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(54) **Material cutting apparatus.**

(57) A drive arrangement for a cutter blade, wherein operational cutting movement of the blade (11) is arranged to be derived from a servo-type motor (9) whose output is so controllable as to provide a drive output voltage/time relationship which produces a rapid initial acceleration from rest to a value which produces such angular velocity of the output shaft (10) of the motor as to establish a pretermined torque (angular momentum) in the blade (11) sufficient to cause the blade to effect a material cutting stroke and then on completion of a blade cutting stoke a rapid deceleration to bring the output shaft and thus the blade to a rest position.

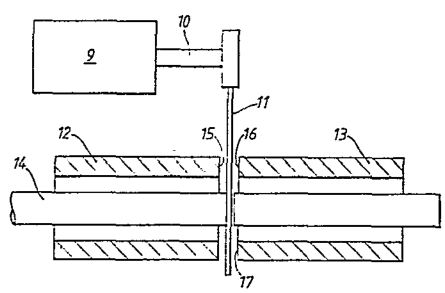

Fig. 3.

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Description

MATERIAL CUTTING APPARATUS

This invention relates to material cutting apparatus and more particularly, but not exclusively, to the cutting of plastics material in strip form.

It is a very important requirement to be able to cut continuous lengths of plastics of rectangular or other sectionstrip, tubing, profiled strip forms or the like on a continuous basis so that, for example, extremely long lengths of tubing may be cut into accurately defined lengths of required sizes.

As is well known plastics materials take many forms and, for example, in the case of plastics tubing the physical nature of the tubing can vary over a wide range of factors including, for example, cross section, diameters, flexibility, hardness, resistance to cut and so on.

It is well known to cut such material using a rotatable blade which is caused to rotate through a predetermined cutting zone into which the material to be cut is progressively fed. Conventionally means may be provided for determining the cut length.

Thus, for example, the material to be cut can be fed through a pair of aligned guides spaced apart by a distance sufficient to allow the operational passage of the cutter blade through the gap between the guides.

Stop means can be provided for locating the free end of the material to be cut when cooperating with the guides thereby to set the cut length.

With the known apparatus, as a consequence of the widely differing forms of plastics materials to be cut even in the case of strip or tubing, it has been considered essential to provide cutting apparatus which incorporates a cutter blade mounted from a mandrel which is connected to receive drive from an electric motor by way of a clutch unit or assembly, control means being provided to sequence the operation of the clutch unit or assembly with the cutter blade cutting cycle.

The conventional arrangement is for the cutter blade to effect a cut once per revolution and for the blade to come to rest between each cutting revolution to provide a dwell time within which the feed of material to attain the next length to be cut is completed.

Alternatively, and/or in conjunction therewith the material to be cut can be fed to the cutting zone by a pushing or puller arrangement as may be found convenient.

Since the arrangement is that after the cutter blade has been rotated through a complete revolution it has to be brought to rest and then restarted to commence the next revolution it follows that the clutch unit or assembly needs to be able to enable stopping and starting of the drive from the motor to the cutter blade rapidly and efficiently.

As a result of the demand for high rates of cutting in production in industrial terms it is highly desirable that the cutting rate should be as rapid as possible, and in fact the rate of cutting is conventionally considered in terms of hundreds of cuts per minute.

Since each revolution involves starting and stopping it will be appreciated that the clutch units need to be able to stop and start the drive from the motor to the cutter blade at twice the desired cutting rate.

In practice, the demand for a high rate of cutting has resulted in excessive wear and tear on the clutch units and thus early (in terms of useful working life) break down of the clutches being used. In practice, the provision of higher rated output motors and heavy and heaver clutch units has not eliminated the problem.

These difficulties have been found not only to relate to mechanical forms of clutches such as friction plate clutches but also to vacuum types of clutches.

It is an object of the present invention to provide apparatus which avoids the problems arising from the utilisation of clutches in apparatus for cutting plastics material of the kind above mentioned.

In investigating the requirements for overcoming the difficulties met with known apparatus the Applicants have found in accordance with the concepts of the invention that optimum cutting performance and quality is related to the rate of cut, that is the angular momentum of the cutter blade. Since the cutter blade is required to be of a relatively light weight and size, e.g., 50 mm. in length, 15mm. deep and some 1,5 mm. in blade thickness the angular cutting velocity needs to be high so as to achieve effective cutting momentum.

Thus, in accordance with a first aspect of the invention the drive arrangements for the cutter blade are such that the angular velocity (rate of rotation per unit of time) of the blade is arranged to be independent of the number of cutting revolutions of the blade for the same unit of time.

In accordance with a particular aspect of the invention drive for a cutter blade is derived from a servo-type motor whose output is so controllable as to provide a drive output voltage/time relationship which produces a rapid initial acceleration from rest to a value which produces such angular velocity of the output shaft as to establish a pretermined torque (angular momentum) in the blade sufficient to cause the blade to effect a material cutting stroke and then on completion of a blade cutting stoke a rapid deceleration to bring the output shaft and thus the blade to a rest position.

Conveniently, the blade is mounted for rotational operation, and the rate of the rotation of the blade is arranged to be greater than the number of cuts effected in the same unit of time.

Preferably, the blade is rotationally mounted directly to said output shaft or to said output shaft by way of a drive transmission which can be a fixed ratio drive or a variable ratio drive.

In particular, the relationship between the angular velocity of the blade and the number of cutting strokes for the same unit of time is selectivley adjustable.

Conveniently, the drive arrangement is so mounted from a support means such that the cutter blade is overhangs means for collecting the cut material.

Preferably, guide means are provided for the material to be cut, said guide means including a guide tube, sleeve, channel or the like located both upstream and downstream of the cutter blade whereby the adjacent end regions of the guides define a gap or space through which the blade is able operationally to pass during its cutting operation, the arrangement being such that the material to be cut is supported on both sides of the region of cut.

For a better understanding of the invention and to show how to carry the same into effect reference will now be made to the accompanying drawings in which:-

Figure 1 schematically illustrates in side view apparatus for cutting elongate or strip marerial;

Figure 2 is a front view of the apparatus of Figure 1;

Figure 3 is a schematic representation to an enlarged scale of a detail of the apparatus of Figures 1 and 2.

Figure 4 illustrates schematically a graphical plot relating a possible output voltage/time relationship for the output of a motor and thus a blade controlled in accordance with the proposals of the invention.

Referring now to Figures 1, 2 and 3. The machine shown therein comprises three major sections, a bottom section 1, a central section 2, and a top section 3.

The bottom section 1 which provides a generally rectangularly shaped housing 4 for control systems and equipment for effecting control and the requisite inter-relating of the operation of the various components of the apparatus. As will be seen from Figures 1 and 2 the upper surface 5 of the housing 4 presents a flat table like surface.

The bottom section is mounted upon wheels 6, therebeing bracing means 7 for restraining the apparatus against movement during use.

The central section 2 as can be seen from the drawings is so shaped as to form, as seen in side view, with the bottom section a generally C-shape formation whereby the upper part 8 of the central section 2 overhangs the top surface 5 of the bottom section 1. The central section 5 provides a housing and support for a servo-type electric motor 9 whose output shaft 10 mounts the cutter blade 11 of the apparatus.

A pair of guides 12 and 13 for supporting material to be cut is mounted to the structure of the upper part 8 of the central section 2. The guides 12 and 13 each comprises a hollow tubular member through the central bore 14 of which the material 15 to be cut is arranged to be fed. The guides 12 and 13 are so mounted that the facing ends 16 and 17 thereof are spaced apart to provide a gap 18 through which the cutter blade 11 is able operationally to pass during its cutting operation.

The control apparatus provided in the bottom section 1 is adapted to produce output control signals which allow control of the operation of the motor such that the output shaft thereof can be caused to rotate according to a predefined angular velocity profile which is represented by the graphical plot of Figure 4.

In addition, the control system will enable the setting and adjustment of any parameters considered necessary to the control of effective cutting.

As will be noted the profile indicates that the output shaft 10 of the motor 9 is rapidly accelerated from a rest condition (point A) to a cutting velocity (point B) which is maintained for the major part of a blade revolution (from point B to a point C). At the end of this period the output from the motor is reduced to zero as rapidly as possible (that is from point 6 to point D). It will be noted from the profile that a considerable portion, namely from point B to point C, of the rotation period for the shaft is at the required cutting speed whereby the angular momentum of the blade at the time of cutting is as high as possible.

The rate of rotation for the blade 11 is arranged to be at, for example, a relatively high speed as compared with conventional apparatus for cutting similar materials. For example, the rotational speed can be with a range of, for instance, 600 to 1000 revolutions per minute. A particular range can be from 750 to 950 with a particular value of, for example, 900.

At the same time the control arrangements are arranged to control the motor so that the number of operation cycles per unit time is considerably less than the rate of rotation. Thus, for instance, it is proposed that the number of cycles per unit time can be in the range 300 to 700 with a particular range of 400 to 700. In the case of a blade rotation rate of 900 revolutions per unit time the number of cutting cycles can be 500.

The upper section 4 houses a number of control switches or the like, the switches being exemplified by the switching and operational conditions indicator panel 19. The panel 19 can indicate total number of cuts made, can indicate and enable setting of factors such as cutting rates, cutting speeds, cut lengths of materials being cut etc.

It will be noted from the drawings that the cutting zone of the apparatus overhangs the bottom section top surface 5. This arrangement makes it possible for cut material collection means, conveyors or the like to be conveniently located below the cutting zone.

It will be appreciated that although the drawings indicate that the cutter blade 11 is mounted directly to the motor shaft 10 the motor could be connected to rotate the cutter blade through a convenient drive transmission. This could be a variable speed drive of any convenient form or a fixed ratio drive.

It has been found that the consequences of the Applicant's proposals according to the invention of eliminating the use of clutch units or assemblies in the drive to the cutter blade and effectively separating the rate per unit of time of blade rotation from the number of operational cycles for the same unit of time of the cutter blade by, in particular, rotating the cutting blades at an effective rotational rate greater than the number of cuts per unit of time, include factors such that the blade is able to cut through a wide range of thicknesses of material and through materials comprising a wide range of physical strengths for the material being cut using the same power rating for a drive motor whose horse power rating can considerably lower than that hitherto considered necessary for the cutting of the same forms of material.

Examination of the cuts produced by the apparatus of the invention indicates a very clean smooth surface finish to the cut surface as compared with the nature of the cut surfaces produced by known apparatus.

This is believed to arise from the fact that the high speed of blade rotation is accompanied by high torque arising from the fact that a relatively lengthy period is enabled within a revolution during which the blade is travelling at the high velocity.

Claims

1. A drive arrangement for a cutter blade is such that the angular velocity (rate of rotation per unit of time) of the blade is arranged to be independent of the number of cutting strokes of the blade for the same unit of time.

2. A drive arrangement as claimed in claim 1, and wherein the blade is mounted for rotational operation, and wherein rate of the rotation of the blade is arranged to be greater than the number of cuts effected in the same unit of time

3. A drive arrangement for a cutter blade, wherein operational cutting movement of the blade is arranged to be derived from a servo-type motor whose output is so controllable as to provide a drive output voltage/time relationship which produces a rapid initial acceleration from rest to a value which produces such angular velocity of the output shaft of the motor as to establish a pretermined torque (angular momentum) in the blade sufficient to cause the blade to effect a material cutting stroke and then on completion of a blade cutting stoke a rapid deceleration to bring the output shaft and thus the blade to a rest position.

4. A drive arrangement as claimed in claim 3, and wherein the blade is mounted for rotational operation and wherein rate of the rotation of the blade is arranged to be greater than the number of cuts effected in the same unit of time.

5. A drive arrangement as claimed in claim 3 or 4, and wherein the blade is rotationally mounted directly to said output shaft or to said output shaft by way of a drive transmission which can be a fixed ratio drive or a variable ratio drive.

6. A drive arrangement as claimed in any preceding claim, wherein the relationship between the angular velocity of the blade and the number of cutting strokes for the same unit of time is selectively adjustable.

7. A drive arrangement constructed and arranged to operate substantially as hereinbefore described with reference to the accompanying drawings.

8. Apparatus for incorporating a drive arrangement as claimed in any preceding claim, wherein the drive arrangement is so mounted from a support means that the cutter blade is overhangs means for collecting the cut material.

9. Apparatus as claimed in claim 9, in which the cut material collection means includes a conveyor or the like.

10. Apparatus as claimed in claim 8 or 9, and in which guide means are provided for the material to be cut, said guide means including a guide tube, sleeve, channel or the like located both upstream and downstream of the cutter blade whereby the adjacent end regions of the guides define a gap or space through which the blade is able operationally to pass during its cutting operation, the arrangement being such that the material to be cut is supported on both sides of the region of cut.

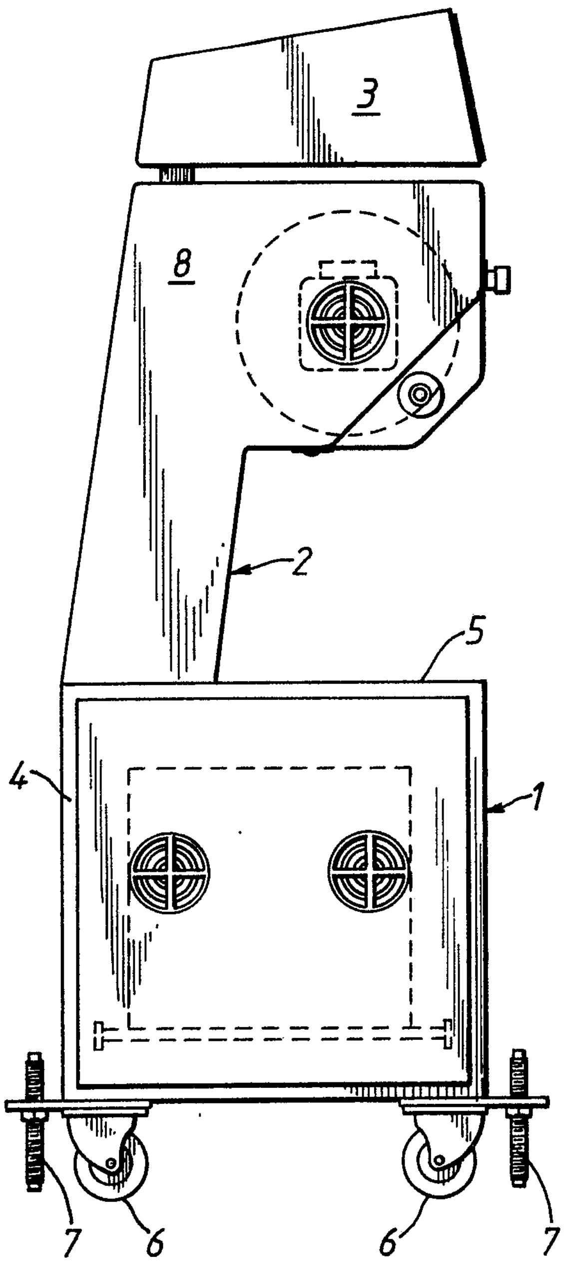


Fig. 1.

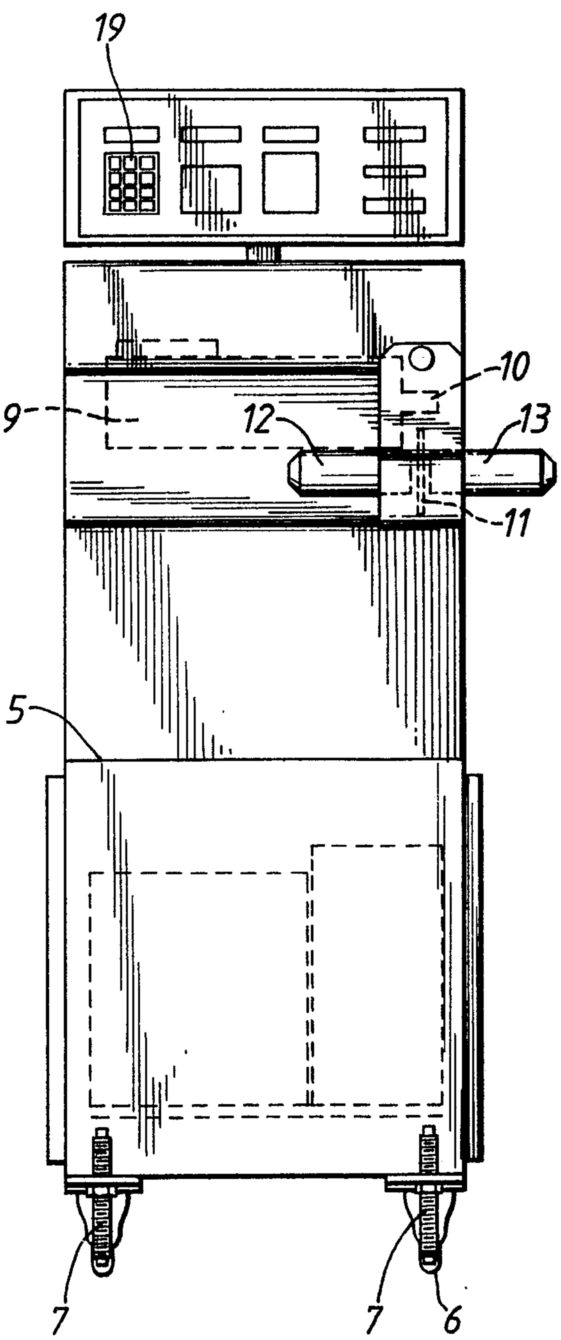
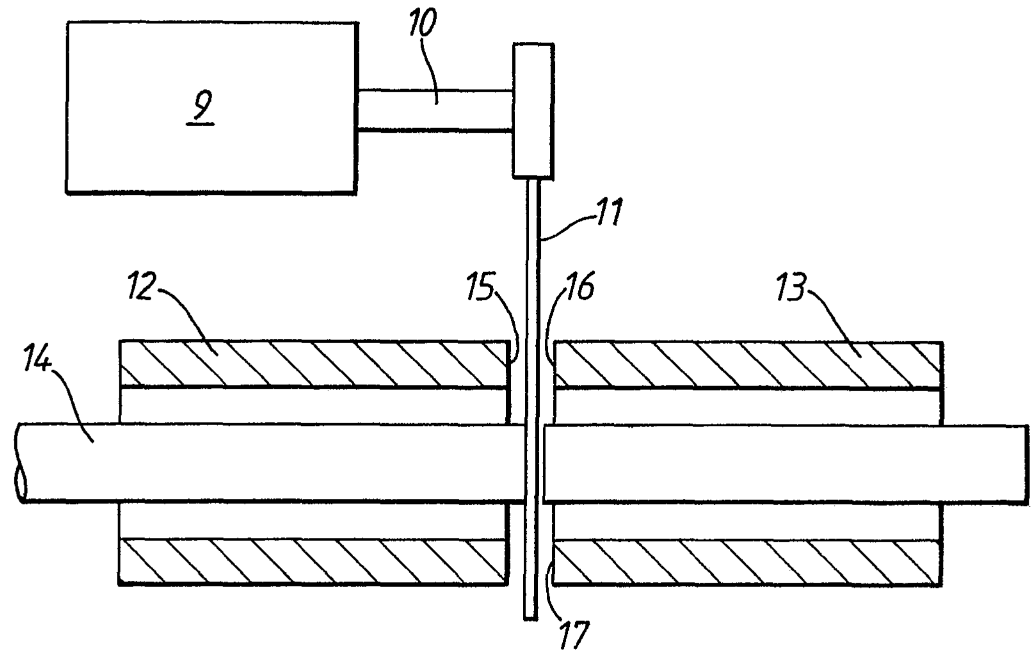


Fig. 2.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11
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Fig. 3.

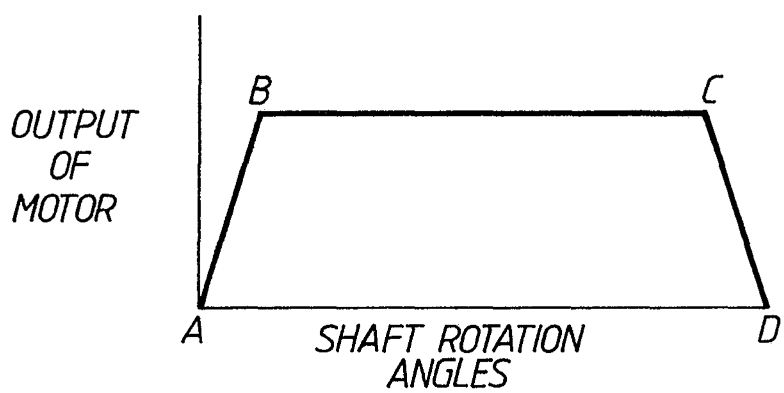
OUTPUT
OF
MOTOR
B
C
A
D
SHAFT ROTATION
ANGLES

Fig. 4.