CLAIMS

1. A linear motor activator for a downhole safety valve comprising:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier; and

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to a component of a downhole safety valve.

2. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein the permanent magnet carrier is operably connected to a piston.

3. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein the plurality of permanent magnets are arranged with poles oriented radially.

4. A linear motor activator for a downhole safety valve as claimed in claim 3 wherein the poles are alternated on adjacent magnets.

5. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein the permanent magnets are Samarium Cobalt magnets.

6. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein the permanent magnets are Neodymium magnets.

7. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein one or more of the permanent magnets are annular.

8. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein the one or more of the permanent magnets are made up of annular arrays of permanent magnets.

9. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein one or more of the plurality of coils are annular.

10. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein one or more of the plurality of coils are coilettes.

11. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein one or more of the plurality of coils are wound in a counterclockwise pattern viewed from uphole of the downhole safety valve.

12. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein one or more of the plurality of coils are wound in a clockwise pattern viewed from uphole of the downhole safety valve.

13. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein every third coil of the plurality of coils is wound in a direction opposite that of the two coils on either side thereof.

14. A linear motor activator for a downhole safety valve as claimed in claim 1 wherein the coil carrier includes a groove receptive to coil conductors.

15. A downhole safety valve comprising:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier;

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to a component of a downhole safety valve; and

a controller configured to sequentially power phases of coils to cause the permanent magnet carrier to actuate the safety valve.

16. A tubing pressure insensitive actuator system comprising:

a housing having a bore therein;

a force transmitter sealingly moveable within the bore the force transmitter defining with the bore two fluid chambers, one at each longitudinal end of the force transmitter;

at least two seals sealingly positioned between the housing and the force transmitter, one of the seals isolating one end of the force transmitter from tubing pressure and another of the seals isolating another end of the force transmitter from tubing pressure;

an activator having:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier; and

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to the force transmitter.

17. A tubing pressure insensitive actuator system for an electric surface controlled subsurface safety valve comprising:

a subsurface safety valve housing supporting a flow tube, a flapper and a power spring, the housing having a force transmitter bore therein;

a force transmitter sealingly moveable within the force transmitter bore, the force transmitter defining with the bore two fluid chambers, one at each longitudinal end of the force transmitter, at least one of the chambers containing an electric activator in operable communication with the force transmitter;

an interengagement at the force transmitter, force transmissively engaged with the flow tube, the interengagement exposed to tubing pressure during use;

at least two seals sealingly positioned between the housing and the force transmitter, one of the seals isolating one end of the force transmitter from tubing pressure and another of the seals isolating another end of the force transmitter from tubing pressure;

an activator having:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier; and

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to the force transmitter.

18. A method for reducing force requirements of an actuator in a downhole environment comprising:

sealing a force transmitter within a housing to isolate ends of the force transmitter from tubing pressure during use;

initiating an activator having:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier;

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to the force transmitter; and

urging the force transmitter in a direction commensurate with activating a downhole tool, the actuator generating enough force to activate the downhole tool other than to overcome tubing pressure.

CLAIMS

1. A tubing pressure insensitive actuator system comprising:

a housing having a bore therein;

a force transmitter sealingly moveable within the bore the force transmitter defining with the bore two fluid chambers, one at each longitudinal end of the force transmitter;

at least two seals sealingly positioned between the housing and the force transmitter, one of the seals isolating one end of the force transmitter from tubing pressure and another of the seals isolating another end of the force transmitter from tubing pressure;

an activator having:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier; and

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to the force transmitter.

2. A tubing pressure insensitive actuator system for an electric surface controlled subsurface safety valve comprising:

a subsurface safety valve housing supporting a flow tube, a flapper and a power spring, the housing having a force transmitter bore therein;

a force transmitter sealingly moveable within the force transmitter bore, the force transmitter defining with the bore two fluid chambers, one at each longitudinal end of the force transmitter, at least one of the chambers containing an electric activator in operable communication with the force transmitter;

an interengagement at the force transmitter, force transmissively engaged with the flow tube, the interengagement exposed to tubing pressure during use;

at least two seals sealingly positioned between the housing and the force transmitter, one of the seals isolating one end of the force transmitter from tubing pressure and another of the seals isolating another end of the force transmitter from tubing pressure;

an activator having:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier; and

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to the force transmitter.

3. A method for reducing force requirements of an actuator in a downhole environment comprising:

sealing a force transmitter within a housing to isolate ends of the force transmitter from tubing pressure during use;

initiating an activator having:

a permanent magnet carrier;

a plurality of permanent magnets mounted to the permanent magnet carrier;

a coil carrier disposed in magnetic field proximity to the permanent magnet carrier;

a plurality of coils mounted to the coil carrier, one of the permanent magnet carrier and the coil carrier being movable relative to the other of the permanent magnet carrier and coil carrier, and being connected to the force transmitter; and

urging the force transmitter in a direction commensurate with activating a downhole tool, the actuator generating enough force to activate the downhole tool other than to overcome tubing pressure.