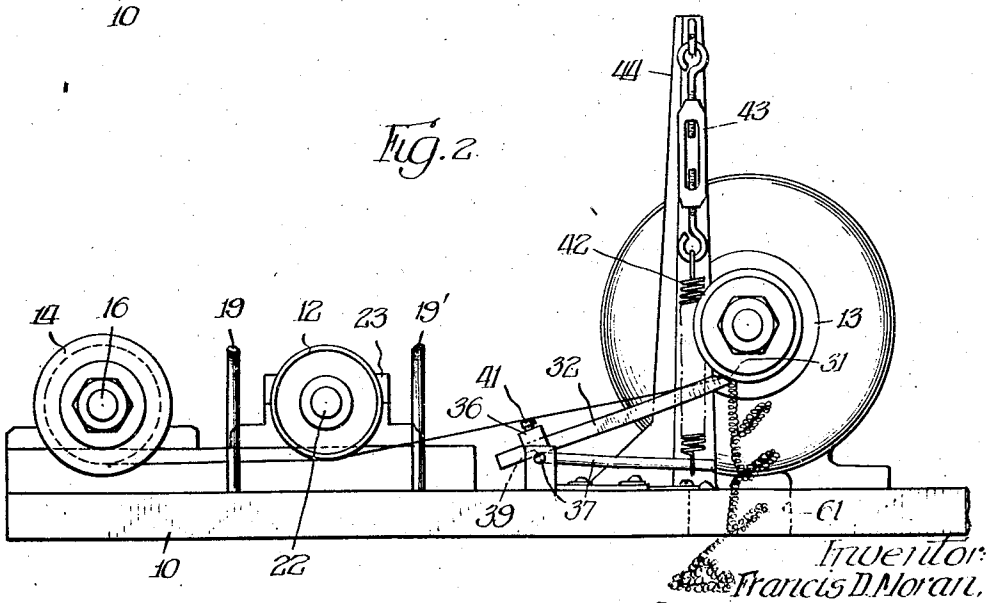


Fig. 2



Inventor:
Francis D. Moran,
By Foorman L. Muelly
Atty.

April 2, 1940. F. D. MORAN 2,196,076

APPARATUS FOR MAKING METAL SPONGE

Filed June 22, 1937 3 Sheets-Sheet 2

Fig. 5

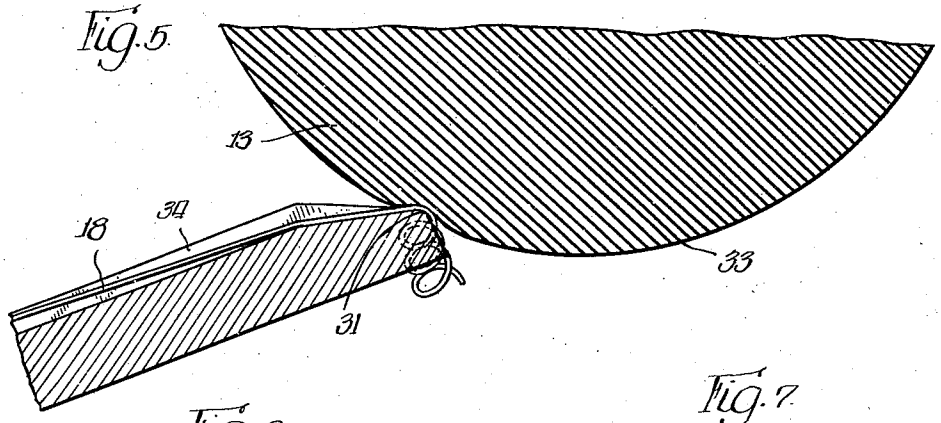


Fig. 6

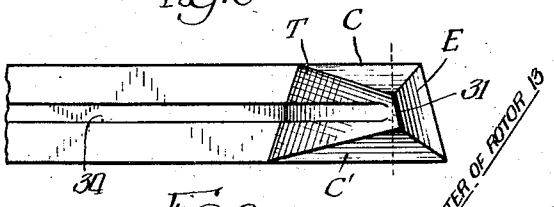


Fig. 7

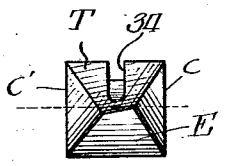


Fig. 8

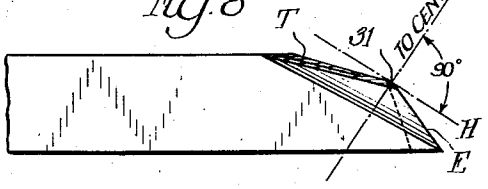


Fig. 15.

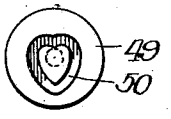


Fig. 4.

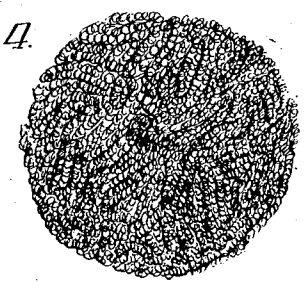
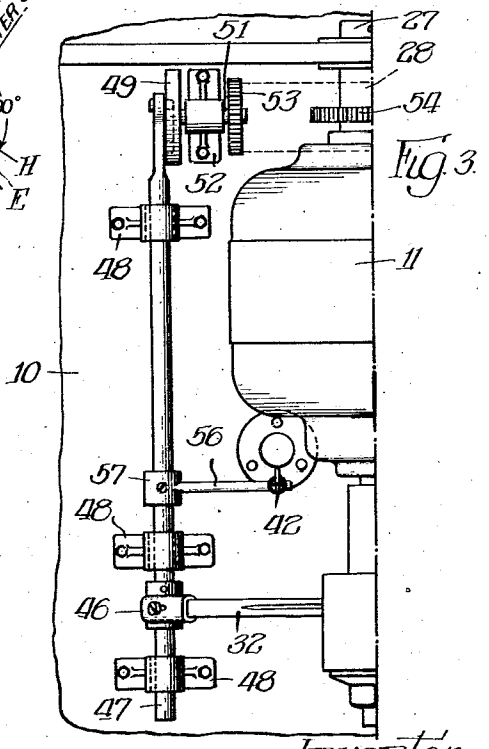


Fig. 3.



Inventor:
Francis D. Moran,
By Foorman L. Mueller
Atty.

April 2, 1940. F. D. MORAN 2,196,076

APPARATUS FOR MAKING METAL SPONGE

Filed June 22, 1937 3 Sheets-Sheet 3

Fig. 9

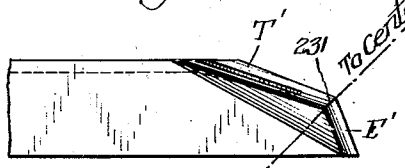


Fig. 10

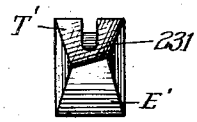


Fig. 12

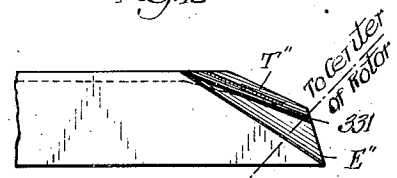


Fig. 13

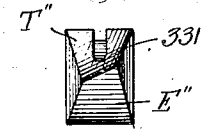


Fig. 11

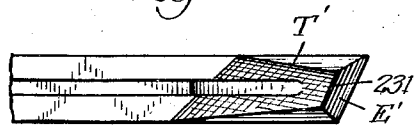


Fig. 14

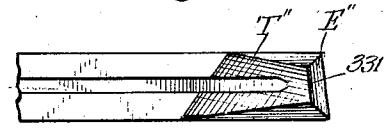
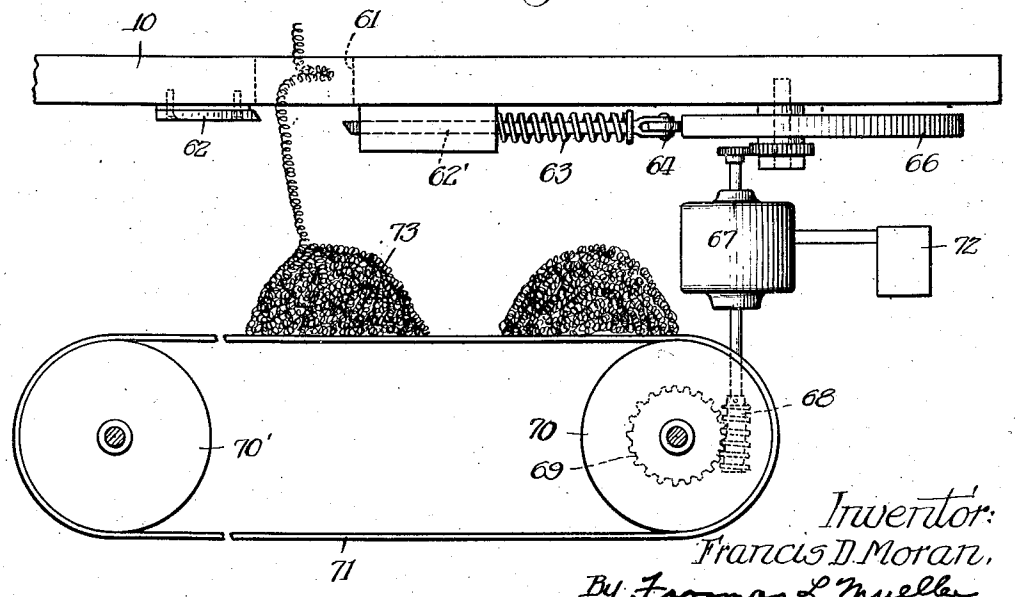


Fig. 16



Inventor:
Francis D. Moran,
By Foorman L. Mueller
atty.

Patented Apr. 2, 1940 2,196,076

UNITED STATES PATENT OFFICE

2,196,076

APPARATUS FOR MAKING METAL SPONGE

Francis D. Moran, Downers Grove, Ill.

Application June 22, 1937, Serial No. 149,723

22 Claims. (Cl. 140—71)

My invention relates in general to curled wire, and more in particular to a method and apparatus for curling said wire, and a metallic cleaning sponge formed from such curled wire.

In recent years it has been demonstrated that metallic sponges or pads are more satisfactory for substantially all types of scraping and cleaning operations than the many other types of brushes, sponges, pads, and the like, which had theretofore been used for such purpose. Fine steel strands, or, as it is commonly known, steel wool, for pads has been unsatisfactory for many purposes because the steel wool may injure the hand of the user unless a glove is worn, and such steel wool pads and sponges wear down rapidly with use and become packed in the normal cleaning operation so as to lose a desirable resiliency. Furthermore, as the pad becomes packed, the removal of dust, paint, grease, or the like, which has collected in the use of the same, becomes impossible, and the pad sometimes becomes useless before the material is all used up.

The same disadvantage as to resiliency and removal of accumulated dirt or the like is apparent in metallic pads or sponges formed of coiled wire, which at the present time are wound in such a shape that each strand of coiled wire has resiliency in only a single direction, and the strands aren't easily manipulated to utilize all the material as a cleaning surface. Furthermore, the coils in the wire are wound closely so that the pad packs with use, and thus can not be cleaned, or at least readily cleaned.

With respect to the coiled metal wire pads, there are the disadvantages in the pad itself mentioned above, and in addition the method of making the coiled wire and forming the sponge, as well as the apparatus for practicing such method are somewhat complicated and expensive. As a result, the cost of the finished coiled metal pad is high, and because of the high price, it is not strictly competitive with steel wool pads and the like, while at the same time having some general advantages thereover.

It is an object of the invention, therefore, to provide an improved curled metal wire rubbing or cleaning sponge.

One of the features of this sponge is the general open resilient formation so that the volume for a satisfactory amount of material in a sponge is considerably greater than any metallic pad of the prior art.

A still further feature of my invention is the provision of such a sponge structure that the curled metal wire constituting the same retains a desirable amount of resiliency and openness throughout extended use and throughout an extended life, and in this structure can be readily handled for providing a new cleaning or rubbing surface and for cleaning out the accumulated debris therein. Likewise, the present structure with the open curls, provides for more cleaning edges than have the prior art sponges, thus making for more rapid and efficient cleaning.

Another object of my invention is to provide a simplified method for manufacturing the metallic sponge.

A further object is to practice such simplified method with a simple and inexpensive apparatus that may even be portable by virtue of its size and simplicity.

Another feature of the method and apparatus for curling the wire to make such sponge is that the wire for the sponge is pulled from a source of supply, and simultaneously with the pulling operation is pressed against a curling edge on a curling tool to form successive relatively open curls therein, whereupon the curled wire is dropped from the curling tool in a long strand without any tautness therein, into a pile. When a suitable quantity of curled wire has accumulated below the curling edge, the strand as it comes from such curling edge is cut. The pile or quantity of wire thus separated is manipulated slightly to intertwine the coils, and the pad or sponge is then complete and ready for use.

An alternate method is to accumulate a large pile and merely pick up the desired quantity of curled wire from the pile, compress it in the hand, to cause the curls to interengage, and then cut this quantity from the pile to provide the finished formed sponge, which springs back into an enlarged volume when removed from the hand.

Other objects and advantages of the invention will be apparent from the following description, taken with the drawings, in which:

Fig. 1 is a top plan view of the apparatus of my invention.

Fig. 2 is a side elevation thereof.

Fig. 3 is a fragmentary top plan view of a modification of the apparatus of Figs. 1 and 2.

Fig. 4 is an illustration of the finished sponge of my invention.

Fig. 5 is an enlarged fragmentary view of the preferred embodiment of the curling edge, with an illustration of the manner in which the wire is curled on such edge and drops away by gravity to a pile below the same.

Fig. 6 is a fragmentary top plan view of the curling tool shown in Fig. 5.

Fig. 7 is a front elevation thereof.

Fig. 8 is a side elevation of the curling tool of Figs. 5, 6 and 7.

Fig. 9 is a fragmentary side elevation of a curling tool with a curling edge modified from that illustrated in Figs. 5 to 8.

Fig. 10 is a front view of the curling tool of Fig. 9.

Fig. 11 is a top plan view of the modified curling edge of Figs. 9 and 10.

Fig. 12 is a side elevation of a curling tool with a further modification of the curling edge.

Figs. 13 and 14 are respectively, a front elevation and a top plan view of the structure of Fig. 12.

Fig. 15 in an elevation of the eccentric member of the apparatus illustrated in Fig. 3.

Fig. 16 is a side elevation of the timed cutting mechanism for the curled wire.

The apparatus for curling the wire to make up the metal sponges is illustrated in Fig. 1, with the apparatus mounted on a base 10 of any desirable material and including a motor 11 for driving a capstan 12 and simultaneously driving a curling rotor 13, mounted directly on the shaft of the motor. The preferred wire for curling to be made into the metallic sponge of my invention is a flat brass or bronze wire of .0012" thickness and approximately .020 inch in width, although it is understood that I do not limit the invention to these wire specifications, wire form, or wire materials. This wire may be originally formed from round stock by any desired flattening method and after flattening is reeled onto a spool 14 for mounting on a rotating shaft 16 appropriately journalled at 17 and mounted on the base 10. It is also understood that the wire flattening apparatus may be mounted or assembled in connection with the curling apparatus to feed the wire directly to the curling mechanism rather than first winding it on a spool 14 and then feeding it from such spool as will be hereinafter more fully described.

The flattened brass or bronze wire 18 is passed from the spool 14 on the outside of a slanting guide pin 19 extending upwardly and outwardly away from its securing position at 21 in the base 10. The wire is then looped around the rotary capstan 12 in the ordinary manner and fed around the guide pin 19' to the curling tool. This pin 19' slants upwardly and in an opposite direction from the pin 19, and with the pins spaced to each side of a longitudinal line through the capstan, as is clear from Fig. 1, they act to spread the wire over the capstan into the form of a helix. Flat wire laps readily, and does not tend to stay separated on a capstan. However, with the wire looped about the capstan, as described, it is separated so that the portion of the wire passing on to the capstan from the spool does not engage the portion passing from the capstan to the curling apparatus and thus does not become entangled in any way.

The capstan 12 is rigidly secured to a shaft 22 which in turn is journalled in a pair of bearings 23 and with a pulley 24 on the end of the shaft is driven by means of a belt 26 from a pulley 27 on the shaft 28 of the motor. The pulleys 24 and 27 are the same size, and the shaft 22 will rotate substantially at the speed 28 of the motor. There is probably some slight lag in the shaft 22 as compared with the speed of the shaft 28, because of the slight power losses in the belt drive, and possibly from friction in the bearings 23. However, this is not utilized in any way in the curling operation, as will hereinafter appear.

The wire 18 is pulled over a curling edge 31 on a curling tool 32 of tool steel, by means of the friction between the rotating roller 13 and the wire 18 lying on the curling tool. The roller 13 is provided of a desirable material such as to stand up under extended use and provide a yieldable surface 33 as shown in Fig. 5, to yield slightly as it bears across the wire 18 on the curling edge and thus engage such wire for a slight distance on each side of said edge. To assist in retaining the wire 18 centered on the curling tool, and to guide the wire to the curling edge, a channel 34 extends lengthwise of the tool in the upper portion, and substantially to the curling edge 31. The roller 13 has been very satisfactorily provided in a commercial embodiment of the invention in rubber, and also in leather, with each sufficiently soft to yield slightly as heretofore explained. The rotor 13 of course remains in a single vertical position on the shaft of the motor, and to obtain the necessary curling pressure on the wire 18 it is necessary to pull the curling tool 32 and consequently the curling edge 31 upwardly across the under side of the wire so that such wire is retained under pressure between the yieldable surface 33 and the curling tool 32 at the edge 31.

The curling tool 32 which is provided in high-speed tool steel is adjustably mounted in a U-shaped bracket 36 which in turn is mounted on an L-shaped crank 37 journalled in a bracket or U-shaped support 38 mounted on the base 10. The curling-tool-carrying arm of the member 37 may be provided with a flattened portion 39 as shown in dotted lines in Fig. 2, so that as the screw 41 is tightened upon the top surface of the curling tool 32, the latter is pressed against the flat surface 39 in a rigid mounting. A spring 42, adjustably suspended from a link 43 on a standard 44 mounted on the base 10, slips over the forward extending arm of the lever 37 and by virtue of the construction of this lever discussed above, pulls the curling tool upward to hold the wire 18 between such tool and the rotor 13.

A modification of this curling tool mounting is illustrated in Fig. 3, wherein the curling tool 32 is adjustably mounted in a bracket 46 keyed or secured against rotary movement on a shaft 47 journalled in bearings 48 mounted on the base 10. The end of the shaft 47 is provided with a cam follower or the like moving in the channel 50 of an eccentric cam 49 (Fig. 15), which in turn is secured to a shaft 51 journalled in a bearing 52 and having a gear 53 secured on one end thereof. Appropriate speed-reducing and drive mechanism is provided between the gear 53 and gear 54 secured to the motor shaft 28. The shaft 47 slides back and forth in a reciprocating movement at any desired speed to move the curling tool 32 from one side to the other axially across the rotor 13 to wear the surface 33 down evenly. The cam 49 is cut to provide uniform speed in moving the curling tool across the rotor.

To obtain an upward pull on the curling tool 32 comparable to that described with respect to the embodiment of Figs. 1 and 2, the spring 42 is hooked over an arm 56 extending from an integral bushing 57 rigidly secured on the shaft 47. Inasmuch as the movement of the shaft 47 is approximately only 5/8 of an inch as it moves the curling tool back and forth over the roller 13, no difficulty is encountered by virtue of the fact that the spring 42 is extended and compressed as

the arm 56 moves transversely upon the reciprocating movement of the shaft 47.

As to the curling tool itself, the preferred embodiment is illustrated on an enlarged scale in Figs. 5 to 8 inclusive. The tool illustrated in these figures is three times the actual size of a commerical embodiment of the invention. As shown in Fig. 7, the top surface T at the curling end of the tool is ground to lie in a plane cutting diagonally through the top face of such tool. The end face E of the tool is ground to a plane cutting diagonally across the end of the curling tool and forwardly and downwardly as viewed in Figs. 6 and 7. This provides a curling edge 31 lying intermediate the top and bottom surfaces of the curling tool, which for purposes of complete disclosure is illustrated in connection with imaginary lines on the figures and the edge may be described as extending approximately at an angle of 15° with a horizontal line through the tool as shown dotted in Fig. 7, and at an approximate angle of 15° with the vertical line shown dotted in Fig. 6. The illustration of Fig. 8 shows the curling edge 31 as lying in a plane H which is tangentially disposed as to the rotor 13. In this embodiment, however, the curling edge 31 is not parallel to the axis of the rotor, but is angularly disposed with respect thereto. The pressure between the rotor and the curling tool applied diagonally across the wire, and substantially equally thereover because the width of the wire is so small in comparison to the circumference of the rotor, causes such wire to curl openly as it leaves the edge, as shown in Fig. 5. The action on the wire might be described as "working" on one side of the flat wire ahead of the other side to provide the open curl. The yieldable surface 33 of the rotor bears approximately equally on the wire to each side of the curling edge, "each side" being considered to each side longitudinally of the tool. This causes the wire to normally move slightly to the left at surface T as viewed in Fig. 7, and then move slightly to the right as viewed in Fig. 7 on the surface E, so that as a result of these urgings or pressure on the wire, it follows a path over the curling edge centrally thereof, without any other guide means than the channel 34 leading up to the curling edge. It is understood that the particular angles specified above may be varied so long as the curling edge 31 maintains the same relative position to, and cooperates with, the rotor 13 in the manner specified. The surfaces C and C' of the curling tool are ground merely to narrow down the curling edge, and provide clearance at each side thereof.

Figs. 9 to 11 show a modification of the curling edge of Fig. 5, and in this curling tool the surfaces T' and E' are ground so as to provide a diagonally extending edge 231 with the plane of the surface T' and the plane of the surface E' both slanting relatively in the same direction; that is, to the left as viewed in Figs. 10 and 11. In this embodiment the curling edge 231 stands diagonally with respect to the surface 33 of the rotor 13, and thus the axis of such rotor, and lies in a plane through the axis of the rotor 13, but there is a slight tendency to cause the wire 18 passing thereover to move to the left on the curling edge unless appropriate supplemental guide means, such as bringing channel 34 close to the curling edge, are provided.

A still further embodiment of the curling edge is illustrated in Figs. 12 to 14, wherein a similar curling tool is provided with the curling edge 331 extending diagonally across the tool at the end portion thereof at the junction of the surfaces T'' and E''. The surfaces "T" and "E" are ground so that the curling edge extends diagonally downwardly from the curling surfaces as in Fig. 9, but instead of lying in a plane through the axis of the rotor, the curling edge lies in a plane twisted at an angle of approximately 15° with respect to the axis of the rotor. The extension of the curling edge downwardly away from the surface of the rotor causes an uneven pressure across the curling edge and there is a tendency for the wire to move transversely across the edge unless appropriate supplemental guide means are provided as suggested with respect to the structure of Fig. 9. At the same time one side edge of the wire is being "worked" ahead of the other edge due to the above noted twisted position.

Broadly, in practicing my invention to get an open curl, it is a matter of presenting the curling edge to the rotor surface at some angle in a substantially horizontal plane as is evident from Figs. 5 to 8 so that one side of the wire is worked ahead of the other side, or presenting the edge at an angle with the horizontal as in Figs. 9 to 11 for instance, so that unequal pressure is applied across the width of the wire by virtue of this inclination. The invention may also be practiced with the curling edge extending forwardly and downwardly in relation to the rotor as in Figs. 12 to 14, with this manner of presenting the edge representing a combination of the two previously described curling edge positions. A more concise statement of the above is that it is a matter of applying a wire to a curling edge. Where the latter is positioned diagonally downwardly or inclined with respect to the width of the wire, diagonally crosswise of the wire to work one edge ahead of the other or a combination of the two viz; both diagonally or inclined downwardly, and diagonally crosswise or transversely of the wire. When the curling edge is presented substantially parallel to the axis of the rotor, the less desirable relatively close coil of the prior art sponges is obtained.

As is evident from the above description, the curling tool 32 and rotor 13 each have a dual function. The curling tool provides a carrying means for the wire to support it and press it against the rotor 13 and simultaneously to act at the curling edge to effect, in cooperation with the rotor, curling of the wire. The yieldable rotor surface presses on to the wire on both sides of the curling edge. The friction rotor 13 with a yieldable surface 33 frictionally engages the wire 18 and pulls such wire over the curling edge as it rotates with the motor 11. The rotor 13, simultaneously with the pulling action, cooperates with the curling tool to provide a pressure transversely across the wire 18 as it passes over the diagonally extending curling edge, and by virtue of this pressure, causes the wire to curl, as shown in Fig. 2, and to drop by its own weight through an aperture 61 in the base 10 for the machine. The rotor surface engages the wire in a line contact at the curling edge, and the center of the curling edge would be in effect a point in a line tangential to the circumference of the rotor. The yieldable surface 33 of the rotor is indented slightly to engage the wire on each side of the curling edge as described.

This curled wire accumulates in a pile below

the aperture 61, not unlike the piled form of the final sponge as shown in Fig. 4. When sufficient of the curled wire has accumulated below the aperture 61 so it no longer turns, due to the curling operation as it comes from the curling edge, successive portions of the continuous curled strand engage one another by interengagement of the open coils, to form a tree-like configuration, as shown in Fig. 2, and the curled wire in this form continues to drop upon the pile and build up into a haphazard mass. The apparatus could be mounted on the base in a manner such that the curled wire would accumulate in a pile of approximately a cubic foot, or accumulate in a pile as large as a room, with nothing to guide the coiled wire as it drops from the curling edge, and nothing to direct the general form of the pile other than the walls or slides of the area into which the pile accumulates. The wire drops freely from the curling edge, and there is no tautness in the continuous wire after passing such edge.

Apparatus for piling and cutting the curled wire as it comes from the curling edge is illustrated in Fig. 16. This may desirably be mounted on the board 10 below the aperture 61, or may be simply assembled as a unit and positioned with respect to curling apparatus so it acts upon the curled strands conveniently. This apparatus comprises a stationary cutting tool 62, and a reciprocable cutting tool 62' with a knife edge for cutting the wire strand as it falls from the curling edge. The reciprocable cutting tool 62' is appropriately supported and has an extension for carrying a spring 63, limited in movement at one end by a collar 64 on said extension. The spring maintains the knife 62' in a normally open position and is compressed upon movement of the knife by virtue of the cam roller 64 on the extension, bearing against a cam 66. The cam in turn is keyed to a shaft with gearing intermediate the shaft and a motor 67. A movable belt 71 extends over rollers 70 and 70' and operates below the aperture 61 by gears 68 and 69 intermediate the roller 70 and motor 67. The motor 67 is electrically connected to an appropriate timing device 72 for operation at predetermined intervals to cut off the wire and simultaneously move the belt 71 to permit another pile of wire 73 to accumulate.

To make up the final commercial sponge, as shown in Fig. 4, an operator may merely pick a handful of the curled wire from the pile, or one of the piles 73 on the flexible belt 71, and merely crush or compress the handful of curled wire in the hand with a single operation, as one would crush a handful of snow, of cotton, or similar yieldable material held together by the constituency of the material itself, to increase the interengagement of curls in the wire. The sponge is provided in no particular form, as would be the case with curled strands wound upon a reel or the like, but takes the general round form resulting from the crushing in the hand of the operator or the form from accomplishing the operation with any mechanical means. Instead of packing like snow, however, the mass of curled wire springs back to a relatively open yieldable mass. It has been found that the various portions of the continuous curled strand intertwine with one another by virtue of the substantially open curls merely as they accumulate on the pile. This interengagement or intertwining is extended with the crushing operation so that in the final sponge, the many portions twined throughout the sponge may be pulled out readily in any direction, yet are retained together tenaciously by virtue of this interengagement and intertwining.

The curl in the wire accomplished by the curling operation described above, is not a relatively tight spiral curl similar to the common long screen door spring, but is an open curl with substantial recoil properties. When the finished sponge is pulled in any direction, it springs back readily, but does not pack or become so constricted that the advantages of an open flexible finished sponge are lost. When the user of the finished sponge has exhausted the cleaning possibilities of one surface, the wire of the sponge may be pulled in any direction to provide a new cleaning surface, and this process continued until substantially the entire mass inside and outside of the curled wire has been utilized for cleaning purposes. Similarly, as a result of the properties of the curled wire in the sponge, and the sponge itself, the body of the sponge may be opened up so that grease, paint, dirt, or the like picked up in cleaning or rubbing operations, can be washed therefrom, and if this washing operation is carefully done, the sponge is then in practically original form and constituency again to carry on cleaning therewith. There is practically no disintegration of the particles, and the sponge wears down uniformly over the entire body. It has been found that a sponge made up in the manner described above has substantially twice the volume of metallic sponge of this general class found in the prior art.

As evidence of the simplicity and compactness of the entire apparatus, it might be noted that a commercial embodiment of the apparatus has been successfully employed in the manufacture of the sponges wherein the base 10 for supporting the various elements described, is only 20 to 14 inches. As mentioned above, the base 10 may be mounted on legs or in any desired manner, depending on the space required for piling the curled wire below the aperture 61 or a similar open space below the curling edge.

Although the invention has been described in its preferred embodiments, it is understood that it is not limited thereby, but is limited as to all possible embodiments only by the scope of the appended claims, and as they, of course, may be limited by the prior art.

I claim:

1. An apparatus for curling wire, including a source of supply of wire, and means for pulling said wire from said source and simultaneously curling the same, said means comprising a rotor having a yieldable surface, and a stationary curling tool adjacent said rotor with said wire carried on said curling tool directly between the tool and rotor and acted upon by both said rotor surface and said tool.

2. An apparatus for curling wire including a wire holding member, and means for curling wire movable through the apparatus from the holding member, said means comprising a stationary curling edge for carrying said wire in engagement therewith on one side and a rotary member adjacent said curling edge for bearing against said wire on an opposite side thereof and at a place directly opposite said edge to frictionally engage said wire and pull said wire over said edge and curl the same thereon.

3. An apparatus for curling wire including a wire holder, a curling tool for carrying said wire in a single strand thereover and in a straight line movement from said holder, and means acting

alone for moving said wire over said curling tool in the straight line movement and simultaneously acting on said wire at said curling tool to curl said wire into a plurality of successive relatively open coils.

4. An apparatus for curling wire, including a rotary wire holder, stationary means for carrying said wire in its movement from said holder, and a moving yieldable surfaced member bearing against said wire at said stationary carrying means and cooperating with said carrying means to curl said wire into a plurality of successive curls.

5. An apparatus for curling wire for a metallic sponge, a source of wire in a continuous strand, a stationary member and a movable member adjacent and opposite thereto with the wire from said source movable directly between said two members, with said two members cooperating together to pull said wire from said source and simultaneously curl the same into a plurality of successive curls.

6. In apparatus for manufacturing curled wire cleaning and rubbing devices, a source of continuous straight wire, and means for transforming said straight wire into wire with a plurality of successive curls, said means including an axially supported rotor and an elongated curling tool having a curling edge at one end thereof, with the tool positioned at right angles to the axial center of the rotor, but with said curling edge on the tool disposed diagonally with respect to said axial center of the rotor.

7. In apparatus for curling wire, including a wire holding member, wire adapted to be pulled therefrom and means for curling said wire, said means comprising a stationary curling edge for carrying said wire with said curling edge standing at an angle other than a right angle to the general line of movement of said wire from said holding member, and a rotary member bearing against said wire at said curling edge to pull said wire over said edge and curl the same thereon.

8. Apparatus for curling wire for a metallic sponge, including a source of wire in a continuous strand, guide means for said wire, a stationary member and a rotary member with one of said members having a non-yielding surface and the other of said members having a yieldable surface, with said wire carried between said surfaces, and means including the non-yielding surface, and the yielding surface acting upon the wire therebetween to pull the wire through said apparatus including said guide means and simultaneously transform said wire from a continuous substantially straight strand, to a strand with a plurality of successive relatively open curls.

9. An apparatus for making metallic sponges, including a source of metal wire, means for guiding said wire from said source to a curling edge, a curling tool having one end adjustably mounted and the other end portion shaped in a manner to provide a curling edge extending crosswise of the tool substantially transversely of the tool for carrying the wire thereon, and a movable member having a yieldable surface for frictionally engaging the wire to pull it over the curling edge and simultaneously curl the wire into a plurality of successive curls, with said apparatus provided in such form that there is an opening below the curling edge whereby the curled wire drops downwardly below the curling edge to form a pile thereof with the curls intertwined.

10. An apparatus for making metallic sponges as described in claim 9 including measuring and cutting means for separating a measured pile of curled wire from the curled wire strand dropping from the curling edge.

11. A curling tool for apparatus for curling wire including a rotating curling roller, said tool comprising an elongated bar having an end portion shaped to provide a curling edge at the junction of two plane surfaces on said end portion, with said curling edge extending diagonally across the bar.

12. Apparatus for manufacturing a curled wire cleaning device, including a source of wire, a curling rotor, a curling tool, and wire guide means intermediate said source and said curling members including a rotating capstan in substantial alignment with said source and said curling members for carrying the wire in a loop thereon, and a guide pin on each side of said wire, with each of said guide pins inclined upwardly but outwardly in opposite directions and spaced from one another transversely to the line of movement of the wire through the apparatus so as to spread and guide the looped wire on the capstan into a helical path to prevent any two oppositely moving wire portions from becoming entangled and winding on said capstan and injured.

13. Wire curling apparatus including in combination, a portion of said apparatus having a relatively sharp curling edge thereon for engaging wire movable over said curling edge, and with said curling edge being positioned with reference to such wire at an angle other than a right angle to the line of movement of said wire.

14. Wire curling apparatus including in combination, curling means for curling wire movable through the apparatus and following a generally straight line path immediately in advance of the curling means including a relatively sharp curling edge engaging one side of said wire and positioned with reference thereto at an angle other than a right angle to the generally straight line path, and a pressure member for bearing against a side of said wire opposite to said one side to curl said wire over said curling edge.

15. Wire curling apparatus including in combination, a portion of said apparatus having a relatively sharp curling edge thereon for engaging relatively flat wire movable over said curling edge with one face of said wire thereon, and with said curling edge being presented to said wire transversely of the line of movement of the wire at an angle other than 180° to the engaged face of said wire at such transverse line of engagement.

16. Wire curling apparatus including in combination, curling means for relatively flat wire movable through the apparatus in a generally straight line path portion immediately in advance of the curling means including a relatively sharp curling edge for engaging one side of said relatively flat wire and positioned in a line other than parallel with reference to a line extending through said wire transversely to the path of movement of said wire, and a pressure member for bearing against a side of said wire opposite to said one side to curl said wire over said curling edge.

17. In a wire curling machine, a rotating pressure member and a non-rotating curling member, with the latter having a knife edge thereon for engaging wire movable through said machine which has at least one relatively flat face, and with such knife edge in engagement with the face of the wire, said rotating pressure member being positioned with reference to said knife edge so as to bear against said wire and cause said wire to

be directly pressed against said knife edge, and with said knife edge in a position so as to engage said wire face in a line transversely to the line of movement of the wire through the machine, but said knife edge extending in such a transverse line which is other than parallel with the relatively flat face of the wire.

18. Apparatus for curling relatively flat wire, including means having a curling edge thereon for directly engaging wire moved through said apparatus in a straight line, with said curling edge being presented to said wire at a face of said wire at an angle other than a right angle to the direction of travel of said wire, and at an angle other than 180° with reference to the face of said wire in a line transversely to the line of movement of said wire.

19. An apparatus for curling wire including in combination, curling means having a relatively sharp curling edge for receiving thereon a wire movable through said apparatus, and means adjacent said curling edge having a yieldable surface, with the latter bearing against wire carried on the relatively sharp curling edge and acting with said curling edge to curl the wire.

20. An apparatus for curling wire including a spring-pressed curling member having a knife edge thereon, a rotor having a yieldable surface rotatably mounted in a position adjacent said knife edge, whereby the latter will press into said surface, with said rotor and curling member adapted to receive a movable wire therebetween, and with said knife edge and yieldable surface acting to curl said wire.

21. Curling apparatus for wire, including in combination, means having a relatively sharp curling edge thereon, a driven rotor adjacent said curling edge having a yieldable surface thereon, with said curling edge and said yieldable surface being oppositely disposed and positioned with reference to one another so as to carry a wire therebetween for curling said wire over said curling edge, and with one of said two members as between said curling edge means and said rotor being spring-pressed to press such one member against the wire therebetween to press said wire against the other of said members.

22. In apparatus of the character described, means for curling wire moving through the apparatus into a plurality of successive curls, said means including a curling member having a knife edge for carrying the wire at said knife edge in a single strand, and a pressure member rotatably driven by means independent of the curling member bearing on said wire at said knife edge with the wire between said members and with one of said members being yieldingly pressed toward the wire and toward said other of said members.

FRANCIS D. MORAN.