United States Patent

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[31] **12504/67**

[54] **METHOD AND DEVICE FOR DRAWING METAL CUPS TO CAN BODIES**
7 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** 72/45, 72/349, 72/370
[51] **Int. Cl.** **B21b 45/02**, B21b 17/02, B21d 22/28
[50] **Field of Search** 72/41, 43, 44, 45, 224, 225, 226, 227, 347, 348, 349, 370, 236; 138/177

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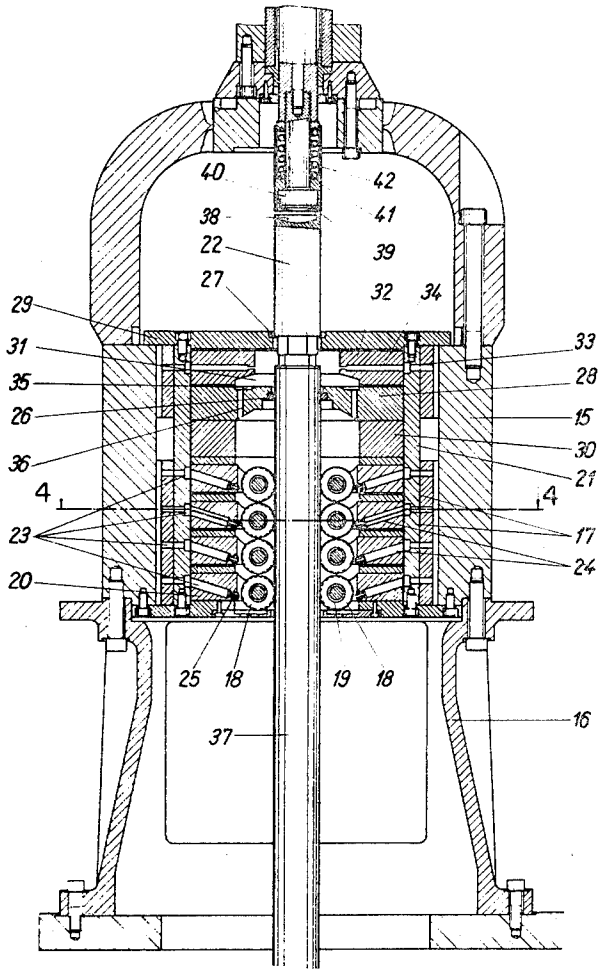
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Assistant Examiner—E. M. Combs
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ABSTRACT: A method for drawing metal cups to can bodies has the steps of drawing the cups through several roll collars while spraying a lubricant in such a way that it lubricates the roll surfaces, the can body and the roll bearings, and also cools, and flushes fine substances. The device for the method has roll collars, a mandrel, ducts connected to a source of lubricant, and orifices for directing the lubricant in spray jets.



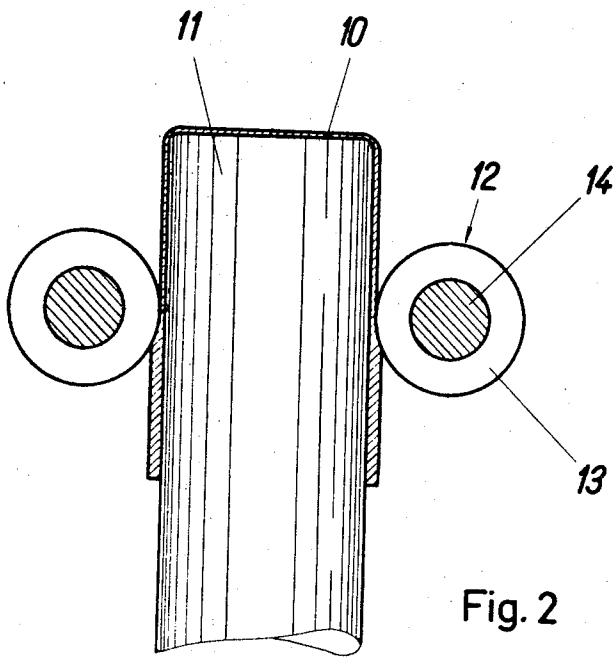


Fig. 2

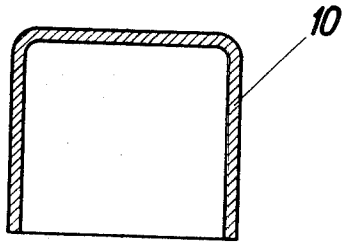


Fig. 1

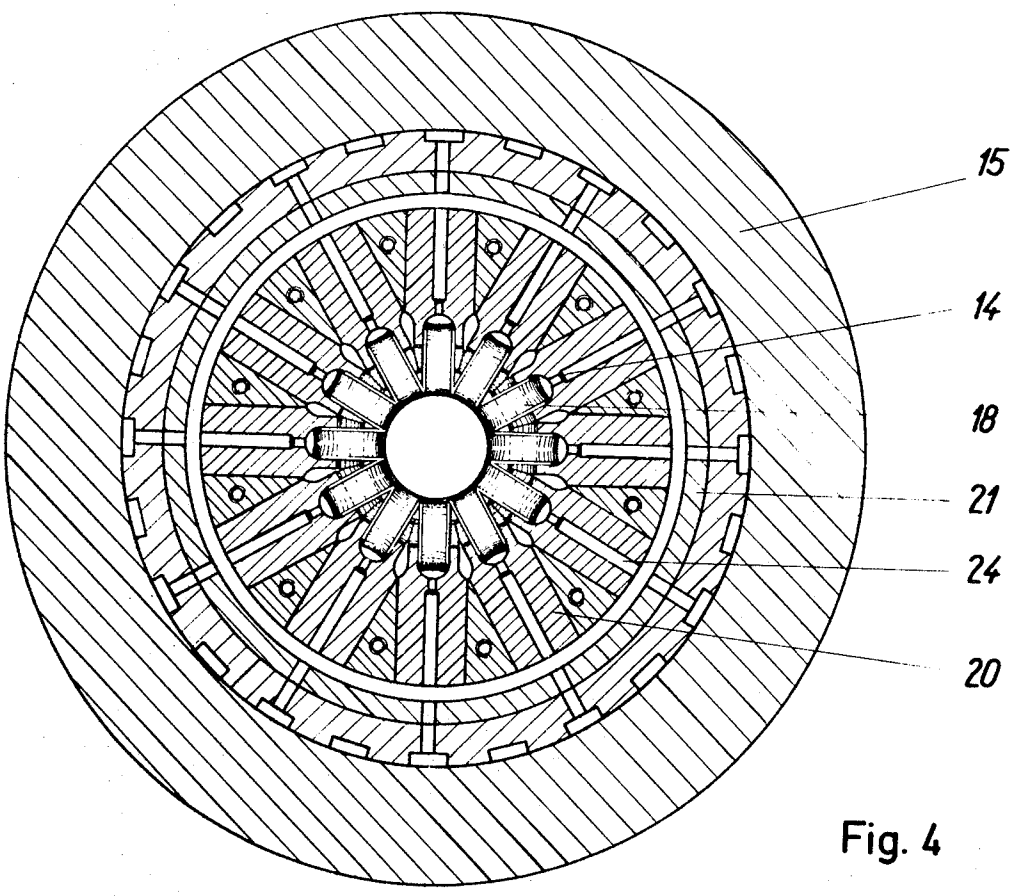


Fig. 4

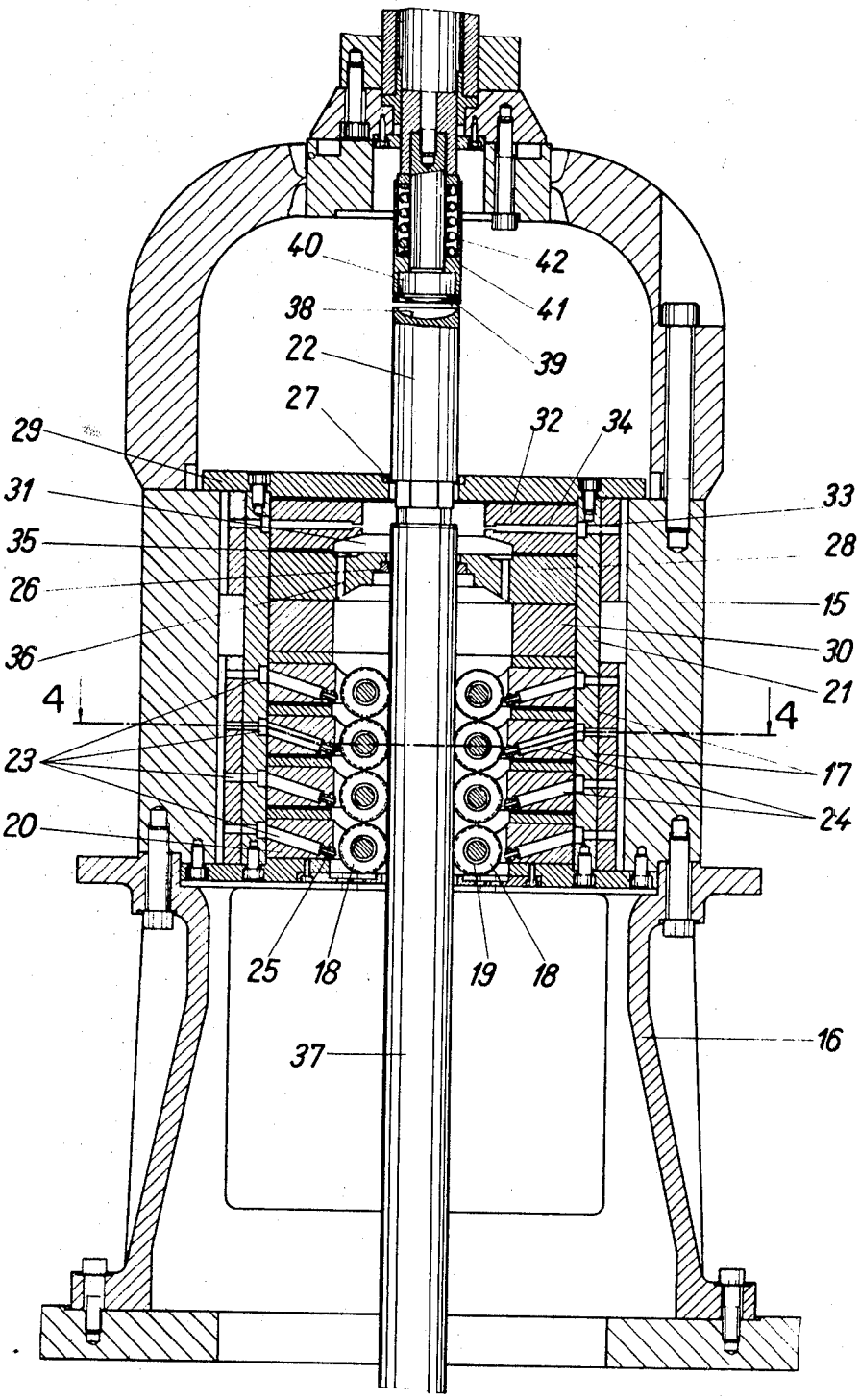

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Fig. 3

METHOD AND DEVICE FOR DRAWING METAL CUPS TO CAN BODIES

The present invention relates to a method for drawing metal cups to can bodies and to a device for carrying out the method.

Tinplate can bodies are generally made by rolling up a blank of tinplate to a hollow cylinder, soldering the abutting longitudinal edges and securing a bottom. Attempts have, however, been made to produce seamless can bodies by roll-bond methods; the bottom, nevertheless, still needed to be secured separately.

In the field of the manufacture of can bodies, aluminum and its alloys are of increasing importance, as the bodies made from them present substantial advantages over the bodies made from tinplate; the advantages include: light weight, absence of rusting danger, many possibilities of opening without use of any special tool, and so on. A great advantage of the light metal can bodies is that they can be made by deep drawing or impact extrusion in one piece and seamless; there remains only the operation to affix the cover in a convenient manner, for instance by a folding border and a sealing ring, or by means of an adhesive, and so on.

For the manufacture of light-metal can bodies one uses generally unalloyed aluminum sheet. The can bodies made therefrom have usually a wall thickness of from 0.2 to 0.5 mm.; for "aerosol" cans a thicker wall is needed, for instance of 0.8 mm. In competition with tin cans it would be necessary in several cases to use an aluminum sheet of such a great thickness for obtaining the same buckling strength that the aluminum can would not be competitive because of its price.

A higher buckling strength may be obtained by using an aluminum alloy instead of unalloyed aluminum, as the alloys have a higher mechanical strength. Then it would be possible to make the wall thinner, so that the cost of the can would be lowered and it would be possible to complete with the tinplate can.

The aluminum alloys AlMg2,* AlMg2,** AlMn with 1.5% Mn*** and AlMnMg with 1% Mn and 1% Mg****

* AA No. 5009 and 5051.
** AA No. 5252. 5452. 5852.
*** AA No. 3003.
**** AA No. 3004.

could be taken into consideration. In the cold worked state these alloys have a tensile strength which surpasses substantially that of cold worked unalloyed aluminum. The aforementioned alloys are composed of aluminum with a low content of alloying elements; in contrast to the alloys AlMgSi,* AlCuMg** and AlZnMg*** for instance, they can

* AA 6000 – Series.
** AA 2000 – Series.
*** AA 7000 – Series.

be hardened only by cold working, but not by heat treatment (solution annealing, quenching and natural or artificial aging); the manufacture of can bodies from heat-treatable alloys is possible, but the necessary heat treatment makes the manufacture more difficult and more expensive.

According to known deep drawing methods for making thin-walled aluminum cans, two successive operational steps are carried out, namely the forming of a cup from a disc by deep drawing and immediately afterwards and in the same machine the thinning of the wall by drawing the formed cup through a number of lubricated dies. According to that method it is possible to make at most 50 to about 100 can bodies from unalloyed aluminum per minute. This method applied to the manufacture of can bodies from aluminum alloys has not until now yielded any satisfactory result.

The difficulties encountered with the last method are caused chiefly by the friction and the heat developed in the drawing dies; after several drawing operations a localization of heat takes place, and the lubricant film becomes ruptured. Furthermore, the method is very much influenced by small variations of the quality of the discs, for instance of their thickness, of the grain size of the sheet of the disc and of its

texture. Finally, the mentioned method is only applicable to the working of unalloyed aluminum, without regard to the fact that when cans are made from aluminum with a low content of alloying elements, for example from the alloy $AlMg_2$ or $AlMg_3$, it is desirable, for the aforementioned reasons of economics, to decrease further the wall thickness of the finished cans.

Numerous attempts have shown that the manufacture of seamless can bodies in one piece from aluminum with a low content of alloying elements ($AlMg_3$ for instance) cannot be carried out according to most of the usual methods of deep drawing.

During the reduction of the thickness by drawing through one or several dies the material becomes brittle in consequence of excessive cold working and the wall of the can body tears. Theoretically it would be possible to avoid brittleness by means of one or more intermediate annealings, but such a complicated method is not any more practical than hot drawing.

It is accordingly among the principal objects of the invention to provide a method and a machine for making one-piece metal cups which avoid the drawbacks of the prior art.

Further objects and advantages of the invention will be set forth in part in the following specification and in part will be obvious therefrom without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

According to the invention the difficulties of manufacturing can bodies from aluminum alloys are overcome by substituting a rolling operation for the drawing operation, in which rolling operation the tool surfaces which reduce the wall thickness move in the same direction as the can wall to be drawn, so that no substantial reciprocal movement takes place between the wall of the can body and the surface of the tool. The rolling operation may be completed by the usual drawing operation (through drawing dies).

The method according to the invention comprises drawing (elongating) metal cups, for instance of aluminum or preferably of aluminum alloys, by means of a number of drawing-roll collars and a drawing mandrel, while spraying a diluted lubricant preferably an emulsion of oil in water, in such a manner against the periphery of the drawing rolls that the diluted lubricant does not only lubricate the outer forming surface (periphery) of the rolls and the outer surface of the hollow body to be drawn, but also has a cooling effect and flushes away fine wear particles and other substances.

The "roll collar" or "drawing-roll collar" is an annular tool comprising a series of separately mechanically adjusted rolls acting radially against a mandrel on which a hollow body is pushed through the rolls. The periphery of the rolls is concave in order to fit to the convexity of the hollow body to be drawn. Such a roll collar is represented, for instance, in FIG. 9 of U.S. Pat. No. 2,361,318 and in FIG. 4 of the present application.

Emulsions of from about 2 to about 10 percent by volume of oil in water have been found to be advantageous as lubricant for the instant purpose.

According to a preferred embodiment the lubricant is directed in form of jets against the rolls under such an angle that the rolls are put in motion in that sense of rotation which corresponds to the direction of movement of the can body during drawing; the jets must therefore impinge excentrically on the roll periphery.

It is known to reduce the wall thickness of relatively thick-walled tubes by means of one or more roll collars. For instance, the German Pat. No. 890,937 shows a drawing-roll collar for the cold drawing of tubes which comprises three or preferably four rolls of small diameter resting upon a corresponding number of supporting rolls of greater diameter. The published German Pat. application No. 1,040,994 describes a similar tool having drawing-roll collars which comprise each five to seven rolls, preferably six rolls. According to the U.S. Pat. No. 2,361,318 a seamless steel tube becomes

stretched through a drawing-roll collar until it has a wall thickness of 13 mm. with an outer diameter of 290 mm.; the ratio of the wall thickness to the outer diameter is therefore about 4.5 percent (4.5 : 100). The number of rolls amounts to eight for each collar and there may be used one to ten or more collars, but preferably two or three.

It seemed from the first rather doubtful whether one would succeed in drawing cups to extremely thin-walled cylindrical cans by means of roll-collars, that is to say by a method which has been applied up to now only for elongating thick-walled tubes.

The difference between iron and steel tubes used for water pipes and so on, on one hand, and can bodies for packing purposes, on the other hand, is extremely great regarding the wall thickness involved. For aluminum-alloy can bodies of a diameter of 50 to 120 mm., for instance, a wall thickness of from about 0.15 to 0.3 mm. may be considered; the ratio of the wall thickness to the outer diameter is therefore about 0.3 to 0.25 percent (0.3—0.25 : 100).

Moreover, the working speed in connection with the can body manufacture exceeds many times that of the steel tube elongating. In the drawing of can bodies the mandrel needs to execute about 1 to 5 reciprocating strokes per second. The working speed of the mandrel amounts therefore to about 100 to 500 meters per minute. The moving direction changes from 120 to 600 times during this period.

Another substantial difference between the elongating of tubes and the drawing of can bodies consists in the fact that tubes are open at both ends whereas can bodies which are drawn from cups have a bottom and are therefore open only at one end. The great importance of this difference will be pointed out further below.

According to the method of the invention, one may elongate by 2 to 4 times cups made not only from aluminum alloys and from unalloyed aluminum, but also from other workable metals, including steel, for manufacturing for instance can bodies with a diameter of from about 50 to about 100 mm. and a length of from about 100 to about 350 mm.

The instant invention is particularly suited for the manufacture of can bodies for beer cans (length 140 mm.), food cans (length 120 mm.) and "aerosol" cans (length at present up to 340 mm.) from aluminum alloys.

When carrying out the method according to the invention the initial wall thickness of the cylindrical part amounts at the most to 3 percent of the inner diameter of the hollow body; but preferably to 1.5 percent or less.

The device or machine for carrying out the method according to the invention includes several drawing-roll collars, a drawing mandrel known per se and lubrication ducts, the discharge orifice of which being directed against the forming surface (periphery) of the rolls and which are connected to a source of lubricant under pressure; the device is preferably disposed vertically, the free end of the mandrel being directed upwardly.

The equipment for supplying the cups and for stripping off the elongated can bodies by means of compressed air or other compressed gas or mechanically is of conventional construction; likewise conventional is the counterpunch with which the device is preferably equipped and the purpose of which is chiefly to form the bottom of the can body to the desired shape respectively to provide a stamping or a protruding plug.

In contrast to the known machines for stretching relatively thick-walled tubes, the ratio of the diameter of the rolls of the device according to the invention relative to the wall thickness of the hollow body, is of great importance if a counterpunch is used: as the can bodies have a bottom which, during the elongating operation or better just after the same, will be shaped for instance vaulted or stamped in the device.

The bottom of the can body must therefore remain in contact with the front end of the mandrel, as the latter together with the counterpunch must serve as a forming, respectively stamping tool. Any forward slipping of the bottom of the can body must be avoided during drawing (elongating) and the bottom of the body must not be loosened from the front end of the mandrel. Otherwise it would not be possible to carry out the desired forming respectively stamping, and the bottom would become squashed in consequence of the resulting cavity. When stretching steel tubes and the like, this problem does not arise and a possible forward slipping of the hollow body there would not disturb the operation.

According to a further embodiment of the invention, the forward slipping is avoided by choosing accurately the diameter of the rolls relative to the wall thickness of the hollow bodies. The diameter of the rolls must not be smaller than 50 times the final wall thickness of the can body and not larger than 300 times; it is preferably from 100 to 250 times larger than the rolled wall thickness. For instance, when manufacturing can bodies from aluminum alloy with a wall thickness of 0.15 to 0.3 mm. (the diameter of the can being 50 to 120 mm. for example), one uses suitably rolls of a diameter of from 15 to 80 mm. The diameter of the rolls does not depend on the diameter of the can body. For a wall thickness of 0.2 to 0.5 mm. the diameter of the rolls is preferably from 45 to 50 mm.; for a wall thickness of 0.8 mm., for instance, one could get along with a roll diameter of 60 mm., but one should manage for a smaller reduction in thickness in each roll collar, because too great a reduction leads to the formation of too great fins. Accordingly, one must take in constructing the device for carrying out the method according to the invention that the rolls have a diameter of 50 to 300 times, preferably of 100 to 250 times the smallest clearance between the roll periphery and the surface of the mandrel, the said clearance being substantially uniform on the whole circumference of the mandrel.

It may be advantageous to diminish the roll diameter from one roll collar to the next in the drawing direction.

When reducing the wall thickness of a cylindrical hollow body, ribs (fins) are formed between the rolls of the drawing tool in the drawing direction. This involves the necessity in the manufacture of hollow bodies having a smooth surface to use at least two roll collars, the rolls of them being offset from one collar to the other in such a way that at the passage through the second roll collar the fins formed by the first collar are flattened out. The clearance between two laterally adjacent rolls should be as small as practicable so that the formed fins are as small as possible. The clearance should be less than 0.3 mm., preferably 0.2 mm. or less.

Generally, the wall thickness will not be reduced as much as desired in the first roll collar. Therefore, the second roll collar must not only suppress the fins produced by the first one, but also reduce the thickness of the remainder of the wall. In this case a third roll collar is necessary or at least desirable, the purpose of which is again as well to flatten the fins as to reduce further the wall thickness. The number of the roll collars may exceed four and may amount, for instance, to 10. The number of roll collars should only be as large as absolutely necessary, as the difficulties of construction increase with the number of the roll collars because of the length of the stroke of the mandrel; the mandrel performing the drawing must pickup the cup at the inlet of the drawing device and project beyond the other end of the drawing device far enough so that the drawn hollow body may be removed easily. For the manufacture of beer cans of a height of about 140 mm. and a diameter of 65 mm., the mandrel must have a stroke of 650 mm.

In order to obtain the final smoothing of the can body before leaving the drawing device it is suitable, but not indispensable, to dispose near the outlet of the device instead of a roll collar one or more normal drawing dies, for instance self-centering dies, with polished working surface.

Thorough investigations have shown that for the drawing of can bodies each roll collar must have at least 10 rolls, preferably 12 or more. Generally one would, for the same precision of the surface of the rolls and for the same material of the hollow body, choose a number of rolls that increases with a decrease in the ratio of the wall thickness relative to the diameter of the hollow body. For instance, a roll collar for the manufacture of cans of an aluminum-magnesium alloy con-

taining about 2 percent Mg with a wall thickness of 0.2 mm. and a diameter of 65 mm. is provided according to the invention with from 12 to 18 rolls.

Considering the extremely thin wall of the drawn can body (for instance 0.2 to 0.3 mm.) one realizes immediately that extremely great emphasis must be put on the precision of the guiding of the mandrel, which cannot be compared with the guiding of a mandrel while stretching relatively thick-walled tubes, for example of iron or steel.

The known machines with roll collars for stretching tubes are disposed horizontally. Also most devices for drawing can bodies are disposed horizontally. However, the tests and research which led to the construction of the can-body drawing-device according to the invention have shown that the new device should preferably be disposed vertically or almost vertically, as otherwise the long shaft of the mandrel, due to its own weight, would have the tendency to be bent against the lower drawing rolls. Although such a deflection can be kept extremely small, the difference of wall thickness (in cross section through the can body) caused by the deflection may nevertheless be important because of the extreme thinness of the wall. These considerations also militate against an inclined mounting of the device.

When mounted vertically or substantially vertically, the drawing device can be disposed either in such a way that the mandrel pushes the cup downwards through the roll collars, and the can body leaves the tool at the bottom, or in such a way that the mandrel pushes the cup upwards. The last disposition is by far the most advantageous because of the lubricating according to the invention.

Thorough tests have proved that sliding bearings are poorly suitable for the rolls of the device according to the invention, and only roller bearings are adequate. Needle bearings are preferred, because of the space available for the bearings is small.

In one and the same collar the rolls need not all have the same thickness. The ring may, if desired, be equipped with alternating thin and thick rolls.

The outlet diameter of the lubricant ducts, which are directed against the periphery of the rolls, must be so narrow that the diluted lubricant under the applied pressure impinges with a strong jet on the rolls. The speed of the lubricant jet may be 15 to 20 meters per second with an emulsion of oil in water under an atmospheric excess pressure of 2 to 5 and a lubricant duct outlet diameter of about 1 mm.

If the lubricant jets impinge eccentrically on the periphery of the freely rotating rolls, the latter get a supplementary propulsion that makes possible a considerable increase of the number of strokes.

The instant lubricating system favors the instant vertical arrangement of the machine. If the device had instead a horizontal or an inclined position, the unilateral flow of the lubricant would have the troublesome consequence that dirt would enter temporarily the bearings of the rolls of the different collars and would disturb the operation; the high working speed of the device and the extreme thinness of the can body wall could not tolerate such disturbances. Also this problem does not arise with the known stretching of tubes by means of roll-collars. With the method according to the invention, however, the mentioned danger of disturbances is a further ground for the preferred choice of the substantially vertical disposition of the device.

Furthermore, the lubricating system according to the invention is best suited for the arrangement where the vertical mandrel pushes the hollow body upwards. The lubricant which streams in the drawing device will be collected at the bottom, filtered and put again into circulation. If the can bodies would leave the drawing device at the bottom, they would carry away a part of the streaming lubricant, as one should strip them away with the bottom down; there would result a serious disturbance of the lubricant circulation, besides the greater difficulty in ejecting the elongated can bodies.

With the device according to the invention the stripping of the can bodies is done in a known manner either by compressed air supplied to the mandrel through a longitudinal bore hole, or mechanically; then the can bodies are suitably blown away in a known manner by a lateral air jet.

In the drawings,

FIG. **1** is vertical sectional view of a cup (from which the can body will be produced);

FIG. **2** is a fragmentary sectional view showing the cup of FIG. **1** being operated on;

FIG. **3** is vertical sectional view of a machine for producing a can body from the cup of FIG. **1**; and

FIG. **4** is a sectional view taken on the line **4–4** of FIG. **3**.

The cup **10** according to FIG. **1** is obtained by deep drawing or by any other method. According to the invention the cup is pushed by means of a mandrel **11** (FIG. **2**) through one or more roll collars **12**, whereby its wall becomes stretched and thinned; the drawing tool represented schematically comprises substantially a collar of rolls **13** and trunnions **14**.

The device according to FIGS. **3** and **4** comprises four superposed roll collars **17** in a housing **15** resting on a base **16**. The roll collars **17** are each provided with twelve forming rolls **18** rotating on needle bearings **19**. The supports **20** lean against the cylinder wall **21** without clearance. The distance of the periphery of the rolls **18**, that is to say of their forming surface, to the mandrel **22** is, for instance, 0.45 mm. at the lower roll collar. This distance diminishes from collar to collar and is at the upper collar for instance only 0.25 mm. In this case the wall thickness of the cup will be reduced for instance from 0.6 mm. to 0.25 mm.

The ring conduits **23** serve to supply lubricant to the bore holes **24**, which operate as lubricant ducts. The orifices of the lubricant ducts have nozzles **25** which are directed eccentrically against the rolls **18**. The splashing lubricant thus not only lubricates the forming surfaces of the rolls, the outer surface of the body to be drawn and the bearings **19** of the rolls, effects a cooling, and flushes away fins and other dirt, but also that there will be rotated the rolls **18** in such a way that their forming surface moves upward at the side facing the mandrel **22**.

For the final smoothing of the outer surface of the can body two usual drawing dies **26** and **27** are shrunk in bushings **28** or **29** over the roll collars **17**. The intermediate ring **30** is not absolutely necessary; it enables the subsequent mounting of a further roll collar or a further drawing die. The enlarged space **31** at the inner lower part of the lubrication ring duct **32** serves to collect lubricant sprayed through the ring duct **33** and the bore holes **34** against the surface of the can body; the collected lubricant flows through the ring like recess **35** and the bore holes **36** into the inside of the drawing device.

The drawing mandrel **22** is screwed into the upper end of the shaft **37** which is operated by a drive disposed underneath (not shown). It is provided with a recess **38** which in cooperation with the bottom face **39** of the counterpunch **40** imparts to the bottom of the can body the desired vaulted shape.

In this example, the counterpunch **40** is driven in a known manner; a coil spring would be sufficient. A down holder **41** bears elastically on the coil spring **42**. When the tool ends **38** and **39** meet one another, the pressure deforms the bottom of the can bodies as desired.

The lateral supply of compressed air for blowing away the can bodies after stripping from the mandrel **22**, and the drive of the shaft **37**, are well known and hence not shown.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. A method for drawing can bodies from metal cups, comprising the steps of placing a cup over a mandrel and forcing it upwardly through several drawing-roll collars, each collar being provided with a plurality of forming rolls, while directing a pressurized diluted lubricant spray in jets eccentrically or

tangentially against the periphery of the rolls of each collar and putting them in motion in that sense of rotation which corresponds to the direction of movement of the can body during drawing, whereby the forming rolls of each collar receive additional propulsion by the eccentrically applied lubricant spray, and the forming surfaces of said rolls, the outer surfaces of the can body to be drawn, and the roll bearings are cleaned, cooled, and lubricated.

2. A substantially vertically disposed device for drawing can bodies from metal cups, said device comprising at least two drawing-roll collars, each collar being provided with a plurality of forming rolls, said collars being pivoted on needle bearings, a mandrel having an upwardly directed front surface, a plurality of ducts having orifices and being connected to a source of lubricant under pressure, the orifices of said ducts being arranged o direct jets of pressurized lubricant eccentrically or tangentially against the peripheries of the rolls of each collar for putting the rolls in motion in that sense of rotation which corresponds to the direction of the can body during drawing, whereby the forming rolls of each collar receive additional propulsion by the eccentrically applied lubricant spray, and the forming surfaces of said rolls, the outer surfaces of the can body to be drawn, and the roll bearings are cleaned, cooled, and lubricated.

3. A device according to claim 2, the diameter of the rolls being from 50 to 300 times the smallest uniform clearance between the periphery of the rolls and the surface of the mandrel.

4. A device according to claim 2, the diameter of the rolls being from 100 to 250 the smallest uniform clearance between the periphery of the rolls and the surface of the mandrel.

5. A device according to claim 2, each drawing-roll collar carrying at least 10 rolls.

6. A device according to claim 2, each drawing-roll collar carrying from 12 to 18 rolls.

7. A device according to claim 2, comprising at least one drawing die through which the can body is pushed at the termination of the elongation of said body.