to achieve the desired groove radius. Additionally, prior art roll grooving machines have low production rates, often requiring many revolutions of the pipe element to achieve a finished circumferential groove. There is clearly a need for devices, for example, those using cams, to cold work pipe elements which are simple yet produce results more quickly with less operator involvement.

Summary

According to an aspect of the present invention, there is provided a device for cold working a pipe element, said device comprising: a housing; a plurality of cam gears mounted within said housing, each one of said cam gears being rotatable about a respective one of a plurality of first axes of rotation, said first axes of rotation being parallel to one another, said cam gears being positioned about a central space for receiving said pipe element;a plurality of cam bodies, each said cam body mounted on a respective one of said cam gears; a plurality of cam surfaces, each one of said cam surfaces extending around a respective one of said cam bodies and being engageable with said pipe element received within said central space, each one of said cam surfaces comprising a region of increasing radius and a discontinuity of said cam surface, each one of said radii being measured from a respective one of said first axes of rotation;

a traction surface extending around at least one of said cam bodies, said traction surface comprising a plurality of projections extending outwardly from said at least one cam body, said traction surface having a gap therein, said gap being aligned axially with said discontinuity of said one cam surface surrounding said at least one cam body; an engagement assembly

positioned within said central space, wherein said engagement assembly is configured to contact said pipe element upon insertion of said pipe element into said central space; a plurality of synchronization gears mounted within said housing, each one of said synchronization gears being

rotatable about a respective one of a plurality of second axes of rotation, said second axes of rotation being parallel to said first axes of rotation; wherein each one of said synchronization gears meshes with two of said cam gears. By way of example each radius of each cam surface is measured from the respective first axis of rotation of a respective the cam gear. In an example embodiment the number of synchronization gears is one less than the number of cam gears. An example embodiment may comprise at most five of the cam gears. Further by way of example, a device according to the invention may comprise at most four of the synchronization gears.

In an example embodiment, the engagement assembly comprises a cup. The cup surrounds a central axis and defines an opening for receiving the pipe element upon insertion of the pipe element into the central space. Further by way of example the cup comprises an inner surface having a first diameter at the opening and a second diameter distal to the opening. The first diameter is greater than the second diameter in this example. In a specific example the inner surface is conical. An example device according to invention may further comprise a pipe stop body positioned within the cup. The pipe stop body is movable along the central axis relatively to the cup. The cup is movable along the central axis relatively to the cam bodies in this example.

An example device may further comprise a ring mounted on the pipe stop body concentric with the central axis. A first cam stop surface projects from one of the cam bodies. The pipe stop body is movable relatively to the cam bodies between a first position, wherein the ring is engageable with the first cam stop surface thereby limiting rotation of the cam bodies, and a second position, wherein the ring is not engageable with the first cam stop surface, thereby permitting rotation of the cam bodies. In an example embodiment the first cam stop surface is positioned adjacent to the discontinuity of the cam surface on the one

What is claimed is:

1. A device for cold working a pipe element, said device comprising:

a housing;

a plurality of cam gears mounted within said housing, each one of said cam gears being rotatable about a respective one of a plurality of first axes of rotation, said first axes of rotation being parallel to one another, said cam gears being positioned about a central space for receiving said pipe element;

a plurality of cam bodies, each said cam body mounted on a respective one of said cam gears;

a plurality of cam surfaces, each one of said cam surfaces extending around a respective one of said cam bodies and being engageable with said pipe element received within said central space, each one of said cam surfaces comprising a region of increasing radius and a discontinuity of said cam surface, each one of said radii being measured from a respective one of said first axes of rotation;

a traction surface extending around at least one of said cam bodies, said traction surface comprising a plurality of projections extending outwardly from said at least one cam body, said traction surface having a gap therein, said gap being aligned axially with said discontinuity of said one cam surface surrounding said at least one cam body;

an engagement assembly positioned within said central space, wherein said engagement assembly is configured to contact said pipe element upon insertion of said pipe element into said central space;

a plurality of synchronization gears mounted within said housing, each one of said synchronization gears being rotatable about a respective one of a plurality of second axes of rotation, said second axes of rotation being parallel to said first axes of rotation; wherein

each one of said synchronization gears meshes with two of said cam gears.

2. The device according to claim 1, wherein each said radius of each said cam surface is measured from said respective first axis of rotation of a respective said cam gear.

3. The device according to claim 1, wherein the number of synchronization gears is one less than the number of cam gears.

4. The device according to claim 1, comprising at most five of said cam gears.

5. The device according to claim 4, comprising at most four of said synchronization gears.

6. The device according to claim 1, wherein said engagement assembly comprises a cup, said cup surrounding a central axis and defining an opening for receiving said pipe element upon insertion of said pipe element into said central space.

7. The device according to claim 6, wherein said cup comprises an inner surface having a first diameter at said opening and a second diameter distal to said opening, said first diameter being greater than said second diameter.

8. The device according to claim 7, wherein said inner surface is conical.

9. The device according to claim 7, further comprising a pipe stop body positioned within said cup, said pipe stop body being movable along said central axis relatively to said cup, said cup being movable along said central axis relatively to said cam bodies.

10. The device according to claim 9, further comprising:

a ring mounted on said pipe stop body concentric with said central axis;

a first cam stop surface projecting from one of said cam bodies; wherein

said pipe stop body is movable relatively to said cam bodies between a first position, wherein said ring is engageable with said first cam stop surface thereby limiting rotation of said cam bodies, and a second position, wherein said ring is not engageable with said first cam stop surface, thereby permitting rotation of said cam bodies.

11. The device according to claim 10, wherein said first cam stop surface is positioned adjacent to said discontinuity of said cam surface on said one cam body.

12. The device according to claim 10, further comprising a rib projecting from said one cam body, said rib positioned adjacent to said cam surface on said one cam body and extending around a portion of said one cam body, said first cam stop surface being positioned on a first end of said rib.

13. The device according to claim 12, further comprising a second cam stop surface positioned on a second end of said rib, said second cam stop surface projecting from said one cam body, said second cam stop surface being positioned in spaced relation to said first cam stop surface.

14. The device according to claim 13, wherein at least one of said first and second cam stop surfaces has a concave curvature.

15. The device according to claim 10, further comprising a stop spring acting on said pipe stop body for biasing said pipe stop body toward said opening of said cup.

16. The device according to claim 15, further comprising a cup spring acting on said cup for biasing said cup toward said pipe stop body.

17. The device according to claim 10, wherein:

said pipe stop body comprises a plate engageable with said pipe element received within said central space, a plurality of legs projecting from said plate, said ring being attached to said legs, said ring being arranged coaxially with said central axis;

said cup comprises a plurality of slots extending axially along said central axis, said legs extending through said slots.

18. The device according to claim 9, further comprising a shaft positioned coaxially with said central axis, said cup and said pipe stop body surrounding said shaft.

19. The device according to claim 1, wherein each of said cam surfaces further comprises a region of constant radius positioned adjacent to a respective one of said discontinuities.

20. The device according to claim 1, further comprising a plurality of said traction surfaces, each one of said traction surfaces extending around a respective one of said cam bodies.

21. The device according to claim 10, further comprising a plurality of said first cam stop surfaces, each one of said first cam stop surfaces being

positioned adjacent to a respective one of said discontinuities of one of said cam surfaces on each one of said cam bodies.

22. The device according to claim 21, further comprising a plurality of ribs, each said rib projecting from a respective one of said cam bodies, said ribs extending around a portion of said cam bodies, each said first stop surface being positioned on an end of each of said ribs.

23. The device according to claim 1, wherein said traction surface is positioned on said one cam body in spaced relation to said cam surface extending around said one cam body.

24. The device according to claim 1, wherein said traction surface has a constant radius measured from said first axis of rotation of said one cam body.

25. The device according to claim 10, wherein said cam surface on said one cam body is positioned between said gear and said traction surface on said one cam body.

26. The device according to claim 25, wherein said cam surface on said one cam body is positioned proximate to said traction surface on said one cam body.

27. The device according to claim 25, wherein said first cam stop surface is positioned between said cam surface and said gear on said one cam body.

28. The device according to claim 1, further comprising:

a first action surface positioned on a first one of said cam bodies of said plurality of cam bodies, said first action surface being offset from a

first one of said first axes of rotation about which said first one of said cam bodies rotates;

an actuator movably mounted on said housing, said actuator being movable into engagement with said first action surface for rotating said first one of said cam bodies about said first one of said first axes of rotation.

29. The device according to claim 28, wherein said actuator comprises a first lever pivotably mounted on said housing, said first lever having a drive surface engageable with said first action surface for rotating said first one of said cam bodies about said first one of said axes.

30. The device according to claim 29, further comprising:

a second action surface positioned on a second one of said cam bodies of said plurality of cam bodies, said second action surface being offset from a second one of said first axes of rotation about which said second one of said cam bodies rotates;

an over travel stop movably mounted on said housing, said over travel stop being movable into engagement with said second action surface for halting rotation said second one of said cam bodies about said second one of said first axes of rotation.

31. The device according to claim 30, wherein said over travel stop comprises:

a second lever mounted on said housing for pivoting motion about a pivot axis, a hook mounted on said second lever and positioned on one side of said pivot axis, said hook being engageable with said second action surface;

a spur mounted on said second lever on an opposite side of said pivot axis, said first lever being movable into engagement with said spur for pivoting said second lever to move said hook out of engagement with said second action surface upon movement of said first lever into engagement with said first action surface;

a return spring acting between said housing and said second lever for biasing said hook into engagement with said second action surface.

32. The device according to claim 1, further comprising a chuck for receiving said pipe element, said chuck being rotatable about a chuck axis, said chuck axis being arranged coaxially with said central axis.

33. The device according to claim 32, wherein said housing is pivotably and axially slidably mounted adjacent to said chuck.

34. The device according to claim 1, further comprising a motor engaged with a chuck for rotating said chuck about said chuck axis.