

SHUTTLE FOR USE IN INSERTION OF A DRAW LINE INTO A CONDUIT

BACKGROUND

The present invention relates to an apparatus for use in the insertion of a draw line inside
5 a conduit and more particularly relates to an air flow activated shuttle for use in effecting
that insertion. The invention will be described with reference to the use of the shuttle for
the insertion of a draw line in telecommunications cables but this is not to be construed
as limiting of the applications to which the invention in all its forms may be put.

10 PRIOR ART

Telecommunications cables are nowadays generally laid underground in specially
constructed trenches. In order to protect the cables from potential damage by water,
debris and vermin, typically, communications cables are laid inside plastic (usually
polyvinylchloride (PVC)) conduits. There are many thousands of kilometres of such
15 cables already laid in underground conduits, but due to the rapid increase in
telecommunications and thus the need for more cables, conceivably hundreds of
thousands of kilometres of cable will be required in the future.

There are generally three categories of installed conduits, those that are left empty in
20 reserve awaiting receipt of new cables, those that are already partially filled and those
that are fully occupied with cables. It is the first and second of the two aforesaid
categories that the invention is principally concerned with. The process of inserting
cables into conduits is time consuming, labour intensive and thus expensive. Existing
methods of insertion of draw lines in conduits are slow, cumbersome and inefficient.

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In order to feed a cable through a conduit, it is necessary to first insert a draw line inside
the conduit which is then anchored to the leading end of the cable so it can be pulled
through to the end of the length of conduit. Draw lines may be inserted in advance and
simply left lying in a conduit awaiting later insertion of a cable. This is helpful to the
30 cable installer as in this case, the draw line is already placed in the conduit in advance of
the cable installation, enabling the draw line to be readily attached to the leading end of
the cable which is then pulled through by the draw line. One existing method for

insertion of a draw line in a conduit includes the use of a crude parachute to which a draw line is connected. The parachute is inserted via an entry end into the conduit. Pressurised air is then delivered from an air source to the parachute causing it to inflate following which it exits the pipe taking the draw line with it. In order to maintain the positive air pressure required, the entry end of the conduit must be sealed to prevent escape of air through the entry end. This is presently effected in a crude manner by the insertion in the entry end of the conduit of rags and the like which must be manually held in position whilst positive pressure is delivered to the inside of the pipe. Positive pressure is introduced into the conduit via a copper tube which is connected to a source of pressurised air. The rags and other packing surround the copper tube. The draw line must be loose enough to travel through or around the packing resulting in a compromise to the integrity of the seal and in a pressure loss in the conduit via the entry end.

Another problem arising from use of the above method is that of unwanted collapsing or bunching of the parachute. The presently used parachute essentially comprises a sheet of textile or like material to which is connected at peripherally located points one end of each of multiple lengths of string or the like, each of which terminate at their other end at a junction which also receives the leading end of the draw line.

The parachute is prone to collapsing within the conduit particularly if the air is collected asymmetrically in the parachute allowing greater air by pass around one edge compared to symmetric by pass and proper chute balance in normal operation. This imbalance can cause the parachute to rotate, tangling the connecting strings in which case the string can capture the air collecting textile material of the parachute. This means that the tangled parachute can jamb in the pipe and has to be 'fished' out of the conduit and the insertion process recommenced increasing the time and labour involved in drag line insertion. In practice this problem can occur repeatedly before successful insertion is achieved.

A further problem may occur where cables inside a partially filled conduit cross over to form a V which then catches the parachute in the throat of the V shape. When this occurs the draw line (string) continues to be air blown beyond the capture point of the parachute conveying an impression to the operating personnel that the parachute is still drawing the draw line through the conduit when in fact it has jammed. The parachute

must be released from the capture point by pulling the draw line back through the conduit followed by repeated attempts at insertion until the parachute successfully travels through the pipe. This is inefficient, labour intensive and time consuming.

- 5 There are other problems with use of the prior art arrangements: for instance, the string of the draw line comes in contact with the users hands during feeding posing a risk of 'rope burn', and the copper tube must be held in position by an operator along with the packing rags and sponges to prevent blow out. Further, two men are usually required in the conduit pit, one feeding the draw line and the other holding the copper air line and
10 rags in position.

- In another prior art method, rods may be inserted from either end of a conduit until they meet in the middle whereupon the conduit is cut and joined creating a further undesirable join and thus another place through which unwanted water can penetrate. Push rods may
15 be inserted from one end of a conduit up to 100 metres. This method is cumbersome and may lead to cable damage within the conduit particularly where a push rod engages a V formation described above.

THE INVENTION

- 20 The present invention provides an apparatus which enables the trouble free insertion of draw lines inside conduits adapted for carrying cables such as, but not limited to, telecommunications cables. The present invention is used in conjunction with an apparatus which has been made the subject of a co-pending application by the present applicant which overcomes the problems of the prior art methodology referred to above.
25 According to the present invention there is provided an air assisted self supporting shuttle for pulling a draw line through a length of conduit.

- In its broadest form the present invention comprises:
an air flow activated shuttle for pulling a draw line through a length of conduit having
30 entry and exit ends, said shuttle comprising;
a shaft having a leading end and a trailing end;
means on said trailing end which receives and retains a leading end of said draw line;

at least one air flow mitigation element attached to said shaft which at least partially interrupts an air flow introduced into the entry end of said conduit from an air source to said shuttle from the trailing end thereby urging said shuttle along said pipe urging said draw line therealong and through said exit.

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Preferably, the air flow retarding means comprises at least one air collector intermediate the ends of the shaft and disposed radially about said shaft and flared in the direction of the trailing end. Each shuttle preferably comprises at least one radial array of air collecting cells or at least one flexible skirt.

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According to an alternative embodiment air collectors may be defined by a flexible skirt wherein the skirt of each air collector captures the air and displaces radially of said shaft responsive to positive air pressure thereby creating a low friction fit between a flared end of each said skirt and the internal wall of the conduit. The leading edge of the shaft
15 terminates in a nose cone and the leading end of each of any remaining collectors include a small opening allowing positive air pressure to exit in the direction of the leading collector to ensure that the leading collector is not starved of air.

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The skirt of each collector terminates at or near said nose cone and allows positive air pressure in each collector to exit via said nose cone thereby reversing the direction of air exiting each said collector. The collectors may be individually fixed to the shaft.

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In an alternative embodiment the air collector may comprise an umbrella like structure connected to the shaft. The configuration, material and texture of the air collectors may be varied according to circumstances such as the internal state of the conduit in which a draw line is to be inserted.

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According to an alternative embodiment, the shuttle may include means at the leading end and trailing end to enable coupling of one shuttle to multiple shuttles where required. Said means may comprise releasable couplings. The coupling may be effected by means of threaded male/female profile parts on the end of adjacent shaft elements.

The present invention will now be described in more detail according to a preferred but non limiting embodiment and with reference to the accompanying illustrations wherein;

- Figure 1: shows an isometric view of a shuttle having a pair of air collectors and
5 inserted in a conduit according to one embodiment of the invention;
Figure 2: shows an exploded view of a shuttle comprising two shaft elements;
Figure 3: shows the shuttle of figure 2 with shaft elements coupled together;
Figure 4: shows a shuttle with one air collector comprising an array of collecting
cells;
10 Figure 5: shows a tandem shuttle with leading and trailing collectors wherein the
trailing collector has by pass holes.

Referring to figure 1 there is shown a shuttle 1 according to one embodiment adapted to travel along the inside of a conduit 2 under the assistance of positive air pressure from an
15 air source (not shown) applied at an entry end of the pipe. It will be recognised that the
embodiment of the shuttle shown in figure 1 is merely an example of a wide possibility of
shuttle configurations. For instance, a shuttle may comprise one shaft element with one
or more collectors which may be of the flexible skirt type or air collection cell type.
Thus, in the case where multiple collectors are used on one shaft element, the collectors
20 may be the same type or a combination of the skirt variety and air collection cell variety.
Shuttle 1 comprises a generally elongated shaft 3 having a leading end 4 and a trailing
end 5. In use, shuttle 1 pulls a draw line 6 from an entry end of the pipe to an exit end.
Trailing end 5 of shaft 3 includes connecting means 7 which receives the leading end of
draw line 6. Connecting means 7 may comprise a simple loop to which is tied said
25 leading end 6a of the draw line 6. The leading end 4 of shaft 3 has mounted thereon a
nose cone 8 which provides an aerodynamic leading edge profile and contributes to the
balance and operation of the shuttle. Intermediate the ends of the shaft there are
provided two longitudinally spaced apart air collectors 9 and 10. Collectors 9 and 10
shown are each formed from a radial array of air collection cells disposed radially about
30 shaft 3. According to an alternative embodiment one array only may be employed, with
a minimum of two diametrically disposed air collectors. Ideally the air collectors are
symmetrically disposed about the axis of shaft 3 to prevent out of balance forces

generated by the air pressure, tending to rotate or tumble the shuttle compromising directional stability. Ideally, the shuttle is of sufficient length to preclude the possibility of overturning inside the conduit in which case the shuttle would jamb as occurred in the prior art arrangements previously described.

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Each of collectors 9 and 10 comprises a plurality of radially disposed air collecting skirts 11 each of which comprise a flexible material. Each of said collectors are at least partially fixed to shaft 3. Each collecting skirt 11 is tapered from its leading to its trailing edge.

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Once draw line 6 is connected to connecting means 7 which may comprise a resilient loop through which line 6 may be placed and the pipe end sealed, shuttle 1 is ready for use. Once the entry end of conduit 2 is sealed, air from a source of pressurised air is introduced into region 13 of conduit 2 whereupon collecting skirts 11 of shuttle 1

15 displace radially as they collect the pressured air. This causes the shuttle to travel along conduit 2 at an extremely fast rate until it exits the conduit pulling draw line 6 along with it. Once draw line 6 is through the pipe, shuttle 1 is then uncoupled from draw line 6 for re use.

20 Where a single air collector is used, it is preferable that the skirt (where the skirt variety is used) or envelopes (where the collection cell variety is used) radially displaced to an extent which maximises air collection. Thus, it is ideal that the displacement is such that air collection from the full cross sectional area of the pipe is achieved. This will result in the skirt or cells engaging the inner wall of conduit 2 as the skirt or cell envelopes

25 radially displace. Where multiple collectors are used the trailing collectors will include a leading end opening to allow air by pass to ensure that the leading end collector is not staved of pressurised air. Also the trailing collectors will allow by pass about the periphery of the skirt or air collecting cells.

30 Figure 2 shows an exploded view of a double shuttle similar to the embodiment of the invention shown in figure 1.

Each shuttle may be threadably connected to an adjacent shuttle such that uncoupling of a shuttle from an adjacent shuttle is a relatively simple matter. Likewise draw line 6 may as an alternative be uncoupled and coupled by means of a threaded connection on the trailing end 5 of shaft 3.

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Figure 2 shows shaft elements 20 and 21 mutually separated. Shaft element 20 includes flexible skirt collector 22 and shaft element 21 comprises flexible skirt collector 23.

Shaft elements 20 and 21 are engageable by means of threaded male female interfitting.

Element 20 comprises threaded male profile part 24 and element 21 female profile part

10 25. This arrangement enables convenient adjustment to the length of the shuttle according to requirements.

Figure 3 shows skirt collectors 22 and 23 as they appear when the shaft elements (concealed) of the shuttle of figure 2 are coupled together.

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Figure 4 shows a single shaft element 30 with a collector 31 comprising air collecting cells 32 according to an alternative embodiment of the invention.

Figure 5 shows a tandem shuttle 40 comprising shaft elements 41 and 42 including
20 thereon respectively collectors 43 and 44. Collector 43 includes in each air collecting cell 45 an opening or openings 46 which provides an air by pass facility which prevents leading collector 44 from pressurised air starvation.

It will be recognised by persons skilled in the art that numerous variations and
25 modifications may be made to the invention as broadly described herein without departing from the spirit and scope of the invention.

**THE CLAIMS:**

1. An air flow activated shuttle for pulling a draw line through a length of conduit having entry and exit end, said shuttle comprising;
a shaft having a leading end and a trailing end;
means on said trailing end which receives and retains a leading end of said draw line;
at least one air flow mitigation element attached to said shaft which at least partially interrupts an air flow introduced into the entry end of said conduit from an air source to said shuttle from the trailing end thereby urging said shuttle along said pipe urging said draw line therealong and through said exit.
2. A shuttle according to claim 1 wherein said mitigation element/s comprise/s an air collector or collectors which receive air to drive said shuttle along said pipe.
3. A shuttle according to claim 2 wherein at least one collector comprises an array of separate air collecting cells adjacent each other and which are disposed radially about said shaft.
4. A shuttle according to claim 3 wherein each said cells are formed by a flexible envelope which inflates upon ingress of air therein.
5. A shuttle according to claim 2 wherein at least one collector/s comprise/s a flexible membrane in the form of a skirt having one end fixed to said shaft and an opposite free end which displaces radially of said shaft when air is collected by said flexible membrane.
6. A shuttle according to claim 5 wherein, when multiple air collectors are affixed to said shaft, a leading air collector, upon ingress of air, expands to an extent that the flexible envelope may engage the inside wall of the pipe so that minimal, if any, air by-passes said collector and one or more trailing air collectors allow air by-pass to avoid starving said leading air collector of air.
7. A shuttle according to claim 6 wherein at least one collector comprises said flexible skirt and at least one other collector comprises said air collecting cells.
8. A shuttle according to claim 7 wherein a leading collector comprises said cells and at least one trailing collector comprises said flexible skirt.
9. A shuttle according to claim 7 wherein a leading collector comprises said flexible skirt and at least one trailing collector comprises said air collecting cells.



10. A shuttle according to claim 8 or 9 wherein the leading end of a leading collector includes a nose cone.
11. A shuttle according to claim 10 wherein each collector has a nose cone.
12. A shuttle according to claim 11 wherein the shaft comprises interconnected shaft elements detachable from an adjacent shaft element.
13. A shuttle according to claim 12 wherein each shaft element includes at least one air collector mounted thereon.
14. A shuttle according to claim 6 wherein the material of the flexible cells or flexible skirt is a fabric.
15. A shuttle according to claim 14 wherein when multiple collectors are on said shaft they are disposed in axial alignment.
16. A shuttle according to claim 15 wherein one shaft element is screw fitted to an adjacent element.
17. A shuttle according to claim 16 wherein when said shaft includes a plurality of collectors each trailing collector has air by-pass openings to reduce or prevent deprivation of air from a leading collector.
18. A shuttle according to claim 16 wherein the flexible skirt is wire reinforced.