B. E. ELDRED.

FLEXIBLE METALLIC TUBING.

APPLICATION FILED JAN. 7, 1908.

925,317. Patented June 15, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

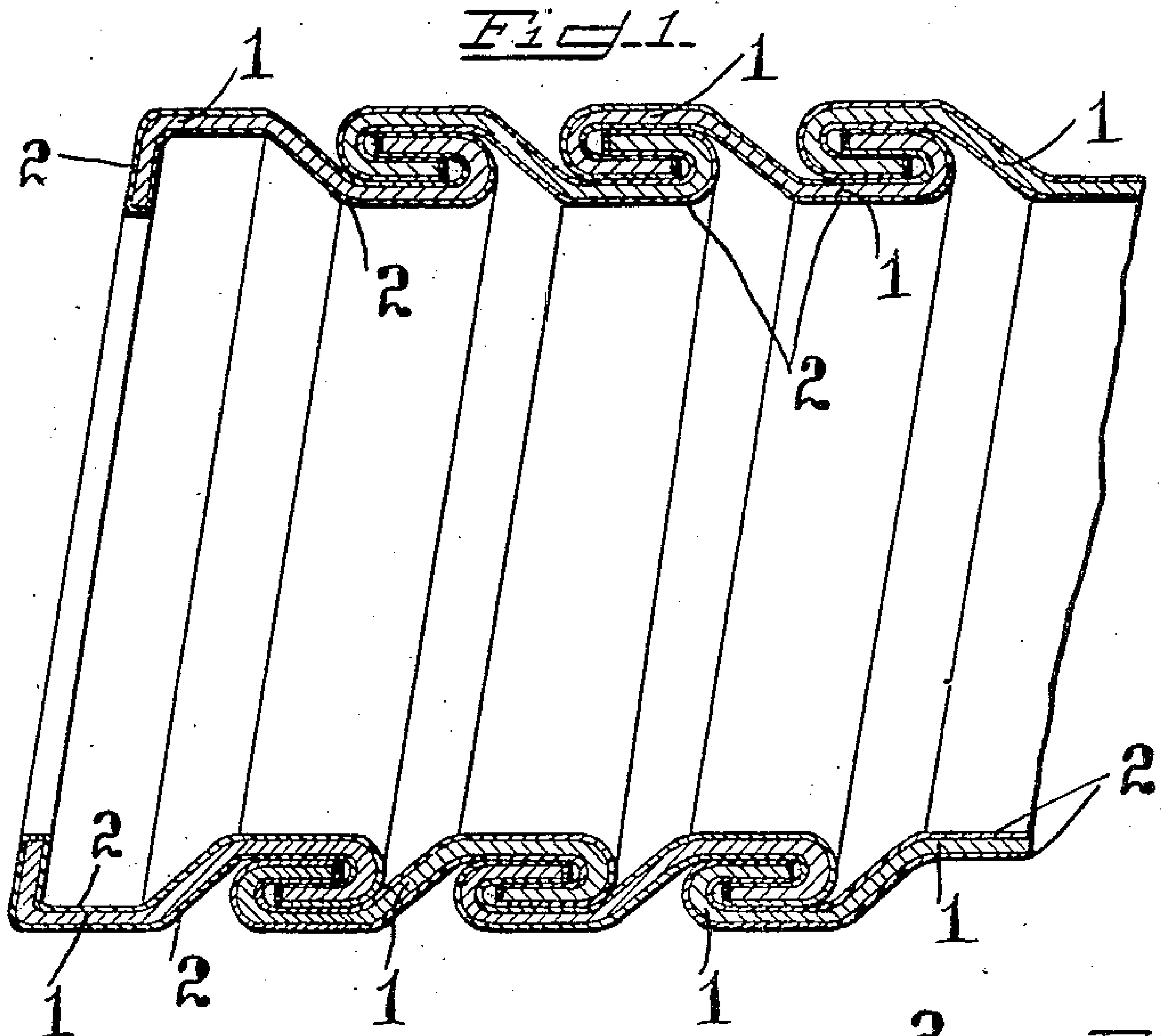


Fig. 4.

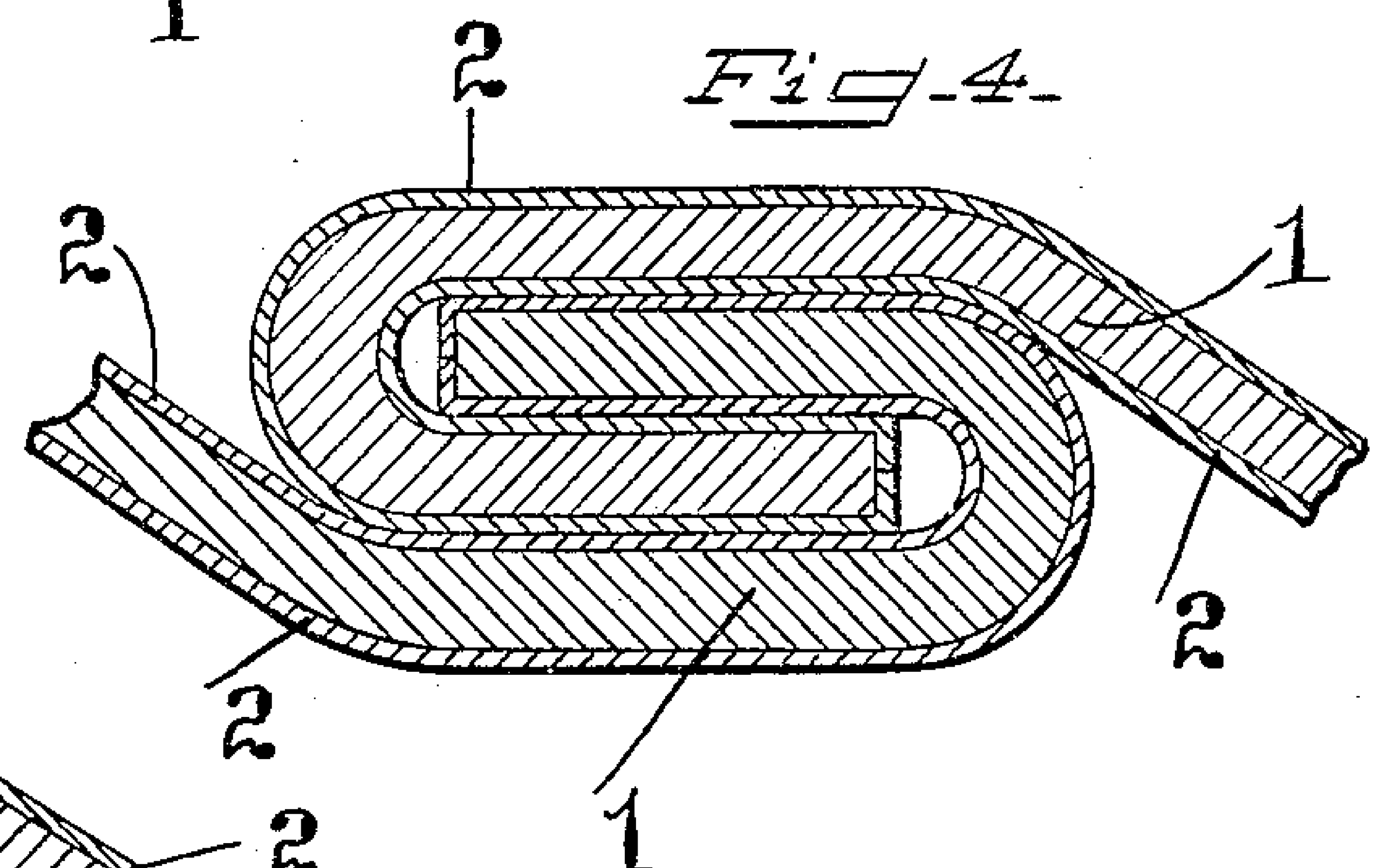


Fig. 2.

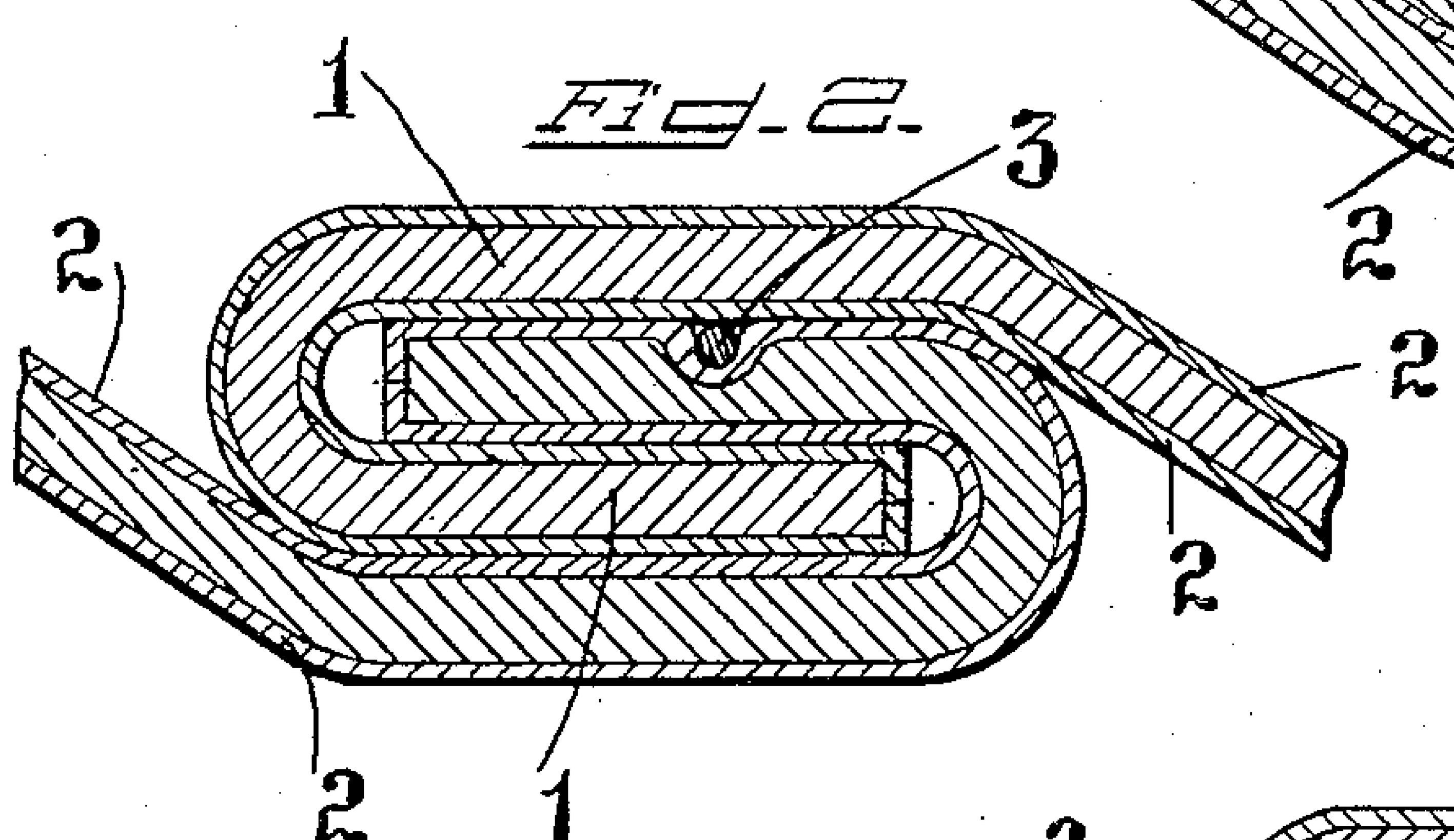
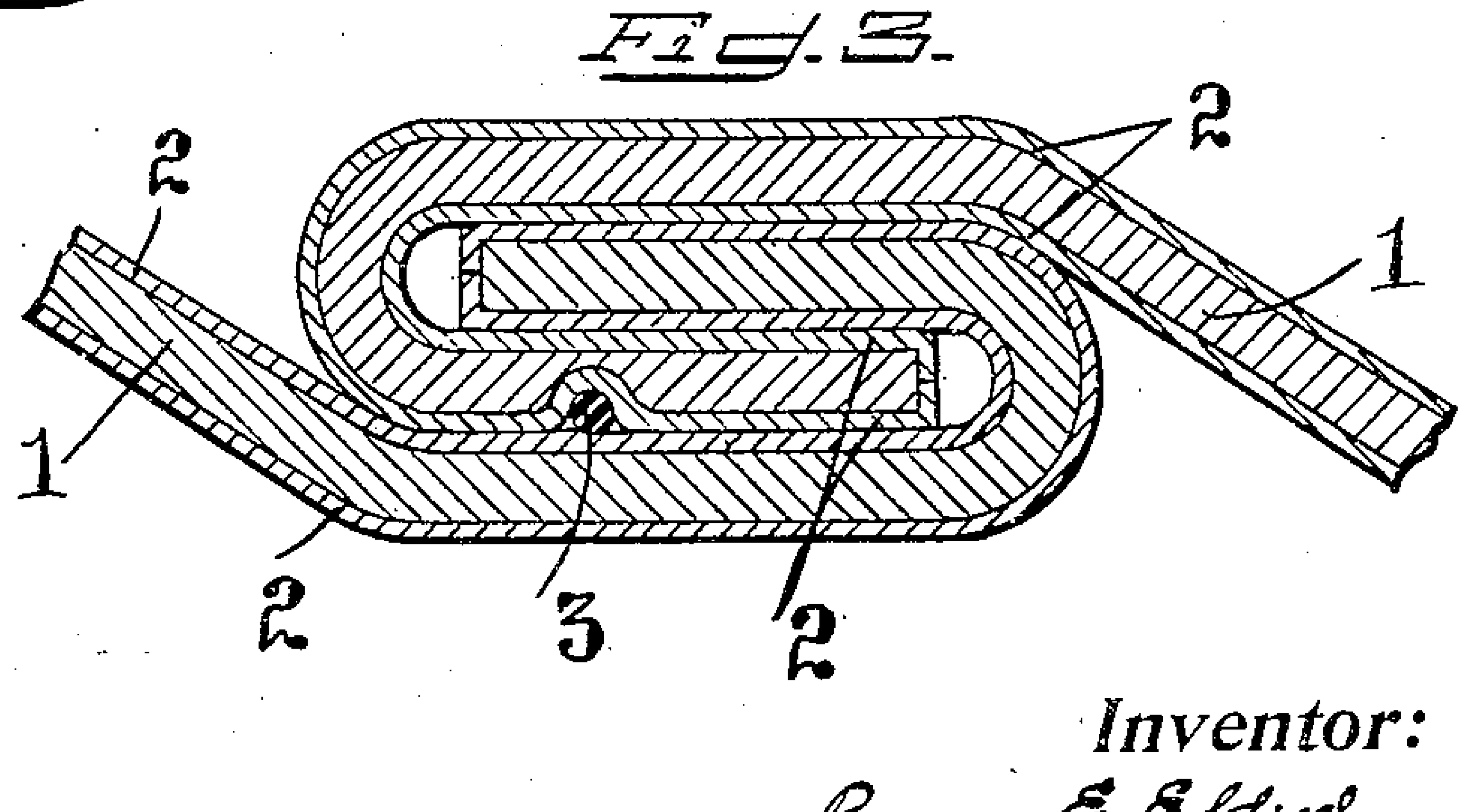


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 5.

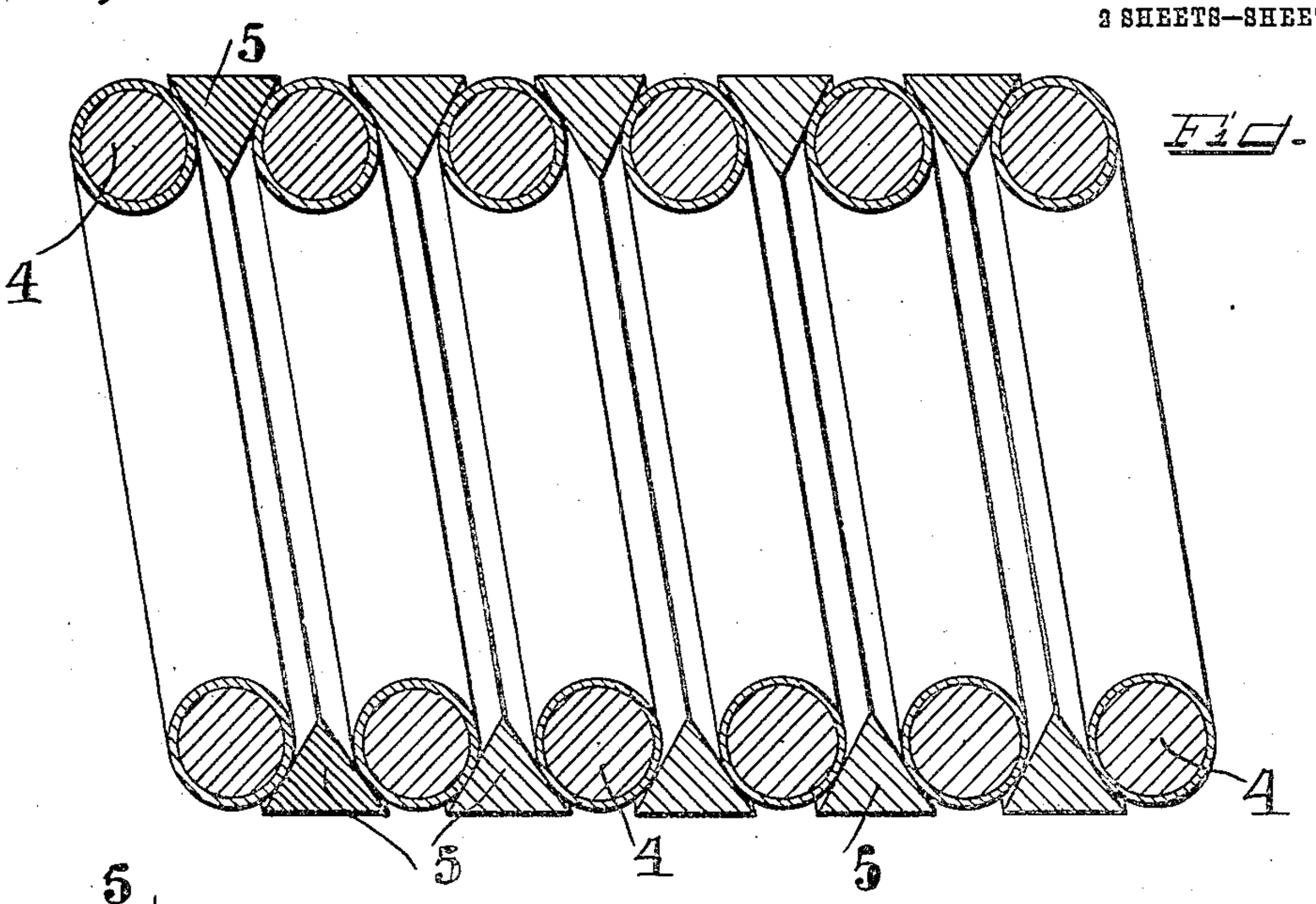
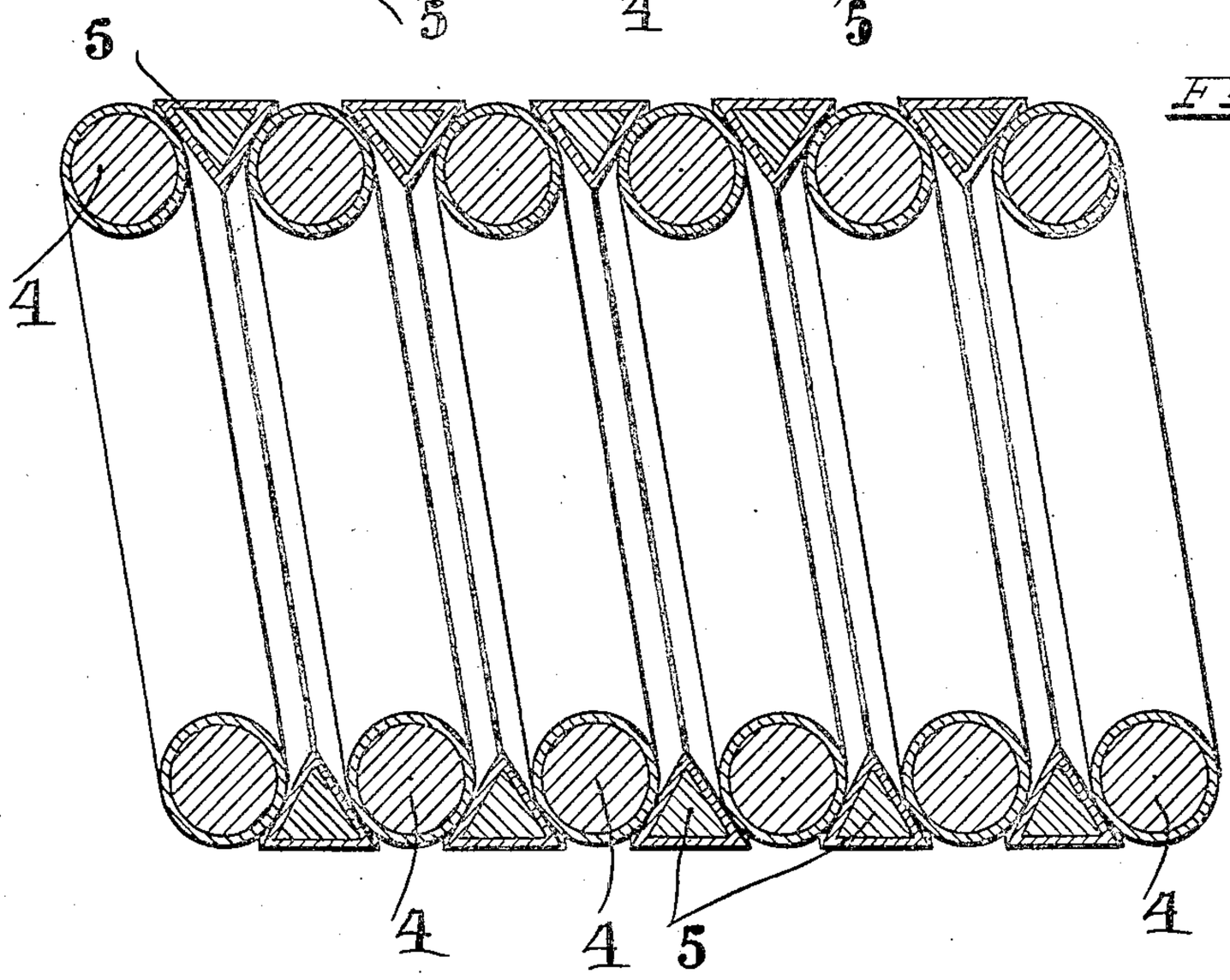


Fig. 6.



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UNITED STATES PATENT OFFICE.

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FLEXIBLE METALLIC TUBING.

No. 925,317. Specification of Letters Patent. Patented June 15, 1909.

Application filed January 7, 1908. Seral No. 409,621.

To all whom it may concern:

Be it known that I, BYRON E. ELDRED, a citizen of the United States, residing at Bronxville, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Flexible Metallic Tubing; and I do hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to flexible metallic tubing, and particularly to flexible tubing adapted to withsand considerable internal or external pressure, and which therefore must have tight joints.

Flexible metallic tubes such as those to which my invention relates are usually composed of one or more spiral strips of metal, the adjacent turns of which are locked together by crimping or otherwise so as to form a tight joint, (packing being sometimes introduced into this joint) or of a pair of interwound spiral wires. In either case it is obvious that overlapping or abutting surfaces must fit together quite accurately and must be smooth and free to move on each other to afford the desired flexibility of the tube. Furthermore, since such tubing when conveying steam, hot water etc. is or may be subjected to great changes of temperature, it is necessary that the joint shall be one which will permit expansion or contraction without development of leaks. Heretofore such tubing has customarily been made either of steel or of copper. Copper, even when hard drawn, has the objections that owing to its well-known weakness and small elasticity, when any considerable pressure is to be resisted the copper walls of the tube must be of considerable thickness, thereby making the tube less flexible than if the walls were thinner. Copper has, however, the important advantage that it is substantially unaffected by oxygen, steam, water of condensation, fatty acids such as may be present in lubricating oils contained in steam or water of condensation, and other liquids and gases or vapors which such tubing is usually called upon to carry. Steel is much stronger than copper, and therefore can be used in much thinner gages; but its well-known susceptibility to oxidation, pitting, etc., makes the use of steel tubing impracticable in most cases.

According to the present invention, the tubing is formed of steel, but layers of copper, silver or other less oxidizable metal are attached to and interposed between adjacent or overlapping layers of steel, such copper, silver etc., because of its relative softness, and relatively high rate of expansion, forming an efficient packing and a superior rubbing or friction surface which is not liable to oxidation, corrosion or pitting; and such layers of copper, silver etc. also protect the steel from oxidation, corrosion or pitting. The copper etc. is preferably weld-united to the steel, being thereby confined as to expansion longitudinally or in a direction parallel to the weld, substantially to the rate of expansion of the steel, but being free to expand in a direction at right angles to the weld, at its own rate. Since this rate is, as stated, much greater than that of steel, as the temperature of the tube rises the joint automatically becomes tighter. This advantage can be attained with weld-clad steel and the copper strip or layer still be very thin. Owing to the copper etc. being welded to the steel, the expansion of the copper etc. at right angles to the weld is greater proportionately than would be the case except for the weld, owing to the limitation of the expansion of the copper in other directions by the weld-union to another metal (steel) having a lower rate of expansion.

In some cases the steel used is one the rate of expansion of which has been regulated, by the use of regulated amounts of an alloying ingredient such as nickel or cobalt, so that it has a particular desired rate of expansion, or even does not expand or contract at all with changes of temperature. In such case the copper, sliver etc. has, of course, a still greater efficiency as a means for insuring tight joints. In forms of tubing comprising two interwound spirals, one of the spirals may be of ordinary steel coated with copper etc., and the other of steel having a less rate of expansion than ordinary steel, and likewise coated with copper etc.; the different rates of expansion tending to make the joints tighter as temperature rises. And in the forms of tubing in which the joints between adjacent turns are formed by crimping or interlocking adjacent edges, a layer of packing material, preferably copper, silver etc., may be included in the joint.

In the patent to J. F. Monnot, No. 853,716, dated May 14, 1907, a method of inseparably

uniting copper, silver etc. to iron, steel and the like is set forth, the union being produced in the ingot and the compound or clad billets so produced being extended by rolling, or other suitable method of extending, to sheets, rods, wires etc.; the covering of copper, silver etc. in the resulting extended object being, if so desired, quite thin, and yet being poreless and impervious to gases, moisture etc., so that such material is no more subject to attack than is the coating metal itself. The union produced between the two metals is equivalent to, and probably is, a true weld; and the term weld as used herein is used as comprising such union. Material such as described in said patent is now available, and is the material which I particularly prefer to use in the construction of my tubing, as it has substantially the strength of steel, and so may be used, even for high pressures, in small gages, and in strips of such material its rate of expansion laterally and longitudinally is substantially that of the steel itself while the copper or like coating has an increased rate of expansion in a direction at right angles to the weld-line or to the surface, for the reason previously stated; and moreover the material is no more liable to corrosion or other attack than is the coating metal. Moreover such coating metal has a peculiar hardness, due doubtless to support received through substantially molecular union to the stronger metal beneath, which makes it a particularly good bearing metal, for my present purpose at least. It is well known that in bearings, copper does not work well against copper, or steel against steel. But such objection is not found, in my tubing, to steel-reinforced copper working against steel-reinforced copper; the copper being, in such case, so hard as to make a good bearing metal.

In the manufacture of thin-coated weld-clad metal strips or wires adapted for the present purposes, the compound metal body is rolled or drawn down to thin gages. In this coextension of the joined metals, the copper, etc., coating, which ultimately becomes quite thin or filmiform, is compressed and compacted between the tool on the one side and the relatively stiff, hard steel on the other, and, being prevented from lateral yielding by the basal weld-union to such steel, it assumes throughout the film a peculiar hard, dense, compact texture, similar to the superficial texture of hard drawn copper, while its surface becomes planished.

In the accompanying drawings I illustrate my invention applied to certain of the well-known types of tubing. It will be understood that my invention is independent of any particular joint between adjacent edges, surfaces, coils or turns, and is not confined to the particular types of tubing shown.

In said drawings: Figure 1 shows a fragmentary longitudinal section of one well-known type of flexible tubing, having joints between adjacent turns formed by overlapping and crimping or interlocking adjacent edges. Figs. 2, 3 and 4 are larger-scale detail sectional views of joints in such tubing, Figs. 2 and 3 showing different arrangements or locations of packing strips. Figs. 5 and 6 are fragmentary longitudinal sections of another type of tubing comprising interwound spirals of different wires or rods.

Referring to Figs. 1, 2, 3 and 4, at the first, the tubing there shown comprises a spirally-wound or helically-wound strip or ribbon comprising a core or base 1 of one metal, steel for example, covered with a protective coating 2 of a different metal, such as copper, silver, aluminum, gold, platinum, nickel, cobalt, brass, bronze, aluminum bronze, etc.; such coating 2 preferably weld-united to the base 1, as is the case with material made as described in the Monnot patent previously mentioned. The adjacent edges of adjacent turns of the spiral are overlapped and interlocked, as is common in this class of tubing, and there may be a strip of packing material 3 in the joint, as indicated in Figs. 2 and 3, such packing material being either the same metal as the coating or another metal having a relatively high rate of expansion as compared with the base metal 1, and which is sufficiently soft and ductile to make a good packing; or the packing may be rubber or asbestos or other suitable packing material. The packing may also be introduced at various places in the joint, Fig. 2 indicating one location and Fig. 3 another location. Or, separate packing may be omitted altogether, as illustrated in Fig. 4, reliance being placed on the coating 2 to act as a packing, which it will do because of its relatively greater rate of expansion than the base 1, and because, being limited in expansion longitudinally or parallel to the union between it and the base 1, it will expand the more at right angles to the union, *i. e.*, radially of the tube. In any of these figures 1–4 inclusive, the base 1 may with advantage be of a special grade of steel, such as above mentioned, having a very small rate of expansion or having no expansion whatever with changes of temperature.

In Figs. 5 and 6, illustrating another type of flexible tubing comprising interwound spiral wires or rods, 4 and 5, usually of different sections, as shown, the base-wire, 4, is preferably of coated or clad metal, as shown; and the packing-wire 5 may either be composed of a single metal, preferably the same as that of which the coating of wire 4 is formed, as indicated in Fig. 5, or it may also be composed of a coated or clad metal, as shown in Fig. 6; in which case the base-wire 4 preferably has a less rate of expansion than the packing-wire 5, though this is not absolutely necessary.

In all of the forms of tubing shown, the hard, planished, surfaces of the coating metal, substantially uncorrodible under conditions of ordinary use, make good bearing surfaces permitting the movement of one surface over another necessary for flexibility of the tubing without disturbing the close fit necessary to prevent the escape of the fluid being conveyed through the pipe, and without material wear; and as previously explained, with changes of temperature the said coating metal expands or contracts so as to maintain close fit between the contacting surfaces. The coating metal may in fact, be so thin as to be practically a mere film, and yet serve to make good bearings and good joints between adjacent turns and to protect the base metal against attack.

I do not regard electro-deposited coatings as the substantial equivalent, for the purpose of my invention, of coatings weld-united to the base metal as are, for example, the coatings of clad metals produced by said Monnot process, for electro-deposited coatings and the like are invariably crystalline, porous, weak, and tend to strip off readily being merely adherent to the base, and not coherent. They may indeed be worse than useless, because tending, under conditions of use, to set up local galvanic action between the coating and the metal beneath. Such is not the case with impervious coherent coatings as produced, for example, by said Monnot process.

What I claim is:

1. Flexible metallic tubing comprising spiral coils of one metal having between abutting faces a layer of another kind of metal having a different rate of expansion, said layer being welded to one of said abutting faces and said abutting faces being free to move relative to each other.

2. Flexible metallic tubing comprising spiral coils of one metal having between them and united to them layers of another metal having a different rate of expansion.

3. Flexible metallic tubing comprising spiral coils of clad metal comprising a base of strong metal inseparably united to a coating of a softer metal, the coatings of adjacent turns in substantial contact, and forming bearing-surfaces.

4. Flexible metallic tubing comprising a spirally-wound strip of one metal, adjacent edges of adjacent turns of such strip interlocked, and a packing consisting of a metal of higher rate of expansion than said strip, included in the joint formed by such interlocked edges, said packing metal in contact with both layers of the metal of the joint.

5. Flexible metallic tubing comprising a spirally-wound strip of ferrous metal having an inseparably-united coating of another metal having a higher rate of expansion, the coatings of adjacent turns in substantial contact, and forming bearing surfaces and welded to the metal of said strip.

6. Flexible metallic tubing comprising a spirally-wound strip of ferrous metal having an inseparably-united coating of another metal having a higher rate of expansion, the coatings of adjacent turns in substantial contact, and a packing strip of the same metal as said coating between such coatings.

7. Flexible metallic tubing comprising a spirally-wound strip of ferrous metal having an inseparably-united welded-on coating of a softer metal, the coatings of adjacent turns in substantial contact, and forming bearing surfaces.

In testimony whereof I affix my signature in the presence of two witnesses.

BYRON E. ELDRED

Witnesses:

K. P. McElroy,

H. M. Marble.