March 20, 1945. F. W. LIVERMONT 2,371,900

CLOSURE CAP

Filed March 9, 1942

Fig. 1

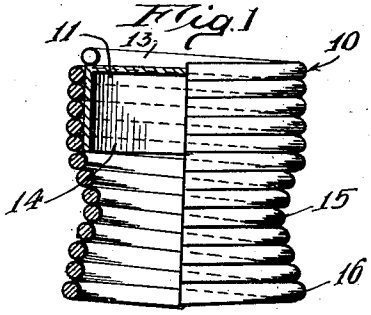


Fig. 2

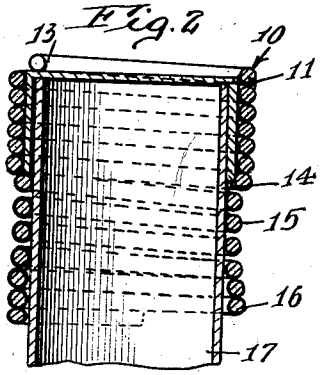


Fig. 3

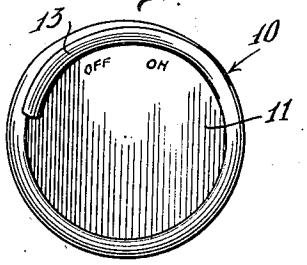


Fig. 4

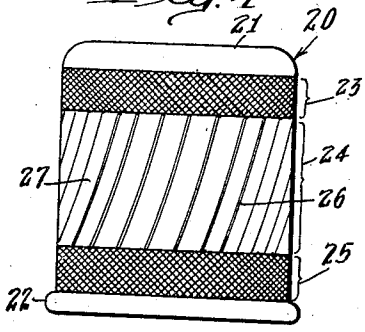


Fig. 5

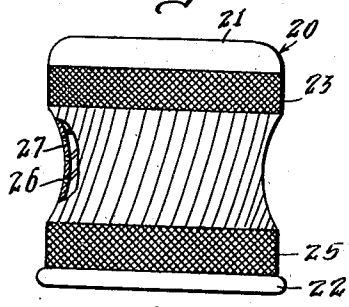


Fig. 6

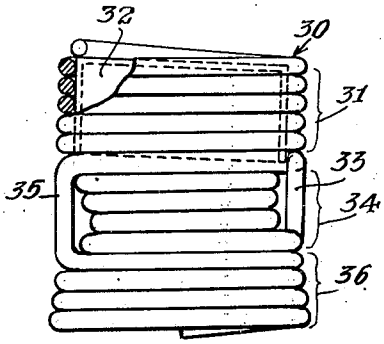
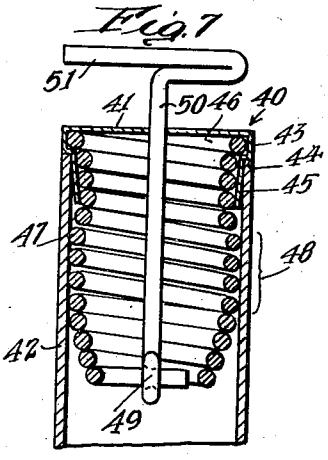


Fig. 7



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UNITED STATES PATENT OFFICE

2,371,900

CLOSURE CAP

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Application March 9, 1942, Serial No. 433,841

3 Claims. (Cl. 220—42)

This invention relates to closure caps for tubing, and the like, and particularly to friction caps for smooth-ended tubing as distinct from caps for tubes having threads or other special devices for locking with the cap.

A broad object of the invention is to provide a simple, inexpensive and easily manipulated friction cap.

Another object is to provide a cap capable of firmly, frictionally engaging a smooth tube without marring or defacing the tubing, and without danger of the cap being accidentally sucked or forced into the tubing.

In certain industries, such as the airplane manufacturing industry, large amounts of soft metal tubing, such as aluminum tubing, are employed for pressure lines and conduits. It is very important that this tubing, which is clean at the time of manufacture, be protected against the entry of dust or foreign matter between the time it leaves the tube department and the time it is completely installed. It has been the practice, therefore, to provide some sort of temporary closure for the open ends of all tubing while it is being transported and installed. Some tubing is provided with threaded ends, or with special connectors, and various types of caps have been developed for keeping dirt out of such tubing. However, a large amount of tubing used has plain, smooth ends to which it is more difficult to attach a closure member. In fact the only closure members that have heretofore been commercially used on smooth-ended tubing, are rubber plugs, caps, and cellulose film. Such devices, however, have the serious objection that they are sometimes drawn into the tubing by suction applied thereto during installation, and remain in the tubing to cause trouble later on, or are fragile to the extent of offering no protection against damage to the ends of tubing.

In accordance with the present invention, I provide a closure cap capable of being firmly attached to a smooth-ended tube by a metallic coil spring side wall that presses firmly against the tube and retains an end member against the open end of the tube. This device is free from the mentioned defect of rubber caps, plugs, and cellulose film without having any serious new objectionable features. It has the further advantage over rubber caps and cellulose film of affording better mechanical protection to the outer surface of the tubing.

Other objects and features of the invention will appear from the detailed description to follow of certain preferred embodiments of the invention illustrated in the drawing.

In the drawing:

Fig. 1 is a view partly in elevation and partly in section of one embodiment of the cap, in accordance with my invention;

Fig. 2 is a sectional view, showing the cap of Fig. 1 attached to a tube;

Fig. 3 is a plan view of the cap shown in Fig. 1;

Fig. 4 is a side elevation view of an alternative construction in accordance with the invention, in process of manufacture;

Fig. 5 is a side elevation with a portion broken away, of the device shown in Fig. 4, when manufacture is completed;

Fig. 6 is a side elevation of a third cap in accordance with the invention; and

Fig. 7 is a sectional view of a fourth cap in accordance with the invention, shown attached to a tube.

Referring, first, to Fig. 1, the cap therein disclosed comprises a closely coiled spring wire coil 10 of roughly cylindrical shape containing therewithin a cup-shaped cap 11, the latter being positioned within the upper end of the coil 10 with its open side down.

The upper turn 13 of the coil is extended inwardly against the top wall of the cup 11, as shown in Fig. 3, to prevent the cup from being forced upwardly out of the coil. The cylindrical wall of the cup is also firmly gripped by the upper fixed turns of the coil 10. Immediately below the open edge 14 of the cup 11 the turns of the coil constrict to a smaller diameter and then expand to a larger diameter toward the lower open end of the cap.

The internal diameter of the cup 11 is slightly larger than the external diameter of the tubing on which the cap is to be used, so that it will slip freely over the end of the tubing. The extent to which the coil is constricted below the margin 14 of the cup can vary according to the frictional grip desired.

When the invention is used for closing the ends of soft metal tubes during handling and installation to prevent the entry of dirt or dust, it is desirable that the cap be easily attachable and removable. In such service, when employing a coil 10 of spring steel wire of 14-gauge for use in a cap designed for aluminum tubing ¾ (.750) in. in external diameter, the smallest diameter turn 15 may have an internal diameter of .725 in. and the internal diameter of the cup 11 and the internal diameter of the lower turn 16 may be .800 in. When a cap so dimensioned is at-

tached to the end of ¾ in. tubing 17 (Fig. 2) the lower three turns are larger than the tubing and stand out from it, but the next four turns are contracted about the tubing to grip it. The cap can be forced onto the tubing 17 by pushing it thereover with or without simultaneous screwing motion, since, as will be observed from Fig. 1, the turns are gradually tapered from a maximum diameter at the bottom turn 16 to a minimum diameter at the turn 15. However, it is sometimes necessary to prevent any rubbing, frictional motion between the cap and tubing, and under such conditions my cap is applied to the tubing by gripping the lower, large diameter turns between the fingers of one hand, gripping the upper end of the cap with the fingers of the other hand, and relatively rotating the two ends of the coil in unwinding direction to expand the middle turns, including turn 15, to a diameter larger than the tubing, and slipping the cap into place on the tubing while it is so expanded.

After the cap has been positioned on the tubing the lower end of the coil is stretched onto the tubing slightly before being released. This slightly separates the middle turns which grip the tubing 17, causing them to maintain the cup 11 against the open end of the tubing with a slight tension. This tension is increased as much as possible by preloading the coil in the winding process. Methods of winding springs to preload them are well-known in the spring manufacturing art. A particular advantage of preloading in the construction of Figs. 1 and 2 is that it enables the attainment of a substantial force holding the cup 11 against the end of the tubing 17 without employing a large separation between adjacent turns of the coil 10. Large spacings between the turns is objectionable in that it facilitates the accumulation of dirt and foreign matter between the turns.

I have shown in Fig. 4 a cap structure in accordance with the invention that can be completely formed from sheet metal. Thus a thin sheet metal cap 20 of cup-shape having a flat end 21 is formed integrally with a cylindrical side wall, which terminates at the open edge in an external bead 22. The cylindrical wall of the cap comprises three zones 23, 24 and 25. The end zones 23 and 25 are imperforate but may be roughened or knurled to facilitate finger engagement therewith. The central zone 24 is perforated by a plurality of steeply helically extending slots 26, which slots divide the metal of zone 24 into a large number of helical strips 27 corresponding in function to the turns of the coil spring in Figs. 1 and 2.

The cap shown in Fig. 4 is of slightly larger diameter than the tubing on which it is to be used. Prior to using the cap, it is distorted by twisting it into hourglass shape, as shown in Fig. 5. Twisting is accomplished by gripping the upper and lower knurled portions 23 and 25 with any suitable tool, or with the fingers, and relatively rotating them in opposite directions. The completed cap shown in Fig. 5 has a smaller internal diameter at its waist than the external diameter of the tubing on which it is to be used. However, it can be applied to the tubing easily by relatively twisting the opposite ends of the cap in the same way as described with reference to Figs. 1 and 2. Of course during the forming of the cap of Fig. 5 the material was twisted beyond its elastic limits, so that it was permanently distorted from the shape shown in Fig. 4; whereas the twist applied during application to or removal from a tube is less, so that there is no permanent deformation of the cap.

There is shown in Fig. 6 a modification of the cap shown in Fig. 1. Whereas in Fig. 1 the coil 10 is wound in a continuous helix from one end to the other, the cap 30 of Fig. 6 consists of three helices rather than one continuous helix. Thus there is an upper helix 31, which grips the cup 32 and is connected at its lower end by a vertically extending section 33 to the lower end of a middle helix 34, which is wound upwardly until its upper coil abuts against the lower coil of the upper helix 31. The uppermost turn of the middle helix 34 is connected by a downwardly extending section 35 to the upper turn of a lower helix 36. The relative internal diameters of the different portions of the coil 30 may be the same as in the coil 10 of Fig. 1, and it can be applied to and removed from a tube by the same manipulation.

An advantage of the construction shown in Fig. 6 is that a force tending to pull the cap off a tube tends to compress the turns of the middle helix 34 against each other instead of separating them, thereby increasing the holding ability of the cap.

The three constructions so far described are adapted to lock against the exterior surface of the tubing. In a modification of the invention, the gripping portion is inserted within the tubing, as shown in Fig. 7. In this construction the closure cap 40 has an end wall 41 of diameter substantially equal to the external diameter of the tubing 42 with which the device is to be used, and merges into a short cylindrical section 43 of the same external diameter. At its lower edge the cylindrical section 43 extends inwardly, defining a flat annular shoulder 44 adapted to fit against the end of the tubing 42. The inner edge of the shoulder 44 merges into the upper end of an inwardly tapered skirt 45 of smaller diameter than the internal diameter of the tubing 42.

The end wall 41, the cylindrical section 43, and the shoulder 44 define an internal groove which receives the upper coil 46 of a spring retaining member 47, which extends inside the tubing 42 and engages therewith. The member 47 is of relatively small diameter within the skirt 45, but the coils become progressively larger below the skirt so that they bear against and frictionally engage the inner surface of the tubing for a length of about four turns, in a zone 48. Below the zone 48, the coils become progressively smaller in diameter, to facilitate the entry of the device into the end of the tubing.

In the particular embodiment shown in Fig. 7, the end of the lowest coil is extended diametrically through an eye 49 formed in the lower end of a rod 50, which is extended axially up through the member 47 and through a snugly fitting hole in the end member 41. Beyond the member 41 the rod is bent to define a handle 51.

The closure device shown in Fig. 7 can be readily placed in position by pressing the handle 51 downwardly relative to the closure cap 40. This elongates the spring member 47 and contracts it radially, so that it can freely enter the tubing until the shoulder 44 engages against the end of the tubing. Thereafter the handle 51 is released permitting the spring member to contract longitudinally and expand radially into engagement with the tubing. The coils in the zone 48 will expand into engagement with the tubing before longitudinal contraction of the spring mem-

ber is completed, thereby maintaining the shoulder **44** firmly against the end of the tubing.

It is also possible to radially contract the spring member **47** for insertion of the device into the tubing by relatively rotating the handle **51** relative to the cap **40** in such direction as to tighten the spring. When the handle is released, the spring then expands to snugly engage the inner surface of the tubing.

It is also possible to insert the spring member **47** into the tubing by simply pressing on the cap **40**, with or without a simultaneous rotary motion tending to screw the member **47** into the tubing. When the device is intended for insertion in this manner the rod **50** can be eliminated and the end wall **41** may be imperforate.

It will be apparent that the constructions described are particularly adapted for protecting the smooth ends of tubing during handling and installation because they lock to the tubing with sufficient force to prevent accidental removal and yet cannot possibly be withdrawn into the tubing by suction therein, as sometimes occurs with rubber caps. Furthermore, it is feasible to form the coils of smooth plated spring wire so that there can be no scratching of the surface of the tubing even if the device is forced on and off the tubing, instead of being expanded (by relative rotation of the opposite ends) prior to attachment and removal.

Although the invention is particularly useful for closing the ends of tubing during transportation and installation, it is by no means limited to such uses, and it may be employed as a closure member or stopper for bottles and other containers, if desired. When so used the neck of the bottle can, if desired, be provided with an annular corrugation or shoulder cooperating with the gripping portion of the cap to help hold the cap against removal.

I claim:

1. A closure cap for covering and sealing the end of a tubular member, said cap comprising: an end section adapted to fit against and close the end of the tubular member, and a lower section connected at one end to the rim of said end section and adapted to enclose and grip the peripheral surface of the tubular member to retain said end section in position, said lower section consisting of helically extending resilient elements tapering in diameter from a large diameter at the open end thereof to a smaller diameter intermediate the ends, to form a gripping section having a portion of a diameter less than the diameter of the tubular member whereby the resilient elements making up the said portion of lesser diameter act to grip the peripheral surface of the tubular member to retain the closure cap in position.

2. A closure cap as described in claim 1, in which said lower member is of larger internal diameter than the external diameter of said tubular member at its open end and is normally of smaller internal diameter at its midportion than the external diameter of the tubular member.

3. A sheet metal cap comprising: a circular end wall connected at its rim to an approximately cylindrical wall, in which a portion of said cylindrical wall is divided by helical slots into radially yieldable helical strips, and said portion varies in diameter from a large diameter at its ends to a smaller diameter at its mid portion.

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