Sept. 4, 1945. F. W. CURTIS 2,384,078

THROTTLE VALVE FOR MACHINE TOOL CONTROL

Filed March 5, 1941

Fig. 1.

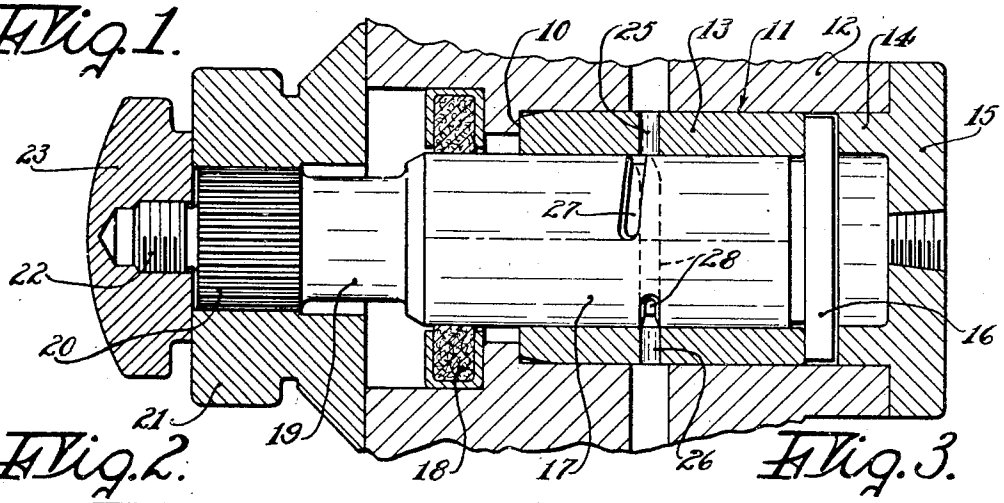


Fig. 2.

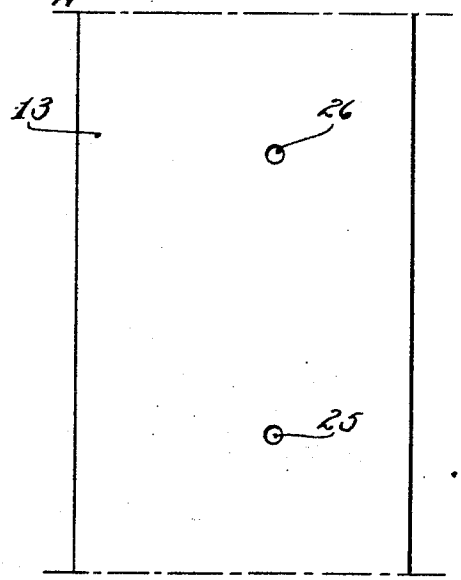


Fig. 3.

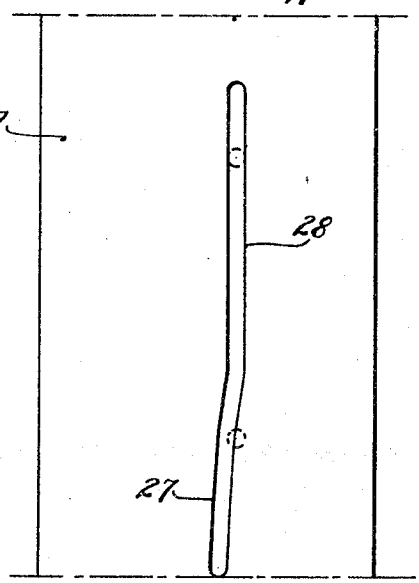


Fig. 4.

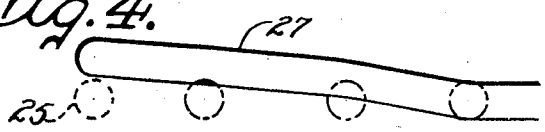


Fig. 5.

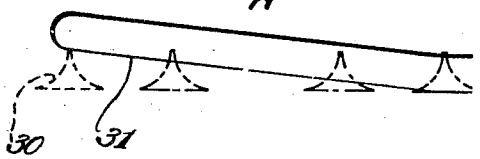
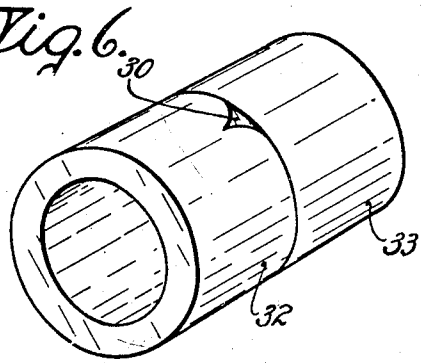


Fig. 6.



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THROTTLE VALVE FOR MACHINE TOOL CONTROL

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Application March 5, 1941, Serial No. 381,780

1 Claim. (Cl. 251—156)

This invention relates to a throttle valve particularly intended for regulating the feed speed of hydraulically operated machine tools such as milling machines. One object is to provide a throttle which can control with great accuracy the feed rate of a machine tool. A further object is to provide an improved throttle which can be graduated in uniformly spaced divisions corresponding to equal increments in speed; or alternatively can be adapted to give speeds increasing in a geometrical or other proportion as the valve is turned through equal increments. A further object is to provide a throttle valve which may be clamped in position after being set. A further object is to provide a throttle valve adapted for incorporation in a unitary control panel. Additional objects will appear from the following description and claim.

Referring to the drawing,

Fig. 1 is a sectional view through a valve embodying the invention;

Fig. 2 is a developed view of the valve sleeve;

Fig. 3 is a developed view of the valve plug;

Fig. 4 is a diagram showing how the area of the port opened is increased as the throttle is turned;

Fig. 5 is a similar diagram showing a modification; and

Fig. 6 is a perspective detail of that modification.

Mechanically the throttle is of great simplicity. Against a shoulder 10 in a bore 11 formed in the casing 12 is located a sleeve 13, preferably formed separate from the casing to facilitate hardening and lapping. Between the end of this sleeve and a cylindrical flange 14 on a cap 15 secured to the casing is a radial flange 16 forming part of the valve plug 17. The plug is thus positioned with great accuracy longitudinally of the sleeve. An oil seal 18 surrounds the plug adjacent the shoulder 10. The stem 19 of the plug projects through the casing and is provided with serrations 20 forming a sliding coupling with complementary serrations in a combined dial and handle 21. Beyond the dial the stem 19 is threaded at 22 to receive a locking nut 23. By tightening this nut the dial is pressed against the wall of the casing 12, firmly holding the plug in the position in which it is adjusted.

The sleeve 13 is provided with an inlet port 25 and an outlet port 26, here shown as diametrically opposite although this relationship is not important. In the plug is a groove having an axially inclined portion 27 and a portion 28 connecting therewith and lying in the same plane as the port 26. As the valve plug is rotated the inclined part 27 of the groove gradually rides over the edge of the inlet port, and as the angle of inclination can be made as gentle as desired the change in speed as the valve plug is turned can be made very gradual and accurate. The action has been shown in Fig. 4, where for the purpose of clarity the port has been shifted along the groove rather than vice versa.

The shape of the groove depends upon two factors, which can be combined to produce whatever over-all effect may be wished. The first of these is the relation between volume of the flow of liquid through the throttle and the area of port exposed. On the lower range, which is the most important, the flow will vary about in proportion to the 0.7 power of the exposed area, and this law may be assumed with reasonable accuracy for the workable range. The exact proportion will vary somewhat as the size and shape of the area changes, but the flow in general can be expressed with reasonable accuracy as being proportional to some power of the area in the range of 0.5 to 0.7. Stating this inversely, in order to keep constant increments of flow between uniform increments of displacement of the valve, the area uncovered should be proportional to the 1.4 power of the amount of rotation of the plug.

Using these values it is possible to proportion the pitch of the generally helical groove 27 to give whatever type of spacing of the graduations on the dial may be desired. In Fig. 3 has been shown an arrangement in which uniformly spaced graduations on the dial will produce proportional changes in the volume of flow of the fluid. In the case shown suitable proportions may be given as an example for a valve plug of 1¼" diameter. It should be noted that the groove has been formed in short helical segments of differing pitch, giving an approximation only to the smooth theoretical curve but facilitating the machining in many cases and giving sufficiently accurate results for most practical purposes. In this case inclination of the groove is 0.015" in the first 40°; 0.035" in the next 50°; and 0.081" in the next 40°.

Instead of changing the pitch of the groove to control the area of port exposed a helical groove may be used and a port of specially designed shape employed. This is of particular utility in cases where it is desired to preserve especial accuracy in the setting for the lower flows. One form of port opening for this purpose is shown at 30 in Figs. 5 and 6, which cooperates

with a helical groove 31. In this case the cusped shape of the port is obtained by forming its sides in curves which are convex inwardly. It is obvious that the exact shape of the curved sides of the port will be determined by the manner in which it is desired to have the feeding rates of the driven member vary with respect to the graduations on the control dial. The form shown has particular reference where for equal divisions on the dial it is desired to have the feeding rates varying in a geometrical progression, as is frequently the case in certain machine tools. If the groove in the plug be made helical the desired result will be obtained very closely if the maximum width of slot exposed at any dial setting is an exponential function of that setting. The area exposed thus increases slowly at first and very rapidly as the dial settings become larger. The use of the sleeve 13 is of considerable importance from this standpoint. For special curves such as is shown on Fig. 6 the port is best shaped with a formed tool, which is difficult to do unless the port is in a piece such as a sleeve which is readily accessible. Furthermore, the provision of a ported sleeve makes it possible to secure any desired relationship between dial setting and feed rate by choosing the proper sleeve in assembly, leaving all other parts standard. If this structure is used the sleeve is preferably made in two parts 32 and 33 as shown in Fig. 6, the former containing the notch forming the port 30 and the latter being formed as a plain cylindrical annulus. The notch is accessible from the end of the section 32 and may be formed much more readily than a hole through an integral sleeve. The sleeve portion 33 may be replaced by a shouldered part of the casing as it acts functionally only as a part of the bore; but in order to insure continuity in the surface of the bore and to permit hardening, grinding, and lapping the two part construction illustrated is preferable.

What I claim is:

A throttle valve for speed control of hydraulically operated machine tools and the like, comprising a casing having a shouldered bore, a sleeve fitting into the bore with one end against the shoulder, a plug fitting into the sleeve and provided with a circumferential flange abutting the second end of the sleeve, a cap engaging the opposite side of the flange, a port in the sleeve, a groove peripherally formed in the plug and having an axially inclined portion positioned to uncover the port progressively during the rotation of the plug, and a second port in the sleeve, said groove having a second portion positioned to connect with the second port throughout the active rotation of the plug.

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