

CUFFED CONNECTION SYSTEM FOR DUCTS AND TUBULAR MEMBERS

This invention relates to apparatus suitable for transferring materials. More particularly the invention relates to components and assemblies whereby a flexible connection as a duct, passageway or the like ("duct") is or can be provided and be retained between components for a transfer of material or materials from one component or the other.

By way of example, component to component transfer can involve transfer of particulate materials under pressure, under vacuum, under gravity, or assisted by gravity, from a hopper or the like storage or accumulation vessel via a flexible duct to a conveyor, processing apparatus or plant or to a container. By way of further example, the transfer of particulate materials (whether a powder, granules, prills or other agglomerations) can be moved from a collection or the like vessel or hopper via a flexible connection (with or without the assistance of gravity or gas movement) to a receiving component, plant or the like. In the dairy industry for instance, milk, casein or other powders are to be transferred from a hopper to a downstream apparatus where the treating apparatus or the hopper is subject to vibration. In such a situation the flexible duct as a coupler leads to allows a reduction in the transfer of any vibration from one component to the other. This can be important to avoid damage, errors in weighing, etc.

It is currently known to hose clamp top and bottom such flexible ducts in a hose like manner about a discharge and/or receive tube. Such flexible ducts or hoses are made of many types of different material depending on the function they are to serve. They can primarily or solely be of a plastics material e.g. polyester, TEFLON™, KEVLAR™, or the like. They can be a fabric (synthetic or natural). They can be some combination of the foregoing.

Frequently such transfers are solely or partially under the effect of gravity or the like. There can be an input of vibration to assist discharge and/or movement. In some situations there can be gas or air entrainment. There can even be some gravity and/or vibrational assistance to any such air or gas entrainment system.

There is however a difficulty with traditional systems that use an encircling hose clamp about a rigid discharge or receiving tube as this leads to crevices that readily lend themselves to the trapping of materials. In the case of an industry such as the food industry (e.g. dairy included) or pharmaceuticals such capture can give rise to hygiene difficulties particularly if not cleaned regularly. The need to remove and replace a hose clamp makes such regular cleaning cumbersome.

The present invention envisages an alternative to such systems where as one connection between a flexible coupling tube or duct and a tube of, or for, component from or to which it is a duct, there is provided a snap lock arrangement reliant upon banding or ferruling at an end region (e.g. cuff) of the flexible tube or duct and a complementary recessed feature the tube of, or

for, the component. Such a recessed feature preferably is a rolled ferrule recess to locate the preferably double beaded seal of the flexible tube.

It is envisaged that it is possible with such a cuff or the like snap locking feature that there can be a reduction in crevices owing to a more flush relationship in the connected passageways and/or a greater likelihood of regular cleaning owing to the snap fit arrangement.

In an aspect the invention is, **as part of a particulate solids transport system, an assembly of or having an inter-engagement between a first tube and a second tube partly nested within the first tube,**

wherein the second tube is a flexible tube with an end region annularly supported by a band or cuff,

and wherein the first tube has its end region provided with an annularly profiled set out,

and wherein each of (a) the band or cuff and (b) the annularly profiled set out has at least one annular rib directed to the other, and at least one of (a) and (b) has two such ribs so as to have the rib of one engagingly flanked by ribs of the other,

and wherein the band or cuff is resilient so as to be deformable inwardly of its tube axis to facilitate insertion or removal of the flexible tube from the first tube but with sufficient return bias to or towards a more relaxed condition such that the rib between two rib engagement holds the tubes against axial separation.

Preferably the two ribs are part of said band or cuff.

Preferably a resilient cylindrical ring underlies a profiled ring that provides the ribs of the band or cuff.

Preferably a fold back of a flexible sleeve of the second tube encloses said profiled ring and cylindrical ring.

Preferably the set out of the first tube has been roll formed.

Preferably the inner surface of the non-set out region of the first tube and the inner surface of the second tube are in alignment and are at least substantially flush one with the other.

In another aspect the invention is **a said first tube and/or a said second tube.**

In an aspect the invention is, **in, as part of, or for apparatus to discharge, or to receive a discharge, of a particulate material, a tube, conduit, duct or the like** adapted by a profiled zone, band or ferrule recessed to the inside to receive a complementary resilient zone, band or ferrule of a flexible tube, conduit, duct or the like.

Preferably there are two annular grooves, each to locate a ridge of the cuff of the connector.

Preferably said tube, conduit, duct or the like is a first tube as defined above.

Preferably profiled zone, band or ferrule is a roll formed feature.

Preferably said roll formed feature is its adaption to locate a double beaded seal (i.e. a cuff or other end modification outwardly of a flexible tube that has two spaced annular beads, ribs or the like).

5 In an aspect the invention is, **in, as part of, or for apparatus to discharge, or to receive a discharge, of a particulate material, a tube, conduit, duct or the like** adapted by a profiled band or ferrule to the inside to receive a complementary resilient band or ferrule of a flexible tube, conduit, duct or the like ("duct").

Preferably said tube, conduit, duct or the like is a first tube as defined above.

10 Preferably the complementary resilient band requires some inward distortion from which it recovers to allow its fit and hold to the said tube, conduit, duct or the like on its profiled band or ferrule.

Preferably said tube, conduit, duct or the like is a first tube as defined above.

Preferably profiled zone, band or ferrule is a roll formed feature.

15 Preferably said roll formed feature is its adaption to locate a double beaded seal (i.e. a cuff or other end modification outwardly of a flexible tube that has two spaced annular beads, ribs or the like).

Preferably there are two annular grooves, each to locate a ridge of the cuff of the connector.

20 In another aspect the present invention consists in **a tube** having a ducting locus and profiled region within which a resiliently banded or ferruled end region of a flexible tube or duct is to fit, the tube profiled region having

- (i) an annular channel set out from its ducting locus,
- (ii) inwardly directed annular rib set out less than the channel, and
- 25 (iii) an annular set out (rebate or channel) out from that annular rib, feature (iii) being closest to that end of the tube from which the flexible duct is or is to be removeably fixed.

The features (i), (ii) and (iii) preferably are consecutive i.e. without any interposed other profiling features. In alternative forms however there can be some alternative profiling
30 features.

Preferably said tube, conduit, duct or the like is a first tube as defined above.

Preferably profiled zone, band or ferrule is a roll formed feature.

35 Preferably said roll formed feature is its adaption to locate a double beaded seal (i.e. a cuff or other end modification outwardly of a flexible tube that has two spaced annular beads, ribs or the like).

Preferably said tube is at least substantially rigid i.e. preferably is for example stainless steel.

In another aspect the invention is **as, or adapted to be used as, a flexible coupling tube** to duct particulate material from a discharge tube, conduit, duct, port, or the like and/or to
5 a receiving tube, conduit, duct, port or the like,

wherein at least one end region of the tube is resiliently banded or ferruled and has for that banded or ferruled zone an external profile adapted to mate after a return from a distorted form of the banded or ferruled zone in a complementary internal profile of a said discharge tube, conduit, or duct.

10 Preferably said flexible coupling tube is a said second tube as defined above.

In another aspect the present invention consists in **a flexible duct** that has a cuff or other end region adapted to resiliently fit to such a profiled tube at least in part into said channel, over said set in and into said rebate or additional channel.

Preferably said duct is of a form substantially as herein described with reference to
15 components assemblies, methods and/or as hereinafter described with or without reference to any one or more of the accompanying drawings.

Preferably said flexible coupling tube is a said second tube as defined above.

In another aspect the invention is, **in, as part of, or for apparatus to discharge, or to receive a discharge of, a particulate material, (A) a tube, conduit, duct or the like and (B)**
20 **a flexible tube** (end received and snap fit inter-engaged within said tube, conduit, duct or the like).

Preferably the receiving has required a resilient deformation of an end region of the tube, conduit, duct or the like from which it has relaxed to, or been allowed to relax to, a condition that holds it engaged by profiled interference features with said tube, conduit, duct or
25 the like.

Preferably in the relaxed condition there is substantial alignment of the resilient tube, conduit, duct or the like with a wall region of said tube, conduit, duct or the like.

Preferably (A) is a said first tube as defined above and (B) is a said second tube as defined above.

30 Preferably said tube, conduit, duct or the like is a first tube as defined above.

Preferably profiled zone, band or ferrule is a roll formed feature.

Preferably said roll formed feature is its adaption to locate a double beaded seal i.e. a cuff or other end modification outwardly of a flexible tube that has two spaced annular beads, ribs or the like.

35 Preferably the roll formed feature defines a tubed profile region having

(i) an annular channel set out from its ducting locus,
(ii) inwardly directed annular rib set out less than the channel, and
(iii) an annular set out (rebate or channel) out from that annular rib, features (iii) being closest to that end of the tube from which the flexible duct is or is to be removeably fixed.

5 In a further aspect the present invention consists in, **in combination**, a tube as defined with its profiled region, and a flexible tube or duct having a banded or ferruled end region that complements the profiled region of said tube.

Preferably the complementing is as a result of a cuff or other set up feature of the flexible duct, such features being supported by a resilient ring which ensure intimate intermeshing
10 notwithstanding any inward distortion of such resilient ring during a fitting or removal and refitting procedure.

In another aspect the present invention consists in, **in combination or assembly, a tube and a flexible duct received within said tube**, the flexible duct having a resiliently provided end feature to engage as if meshed or otherwise engaged against easy axial
15 dislodgement, such meshing or other such engagement requiring a resilient deformation of the flexible duct end to allow its initial insertion before it assumes and holds its relaxed condition which is commensurate with such meshing or other engagement.

In still another aspect the present invention consists in **a method of fitting and/or removing a flexible duct or tube** which is substantially as herein described in respect of any
20 apparatus, combination or assembly in accordance with the present invention.

In another aspect the invention is **as, or adapted to be used as, a flexible coupling tube** to duct particulate material from discharge tube, conduit, duct, port, or the like and/or to a receiving tube, conduit, duct, port or the like,

wherein at least one end region of the tube is resiliently banded or ferruled and has for
25 that border banded or ferruled zone an external profile adapted to mate after a return from a distorted form of the banded or ferruled zone with a complementary internal profile of a said discharge tube, conduit, or duct.

Preferably said tube, conduit, duct or the like is a first tube as defined above.

Preferably profiled zone, band or ferrule is a roll formed feature.

30 Preferably said roll formed feature is its adaption to locate a double beaded seal i.e. a cuff or other end modification outwardly of a flexible tube that has two spaced annular beads, ribs or the like.

In another aspect the invention is **plant** having a discharge tube or port or a receiving tube or port for the ducted passage of a particulate material,

35 **wherein** a flexible tube connects the discharge tube to the receiving tube or port,

and wherein there is at least one tube to tube connection reliant on a resilient end region of the flexible tube having been deformed to allow its insertion and then assumption of a secure more relaxed condition of said end region in the encircling tube.

Preferably said tube, conduit, duct or the like is a first tube as defined above.

5 Preferably profiled zone, band or ferrule is a roll formed feature.

Preferably said roll formed feature is its adaption to locate a double beaded seal i.e. a cuff or other end modification outwardly of a flexible tube that has two spaced annular beads, ribs or the like.

In another aspect the invention consists in, **in a particulate material(s) transport system**, a flexible material(s) ducting tube held at least one of its end regions within a less flexible or rigid tube reliant on an annular profile into annular profile inter-engagement

wherein there is or has been one or both

- (i) resilient deformation of said end region to a non relaxed condition to allow its insertion to a more relaxed or fully relaxed held condition, and/or
- 15 (ii) notwithstanding the profile to profile inter-engagement, the surfaces of the connected tubes are otherwise flush.

As used herein “tube” includes any appropriate section but preferably at the inter-engagement contemplates a round relaxed or round rigid section and “tube axis” and “tube locus” takes its meaning therefrom.

20 As used herein the term “and/or” means “and” or “or”, or both.

As used herein the term “(s)” following a noun includes, as might be appropriate, the singular or plural forms of that noun.

A preferred form of the present invention will now be described with reference to

Figure 1a and 1b which show by reference to a diagrammatic section of one side only of discharge and receiving tubes and a flexible tube, a top connection and a bottom connection, each connection relying on an internal profiling of the discharge tube and the receiving tube and the complementary engagement thereto in an outwardly biased manner a complementary profile of the banded or ferruled region at the end of the flexible tube, both Figures 1a and 1b showing by reference to the flexible tube proper (i.e. between and into its profiled end features) the alignment thereof at least substantially with the inner wall surface of the discharge tube and the receiving tube respectively,

Figure 2 is a view of a discharge tube or receiving tube to show the features of the end profiling thereof by way of a forming outwardly by any appropriate roll forming or other forming means to define (i) an annular channel set out from its ducting locus, (ii) inwardly directed an

annular ribbed set out less than the channel and (iii) an annular set out (in this case a rebate rather than a channel) out from that annular rib,

Figure 3 shows one end of a discharge or receiving tube from the outside, there being shown (to the left) the outwardly rolled features that provide the set ins and rib, etc described
5 with respect to Figure 2,

Figure 4 is a sectional view of a preferred cuff like profiling of the perimeter of the receiving or discharge end of a said flexible tube, the cuff being formed by a fold around and reattachment of part of the flexible preferably non-resilient material of the cuff itself over an underlying resilient ring (e.g. of stainless steel or other resilient material) and a contoured ring
10 best to conform to the inner profile of the end region of the discharge tube or receiving tube,

Figure 5 shows an outside view of the flexible tube feature as shown in Figure 4,

Figure 6 shows the profile ring in the same disposition as is Figure 5 that forms part of the fabricated arrangement of Figure 5,

Figure 7 shows similarly to Figure 6 the underlying stainless steel or other material resilient ring shown in Figure 4,
15

Figure 8 is a perspective view of the arrangement of Figure 3 as it might be provided as a short length to be welded to a discharge port of appropriate apparatus e.g. a hopper, receiving apparatus or the like,

Figure 9 somewhat analogously to Figure 5, 6 and 7 shows from the right the ring of
20 Figure 7, the profiled ring of Figure 6 and the cuff of the flexible tube forming material itself as shown in Figure 5 or the assembly as shown in Figures 4 and 5,

Figure 10 shows the manual deformation of one end of a flexible tube in accordance with the present invention to allow its "snap" placement within the profiled end region of a discharge or receiving tube with a complementary profile,

Figure 11 shows the flexible tube engaged within tube for attachment at a port, the flexible tube and complementary profile in part being cut away to show more,
25

Figure 12 is an enlargement of part of Figure 11,

Figure 13 is a side elevation of an alternative flexible connector this time having similar ends but each of which has a single annular rib supported by a flexible member,

Figure 14 shows the complementary profile spigot to receive either end of a connector of Figure 13,
30

Figure 15 is a sectional view of part of the section of the flexible connector at the single annular rib,

Figure 16 is an enlargement of the complementary profile of the spigot connector of
35 Figure 14,

Figure 17 is a similar diagram to that of **Figure 13** but of a double annular ribbed flexible connector of a kind substantially as previously described, this time the connector being shown in the same drawing format as **Figure 13**,

Figure 18 is a complementary spigot connector for the flexible connector of **Figure 17**,

5 **Figure 19** is a cross-sectional enlargement of the double annular rib of the flexible connector of **Figure 17**,

Figure 20 is an enlargement of the profile of the spigot connector of **Figure 18**,

Figure 21 shows an alternative spigot connector, whether for a single or double rib flexible connector (**Figure 21** actually showing a region to receive a double annular ribbed flexible connector), but having its other end provided with an outward flange adapted for fixing (e.g. by welding) or being retained on an appropriate opening or port,

Figure 22 is a cross section of part of the spigot connector of **Figure 21**,

Figure 23 is an exploded view of a variation of a spigot connector such as shown in **Figure 21** but this time adapted for engagement with multiple components at or about an appropriate opening,

Figure 24 shows the components of **Figure 23** in section,

Figure 25 shows yet a further variation of the spigot connectors of **Figure 21** and **23**, this time being adapted for a square opening at the end remote from the end profiled to receive a double annular ribbed flexible connector,

20 **Figure 26** is a cross-section of the spigot connector of **Figures 25**,

Figure 27 is a perspective view of a most preferred form of the ferrule or spigot connector,

Figure 28 is a plan view of the spigot connector of **Figure 27**,

Figure 29 is an elevational view of the spigot of **Figures 27** and **28**,

25 **Figure 30** is the detail at section AA of **Figure 28** when being viewed in elevation,

Figure 31 is a similar flexible connector to that previously described,

Figure 31A shows the flexibility of the connector, the connector of **Figures 31** and **31A** being adapted for retention by a spigot as in **Figures 27** through **30**,

Figure 32 is the detail in section of the resilient ends of the flexible connector of **Figures 31** and **31A**,

Figure 33 is a plan view of an over sleeve that can be used and, if desired, be attached by any appropriate means (e.g. a hose clamp) or none at all to provide resistance to explosions,

Figure 34 shows such a sleeve in plan view,

Figure 35 shows the sleeve of **Figures 30** through **35** in elevation, and

Figure 36 shows with Figures 36A, 36B and 36C appropriate lengths and spacings, Figure 36A being for in line static equipment, 36B being for offset equipment and Figure 36C being for vibrating equipment.

In the preferred form of the present invention the flexible tube in accordance with the present invention is of any suitable flexible material (even a woven material). It provides a tube form able to be held substantially in its tubular ducting form so as to provide a wall 1 able to be substantially aligned with a wall 2 of a discharge tube 3 and a wall 4 of a receiving tube 5. Preferably top and bottom of the flexible tube there is a band or ferrule 6 and 7 respectively which is each adapted to conform and engage outwardly into a complementary profiled region 8 and 9 respectively of the members 3 and 5.

Figure 2 shows one wall of a short tube 10 as shown in Figure 6.

Shown in Figure 2 is respectively an annular channel set out from the ducting locus, such channel being shown as 11, an inwardly directed and annular rib 12 set out less than the channel 11 and an annular set out rebate (but it could be a channel) 13 out from that annular rib 12.

The end feature as shown in Figure 4 comprises the sleeve of the preferred material of the flexible tube. This material is preferably at least substantially, if not totally, gas impervious as its role is to convey particulate materials rather than to separate particulate materials from any air or gas that may be moving therewith, whether as an entrainment flow or not.

The material 1 extends to a region 1A from which it can be deformed inwardly as in the inter-engagement form shown in Figures 1a and 1b.

The cuff region 6 or 7 as shown, which is to act to the outside in its inter-engagement, has a surround first of a resilient ring 14 as a snap band and there over a profiled ring 15. The assembly of member 15 about the snap band 14 has been captured onto the material 1 by the fold back 1A which is then attached by adhesively and/or stitching at 16.

Members 14 and 15 need not be adhered one to the other but can be if desired.

Such an arrangement shown in Figure 4 is then able to inter-engage in a holding engagement with the interior profile of regions 8 and 9 of rings 3 or 5 respectively.

A preferred method of inter-engaging is as shown in Figure 10. Here you will see there is a ring 10 having an end region 6 or 7 of a flexible ring fitted there into reliant upon the deformability and resilience of the snap ring or band 14. Upon release from the condition as shown in Figure 10 a firm inter-engagement as shown in Figures 1A and 1B will result. To remove the flexible ring from the inter-engagement as shown in Figures 1A and 1B there is a similar distortion required to enable its ready removal.

In preferred forms of the present invention a suitable plastics material can be used for the band 15. It is shape retaining but can be resilient so that it can conform to the deformation required of the snap band 14 which preferably is of a suitable material e.g. a suitable steel (preferably stainless steel) or could be some appropriate composite or plastics material.

5 May different materials single or multiple can be used for the flexible seal. One choice for the flexible sleeve proper is clearflex™ sleeve material which a plastics material having little resilience but being flexible.

The sleeve can be formed from a film material, from fibres (e.g. of a non-woven material or a woven material), or some combination of them both e.g. a hybrid. Fibre examples
10 include polyester, nylon, KEVLAR™, PTFE, polyurethane, TEFLON™, aramid, PP, etc.

As mentioned hybrids of a woven or non-woven material (i.e. formed from fibres) can be used in conjunction with film. One such example is a KEVLAR™ woven fabric and a polyurethane film.

Depending on usage preferably the inner surface of the flexible sleeve is to a food grade.
15 Alternative materials to any of those described can be used. There is no need for the material of the flexible tube to be homogeneous, i.e. it can have localised regions of different properties (e.g. material, rigidity, etc) if that is desirable in a particular application.

Accordingly, any suitable choice of material or materials or variation of the same material or same materials can be used as can any appropriate hybridisation of the structure for
20 example a combination of KEVLAR™/SVEFLEX40 when cuffed by a cuff of the present invention provides much greater explosive resistance than a conventionally fitted SVEFLEX™ flexible coupler, SVEFLEX is a trademark of and is a material.

A person skilled in the art will appreciate how with the substantial flushness possible as shown in Figures 1A and 1B there is little in the way of collection areas for particulate materials
25 such as food powders. These should be easily dislodged by regular cleaning without disassembly in conjunction with the vibrational nature of the structure. Periodic removals of the flexible tube are easy as there is no encircling hose clamp to remove and replace. Removal and replacement is simple.

In some forms of the present invention some additional outside tethering arrangement
30 can, if desired, be provided to ensure that any failure in use is unlikely to be catastrophic. Such external tethering however is not preferred.

Whilst there has been description of a particular profiling of the end of each of the tubes in question, other profiled end forms are within the scope of the invention that provide for appropriate retention. These may include one or more annular rib. They may include one or

more channel. It is preferred that the profiling be of an annular nature rather than helical or otherwise.

It is believed that the present invention provides industry with a useful alternative to existing apparatus and methodologies.

5 Figures 13 through 16 as described show a single annular rib 16 at each end of a flexible connector adapted to be received by a complementary profile. Each rib is analogously made to the twin rib form already described.

Similar set outs etc. 17 exist for the single annular rib interengagement as for the double annular rib interengagement previously described.

10 Figures 17 through 20 show in a similar style to Figures 13 to 16 a double annular rib series of drawings.

Irrespective of whether or not the annular connector is single ribbed at one end or double ribbed, or as a hybrid of both, persons skilled in the art will appreciate how the system works.

15 Figures 21 and 22 show a variation of the spigot of Figures 18 and 20 to the extent that there is provided an outwardly extended flange 18 at the bottom adapted itself to be welded to an appropriate surface about an opening or to be captured by an appropriate capture device.

Figure 23 shows a variation on such a theme, i.e. with a structure adapted to seal with a seal 19 into a bottom end of a connector at 20, the connector of Figures 23 and 24 being adapted
20 to sit down on the appropriate annular seal 19 itself seating to a member 21.

Figures 25 and 26 show how a complementary member such as shown in Figure 20 can instead of maintaining the same general tubular form can evolve into other geometric forms. In the case of Figures 25 and 26 it evolves into a square tubular form 22 adapted for attachment to a square port or conduit.

25 Figures 27 through 30 shows a most preferred form of the spigot or ferrule. It can be of a metal (steel or SS) plastic or a combination of materials. This form has an inturned region 23 thus meaning that the inwardly directed ridge 24 separates two complete annular retention grooves 25 and 26 able to accommodate respectively parts 27 and 28 respectively of a flexible connector end as shown in Figures 31, 31A and 32.

30 This shaping of the distal part to match the connector does two things - ensures a seal on two lips (27 and 28) and ensures less gap with the connector exteriorly to collect dust and dirt.

An over sleeve, for example of explosion suppressing Kevlar, can be provided to slip over the flexible connector and, if desired, extend over the spigot at each end. If desired it can be clamped for example by any clamping method onto the surface 29 or it can be left free but with
35 sufficient lapping to ensure adequate explosion protection.

Figure 31A shows the flexibility of the connector but even though it is connected, attention should be paid to Figures 36A through 36C.

Ø inside diameter of both spigot and connector ends in mm – options suggested being in Table 1

AL separation of spigots in mm

CL connector length in mm

H is spigot or ferrule head/retention profile length (e.g. preferably about 35mm)

T Is spigot or ferrule tail length (e.g. preferably about 52mm)

- 5 Suitable internal diameters for the tail and inside of each end of the connectors is preferably one of the following from the Table.

Table 1

Ø (Diameter)	Length (CL)
100	150
150	150
200	200
250	200
300	300
350	300
400	300
450	300
500	300
550	300
600	300
650	300

- For a diameter Ø (e.g. which can be any of those shown in the Table), the distance AL
- 10 between the spigots relates to a connector length CL as follows:

Spacing AL for in line static equipment as shown in Figure 36A should be the connector length CL minus 10mm. For the off set equipment of Figure 36B, the spacing AL should be the connector length CL minus 20mm. For vibrating equipment the spacing AL should be the connector length CL minus 40mm.

- 15 Advantages include:

Advantages from at least preferred embodiments of the invention are:

more hygienic

- Perfect fit
- No crevices
- 5 - No build up of product

less susceptible to damage

- no hose clips needed
- no tools needed
- no damage as a consequence

10 **explosion resistant**

- can be provided with better resistances to internal explosions than conventional flexible couplers

fast simple replacement

-

15 **effective sealing**

- no leaks

In this specification where reference has been made to patent specifications, other external documents, or other sources of information, this is generally for the purpose of providing a context for discussing the features of the invention. Unless specifically stated

20 otherwise, reference to such external documents is not to be construed as an admission that such documents, or such sources of information, in any jurisdiction, are prior art, or form part of the common general knowledge in the art.

CLAIMS:

1. An assembly as part of a particulate solids transport system, the assembly being of or having an inter-engagement between a first tube and a second tube partly nested within the first tube,

5 **wherein** the second tube is a flexible tube with an end region annularly supported by a band or cuff,

and wherein the first tube has its end region provided with an annularly profiled set out,

and wherein each of (a) the band or cuff and (b) the annularly profiled set out has at least one annular rib directed to the other, and at least one of (a) and (b) has two such ribs so as to have the rib of one engagingly flanked by ribs of the other,

and wherein the band or cuff is resilient so as to be deformable inwardly of its tube axis to facilitate insertion or removal of the flexible tube from the first tube but with sufficient return bias to or towards a more relaxed condition such that the rib between two rib engagement holds the tubes against axial separation.

2. An assembly of claim 1 wherein the two such ribs are part of said band or cuff.

3. An assembly of claim 1 or 2 wherein the band or cuff has a resilient cylindrical ring that underlies a profiled ring, that profiled ring providing the ribs of the band or cuff.

4. An assembly of claim 3 wherein a fold back of a flexible sleeve of the second tube encloses said profiled ring and cylindrical ring.

5. An assembly of any one of the preceding claims wherein the set out of the first tube has been roll formed.

6. An assembly of any one of the preceding claims wherein the inner surface of the non-set out region of the first tube and the inner surface of the second tube are in alignment and are at least substantially flush one with the other.

7. An assembly of any one of the preceding claims wherein the band or cuff has two parallel annular ribs and the first tube has two parallel complementary grooves that each conform to a said annular rib of the band or cuff and which connect via the rib of the first tube.

8. An assembly of any one of the preceding claims substantially as herein described with reference to any one or more of the accompanying drawings.

9. In combination, unassembled or assembled, a said first tube and a said second tube suitable to provide an assembly of any one of claims 1 to 8.

10. **A first tube** substantially as herein described with reference to any one or more of the accompanying drawings.

5 11. **A second tube** substantially as herein described with reference to any one or more of the accompanying drawings.

12. **A tube** having a ducting locus and profiled region within which a resiliently banded or ferruled end region of a flexible tube or duct is to fit, the tube's profiled region having in sequence to or towards an end:

- 10 (i) an inwardly directed annular channel set out from its ducting locus,
(ii) inwardly directed annular rib set out less than the channel, and
(iii) an inwardly directed annular channel or set out rebate set out from that annular rib, feature (iii) being closest to that end of the tube from which the flexible duct is or is to be removeably fixed.

15 13. A tube of claim 12 wherein features (i), (ii) and (iii) are consecutive i.e. without any interposed other profiling features.

14. A tube of claim 12 wherein features (i) and (ii) and/or feature (ii) and (iii) have interposed profiling features.

15. A tube of claim 12, 13 or 14 that is at least substantially rigid.

20 16. **As, or adapted to be used as, a flexible coupling tube** to duct particulate material from a discharge tube, conduit, duct, port, or the like and/or to a receiving tube, conduit, duct, port or the like,

wherein at least one end region of the flexible coupling tube is resiliently banded or ferruled and has for that banded or ferruled zone an external profile adapted to mate after a
25 return from a distorted form of the banded or ferruled zone in a complementary internal profile of a said discharge tube, conduit, or duct.

17. A flexible coupling tube of claim 16 wherein it is a said second tube of any one of claims 1 to 11.

18. **A flexible duct** that has a cuff or other end region adapted to resiliently fit to the profiled region of tube of any one of claims 12 to 15 i.e. at least in part into said annular channel, over said set in annular rib and into said annular rebate or additional annular channel.

19. A duct of claim 18 which is a said second tube of any one of claims 1 to 11.

5 20. **In, as part of, or for apparatus to discharge, or to receive a discharge of, a particulate material, (A) a tube, conduit, duct or the like and (B) a flexible tube** end received and snap fit inter-engaged within said tube, conduit, duct or the like.

10 21. Apparatus of claim 20 wherein the receiving has required a resilient deformation of an end region of the tube, conduit, duct or the like from which it has relaxed to, or been allowed to relax to, a condition that holds it engaged by profiled interference features with said tube, conduit, duct or the like.

22. Apparatus of claim 21 wherein, the relaxed condition, there is substantial alignment of the resilient tube, conduit, duct or the like with a wall region of said tube, conduit, duct or the like.

15 23. **In combination or assembly, a tube and a flexible duct received within said tube,** the flexible duct having a resiliently provided end feature to engage as if meshed or otherwise engaged against easy axial dislodgement, such meshing or other such engagement requiring a resilient deflation of the flexible duct end to allow its initial insertion before it assumes and holds its relaxed condition which is commensurate with such meshing or other engagement.

20 24. **A method of fitting and/or removing a flexible duct or tube** which is substantially as herein described with reference to any one or more of the accompanying drawings.

25. **As, or adapted to be used as, a flexible coupling tube** to duct particulate material from discharge tube, conduit, duct, port, or the like and/or to a receiving tube, conduit, duct, port or the like,

25 **wherein** at least one end region of the tube is resiliently banded or ferruled and has for that border banded or ferruled zone an external profile adapted to mate after a return from a distorted form of the banded or ferruled zone with a complementary internal profile of a said discharge tube, conduit, or duct.

30 26. **Plant** having a discharge tube or port and a receiving tube or port for the ducted passage of a particulate material there between,

wherein a flexible tube connects the discharge tube or port to the receiving tube or port,

and wherein there is at least one tube to tube connection reliant on a resilient end region of the flexible tube having been deformed to allow its insertion and then assumption of a
5 secure more relaxed condition of said end region in the encircling tube.

27. Plant of claim 27 wherein it defines or includes apparatus of any one of claims 1 to 24 and 26.

28. **In a particulate material(s) transport system**, a flexible material(s) ducting tube held
10 at least one of its end regions within a less flexible or rigid tube reliant on an annular profile into annular profile inter-engagement

wherein there is or has been one or both

- (a) resilient deformation of said end region to a non relaxed condition to allow its insertion to a more relaxed or fully relaxed held condition, and/or
- 15 (b) notwithstanding the profile to profile inter-engagement, the surfaces of the connected tubes are otherwise flush.