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(54) **Lug type extruder screw.**

(57) An extruder screw that enables mixing of viscous materials, such as rubber mixtures and thermoplastic materials, is disclosed. The screw includes a core extending from a sealing end to a nose cone end. At least one flight extends radially from the core in a quasi-helical pattern, wherein flights adjacent one another form channels therebetween. A plurality of elongate lugs extend radially from the core and are disposed in the channels. The shape as well as the number of lugs can be varied to ensure the requirements for a thorough and turbulent deflection and mixing of the material stream.

NL C 2006334

NL15654-ZO/mr

LUG TYPE EXTRUDER SCREW

TECHNICAL FIELD

The invention relates to a method and apparatus for the processing or mixing of highly viscous materials such as rubber mixtures in a single screw extruder. More particularly, the present invention relates to an extruder screw which has a thread flight with a mixing region that includes a plurality of mixing lugs that have varied angles and heights with respect to flights of the extruder screw.

BACKGROUND ART

It is known in the art of processing or mixing highly viscous materials, such as rubber, to subject the material to a kneading and blending in an extruder having a screw rotating inside a housing section. The screw can have a single flight or a plurality of flights of the screw thread. The pitch or lead of any flight as well as the depth of the screw channel between the flights can be constant or variable. In the method, different mixing means are used to achieve a satisfactory blending of the material during its feed along the screw.

It is for instance known to change the lead or pitch of the screw flights at periodic or variable intervals or to interpolate reversibly directed flights of the screw threads or to interrupt the thread of the screw by gaps. As the screw rotates, the material is directed into vortex-like patterns that bring about a blending of the various and irregular flow paths caused by these mixing means.

Although prior art extruder screws have used pins or ramps between screw flights to facilitate mixing, these embodiments have still been found to be somewhat limited in their ability to fully mix the rubber material. Accordingly, there is a need in

the art to provide an extruder screw with lugs that permit mixing of rubber or other polymeric material while still allowing the material to flow easily through the housing section without adversely affecting the material's flow rate or the molecular structure of the material.

SUMMARY OF THE INVENTION

In light of the foregoing, it is a first aspect of the present invention to provide a lug type extruder screw.

It is the object of the invention to achieve a satisfactory mixing and homogenizing effect of the material in the processing of highly viscous materials with a high material flow rate through the extruder. According to the invention the material flow is substantially in a forward-directed movement through the extruder. The extruder comprises of a single screw rotating inside a housing section with a plurality of obstacles, such as shaped lugs, which are attached to a root area between the screw threads. The thickness, shape and number of these lugs can be varied according to the materials subjected to mixing and the degree of mixing desired.

The flow path of the material through the extruder and along the screw is therefore subject to local vortex formations of the material. At the interface between the material and the housing section and the screw thread, respectively, there is a continuous change in the surfaces within the material which comes in contact, bringing about an intensive exchange of material and heat.

Furthermore, in cooperation with the screw, there is elevation, to a large extent, in the shearing flow within the material as a result of high pressure gradients. In addition a high material flow rate is possible accomplished by an optimum mechanical and thermal homogeneity of the extruded product.

The lugs are selectively arranged along the root channel of the screw. The shape of all or any of the lugs can be provided with a desired shape or the like to increase or decrease flow resistance.

Another aspect of the present invention is to provide an extruder screw adapted for receipt in a barrel of an extruder comprising a core extending from a sealing end to a nose cone end, at least one flight extending radially from the core in a quasi-helical pattern, wherein flights adjacent one another form channels therebetween, and a plurality of elongate lugs extending radially from the core and are disposed in the channels.

BRIEF DESCRIPTION OF THE DRAWINGS

For a complete understanding of the objects, techniques and structure of the invention, reference should be made to the following detailed description and accompanying drawings, wherein:

Fig. 1 shows an elevational view of an extruder screw in accordance with the concepts of the present invention, wherein the screw comprises at least a drive end, a collecting section, a mixing section, a changeable extrusion section and a changeable nose cone end;

Figs. 1A-1C show detailed views of the extruder screw in accordance with the concepts of the present invention, wherein Fig. 1A shows a detailed view of the collection section, Fig. 1B shows a detailed view of the mixing section; and Fig. 1C shows a detailed view of the changeable extrusion section;

Fig. 2 shows an elevational view of the changeable extrusion section without lugs according to the concepts of the present invention;

Fig. 3 shows an elevational view of the changeable extrusion section with lugs according to the concepts of the present invention;

Fig. 4 shows an elevational view of the changeable nose end of the single screw according to the concepts of the present invention; and

Figs. 5A and 5B show perspective views of the extruder screw made in accordance with the concepts of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to all of the drawings and, in particular to Fig. 1, it can be seen that an extruder screw is designated generally by the numeral 10. The screw 10 is maintained in a housing or barrel section of an extruder which is typically heated and/or cooled during operation. As polymeric material such as rubber, enters the housing, the material is heated and flows through the barrel section as the screw is rotated. Material exits the barrel section and is forced through a tip/die configuration or into a mold to take on a desired final or intermediate shape.

The extruder screw 10 has a number of sections. Specifically, the screw includes a drive end 12 coupled to a drive mechanism of an extruder system. Typically the drive system or drive mechanism is powered by an electric motor, mechanical gearing and/or hydraulic systems. Extending from the drive end 12 is a sealing section 14 which separates the drive end 12 from the remainder of the extruder screw. The sealing section 14 prevents polymeric material from entering the drive mechanism. A collecting section 16 extends from the sealing section and receives polymeric material which is typically in strip, slab or other form through a hopper opening in the barrel which holds the extruder screw. A mixing section 18 extends from the collecting section 16 and further mixes the polymeric material into a desired consistency. Based on the heating/cooling applied to the barrel that holds the screw and configuration of the mixing section, the desired flow properties of the polymeric material are obtained. The mixing section 18 may include a changeable extrusion section 20 which may be provided either with a lug-free section 22 as shown in Fig. 2 or lug sections 24 as shown in Fig. 3. Extending from the extrusion section 20 is a changeable nose cone 26. The nose cone 26 interfits with the appropriate extrusion tip/die or mold

configuration. Skilled artisans will appreciate that the screw 20 may be provided as a single integral piece or that the various sections may be configured to be secured to one another. This is clearly evident in Figs. 2-4 wherein the extrusion section 20 has a threaded extension end that is receivable in an appropriate threaded receptacle of the mixing section 18. Likewise, the cone 26 is provided with a threaded fitting so as to be received in an appropriate end of the mixing section 18.

Throughout all of the sections of the extruder a root or core, designated generally by the numeral 30, extends from the sealing end 14 to the nose cone 26. The root 30 varies in diameter through the various sections so as to facilitate the mixing of the polymeric material. The root 30 includes a center line 32 which is the rotational axis of the extruder screw as it is rotated by the drive mechanism. It will be appreciated that appropriate bearings and support are provided to the extruder screw so that it rotates in a proper manner within the housing or barrel section of the extruder.

Extending radially from the root 30 is at least one flight designated generally by the numeral 34. Indeed, the flight or flights extend from the core in a quasi-helical pattern. In the embodiment shown, two flights are provided and designated by the numerals 34a and 34b. The flights have the same outer diameter and are sized to be slightly smaller than the barrel inner diameter to allow for rotation of the extruder screw within the barrel. It will be appreciated that the fit between the outer diameter of the flights and the inner diameter of the barrel is of such a close fit so as to ensure that the molten polymeric material is pushed out of the screw in a predetermined rate. In the embodiment shown, the flights are spaced about 180 degrees

apart from one another so as to provide for uniform mixing. It will further be appreciated that a single flight or more than one flight may be used by the extruder screw. Each flight 34 includes a flight ridge 36 which is in close proximity to the inner diameter of the sleeve or barrel of the extruder system.

The ridge or ridges 36 may be provided with notches 38 so as to allow for a back flow of polymeric material as the screw is rotated. Each flight forces the material forward toward the nose cone 26, however the notches allow some material to back track for additional mixing with other material. Channels 40 are formed between each flight ridge 36.

A plurality of lugs 50 radially extend from the root 30 and are disposed between the flights 34. In other words, each lug 50 extends upwardly from the root 30 and into the channels 40. The lugs 50 are provided in the mixing region adjacent the collecting section and may extend to the nose cone. As shown in the drawings, the lugs are positioned at 90 degree radial intervals about the root. Of course, the radial intervals can be varied as needed.

Each flight 34 has an angular orientation that facilitates the mixing of the polymeric material. Specifically, a flight angle 52 is associated with each flight 34. The flight angle 52 is determined by extending a line along the slope of each ridge and intersecting that line with the center line 32. In the embodiment shown, the flight angle varies from the sealing end to the nose cone depending upon the particular section and the mixing parameters desired. As shown in Figs. 1A and 1B, the flight angle may range anywhere from about 120° proximal the sealing end to about 100° proximal the nose cone end.

Each lug 50 is provided with an elongate section 60 which is formed from opposed sides 62 that are connected by opposed ends 64. The sides 62 and ends 64 are terminated with a crown 66 which forms the top of each lug 50. The dimensions of the lug features vary depending on their position along the length of the screw and are based on compound evaluations to ensure adequate mixing of the compound. A lug angle 54 is associated with each lug 50 and is determined by extending a line along the slope or angular direction of each crown and intersecting that line with the center line 32. As best seen in Fig. 1B, the lugs are provided with lug angles 54 which range anywhere from about

120° starting at the end of the collecting section to about a 155° angle at the extrusion section. As can be seen from Fig. 1, the lug angles 54 are slightly different from the flight angles 52 of the flights that are immediately adjacent the lugs. It will further be appreciated that a mid-point of the lugs along the elongate section 60 may be aligned with the notches 38.

As discussed, each elongate lug 50 has a lug angle 54 with respect to the center line such that the lug angles are progressively increased from the sealing end to the nose cone end. Although the lug angles can vary as needed, in most embodiments the lug angles range from 95° to 175° with respect to the center line 32. In a similar manner, the flight angles progressively decrease from the sealing end to the nose cone end may vary and can range anywhere from 95° to about 175°. It will further be appreciated that the flight angle is configured such that each lug angle is greater than the flight angles of adjacent flights. In other words, each lug angle disposed between flights has an angle that is greater than the flight angles to which they are closest to. It will further be appreciated that the elongate sides of the lugs are substantially angularly aligned with the flights adjacent thereto. Specifically, the elongate sides and the adjacent flight angles are aligned within about 25° of each other with respect to the center line.

A further feature of the extruder screw 10 is that the height of the lugs are offset from the flights a predetermined distance. In particular, it can be seen in Fig. 1B that an offset value 70 is associated with each lug and the flights adjacent thereto. In particular, the flight offset value is the distance measured between the crown 66 and the outer diameter of the flight ridge 36. The offset value distance becomes progressively smaller along the length of the extruder screw as the material flows toward the nose cone. In particular, it can be seen that the offset value 70 at the initial position closest the collecting section is much greater than the offset value of the lugs provided in the lug section 22.

In operation, the polymeric material is fed into the mixing section 16 where it is pushed forward by the flights 34. Where notches 38 are provided in the flights 34, a small portion of the compound flows back into a wider or earlier flight section for further mixing with the polymeric material that is more recently received from the hopper. As the material is pushed forward by the flights, it enters the mixing section 18 and the lugs 50. As will be appreciated, the angular disposition of the lugs is somewhat parallel to the flights but not exactly. This slight angle differential allows for further mixing of the material as the extruder screw rotates. It will further be appreciated that the heights of the lugs are initially such that the interference is less, but gradually increases as the lugs increase in height so as to further mix the material that comes between the crown and the inner diameter of the barrel. The angular orientation of the lugs also changes as the material travels from the collecting section toward the nose cone end 32. This further mixing facilitates the properties of the polymeric material as it exits the nose cone end. It will further be appreciated that the core diameter may also vary with the changing configuration of the lugs to further facilitate mixing.

If desired in some embodiments, it will be appreciated that the lugs may be replaceable such that different angular configurations of the lugs may be utilized. This can be done so as to determine the beneficial or adverse effects of the lugs on the polymeric material flowing through the screw. Once a desired configuration is obtained, it will be appreciated that in some embodiments the lugs will be integral with the extruder screw. Likewise, it will be appreciated that a lug-free section 22 may be used in place of a lug section 24 in the mixing section 18 as deemed appropriate.

Based on the foregoing the advantages of the present invention are readily apparent. By selectively controlling and adjusting the angular and offset parameters of the lugs, a desired mixing of a polymeric material by the screw can be obtained. It has been found that use of lugs in such a

configuration allow for the screw to be shortened in length in comparison to prior art screws. Moreover, the disclosed screw configuration is adaptable for cold feed screw designs. A cold feed extruder is one that accepts room temperature compound directly into the hopper/screw area of the extruder. A hot feed extruder is one that requires the compound to be heated by other means prior to entering the extruder. As a result, this configuration allows the compound to reach its optimum extrusion condition in much less time than prior art configurations. This is considered to be advantageous in that particular heat-sensitive compounds are being used. Skilled artisans will appreciate that if a polymeric material is maintained at an elevated temperature for an extended period of time that its molecular structure and suitability for a particular end use may be diminished. Accordingly, the present configuration allows for the polymeric material to quickly move through the extruder housing with minimal heat damage. It is also believed that the present configuration requires less power to operate inasmuch as the material flows more easily through the screw barrel.

Yet another advantage of the extruder screw 20 is that geometry and shape of the lugs can be changed to allow the user to alter the working characteristic of the extruder to match a particular criteria or standard. Standards or criteria of interest, for example, are the material temperature (to be measured preferably at the end of the screw), the flow rate and the quality of the mixture (viscosity, degree of shrinkage and homogeneity).

While there has been described a preferred embodiment of this invention, It will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, intended that such changes and modifications fall within the scope of the invention as defined by the claims.

CONCLUSIES

1. Extruderschroef geschikt voor opname in een behuizing van een extruder, omvattende:
   - een kern die zich uitstrekt van een afdichtend uiteinde tot een neuskegel-uiteinde;
   - tenminste één schroeflint dat zich radiaal vanaf de kern uitstrekt met een quasi-spiraalvormige verloop, waarbij tussen opeenvolgende schroeflintdelen kanalen worden gevormd; en
   - een aantal langwerpige nokken die zich vanaf de kern radiaal uitstrekken en die in de genoemde kanalen zijn geplaatst.

2. Extruderschroef volgens conclusie 1 waarbij de genoemde kern een lengteas heeft en waarbij elk van de genoemde langwerpige nokken onder een nokhoek staat ten opzichte van de lengteas zodanig dat de nokhoeken geleidelijk toenemen vanaf het afdichtende uiteinde tot aan het neuskegel-uiteinde.

3. Extruderschroef volgens conclusie 2 waarbij de genoemde nokhoeken ten opzichte van de lengteas tussen 95° en 175° liggen.

4. Extruderschroef volgens conclusie 2, verder omvattende een schroeflintrug bij elk van de schroeflinten, waarbij de schroeflintrug is voorzien van een aantal uitsparingen.

5. Extruderschroef volgens conclusie 4 waarbij elke nok een kruin heeft die in hoogte op een afstand ligt van de genoemde schroeflintrug, welke afstanden geleidelijk afnemen in de richting vanaf het afdichtend uiteinde naar het neuskegel-uiteinde.

6. Extruderschroef volgens conclusie 5 waarbij elke nok twee tegenover elkaar staande lengtezijden omvat die met elkaar zijn verbonden door tegenover elkaar staande uiteinden, waarbij de hoekstand van de lengtezijden in hoofdzaak is uitgelijnd met de aangrenzende schroeflintdelen.

7. Extruderschroef volgens conclusie 6 waarbij de genoemde lengtezijden binnen een hoekbereik van ongeveer 25° zijn uitgelijnd met de hoek van de naastgelegen schroeflintdelen ten opzichte van de genoemde lengteas.

8. Extruderschroef volgens conclusie 4 waarbij elke schroeflintrug onder een schroeflinthoek staat en waarbij elke nokhoek groter is dan de schroeflinthoeken van naastgelegen schroeflintdelen.

9. Extruderschroef volgens conclusie 4 verder omvattende:
een verzamelzone naast het afdichtende uiteinde; en
een mengzone tussen de verzamelzone en het neuskegel-uiteinde.

10. Extruderschroef volgens conclusie 9 waarbij in de mengzone de nokken in de kanalen zijn geplaatst met radiale tussenafstanden van ongeveer 90° vanaf een uiteinde van de verzamelzone tot aan het genoemde neuskegel-uiteinde.

11. Extruderschroef volgens conclusie 9 waarbij de mengzone een nokzone omvat naast de verzamelzone en een extrusiezone naast de nokzone, waarbij de extrusiezone de nokken omvat.

12. Extruderschroef volgens conclusie 9 waarbij de mengzone een nokzone omvat naast de verzamelzone en een

extrusiezone naast de nokzone, waarbij de extrusiezone geen nokken bevat.

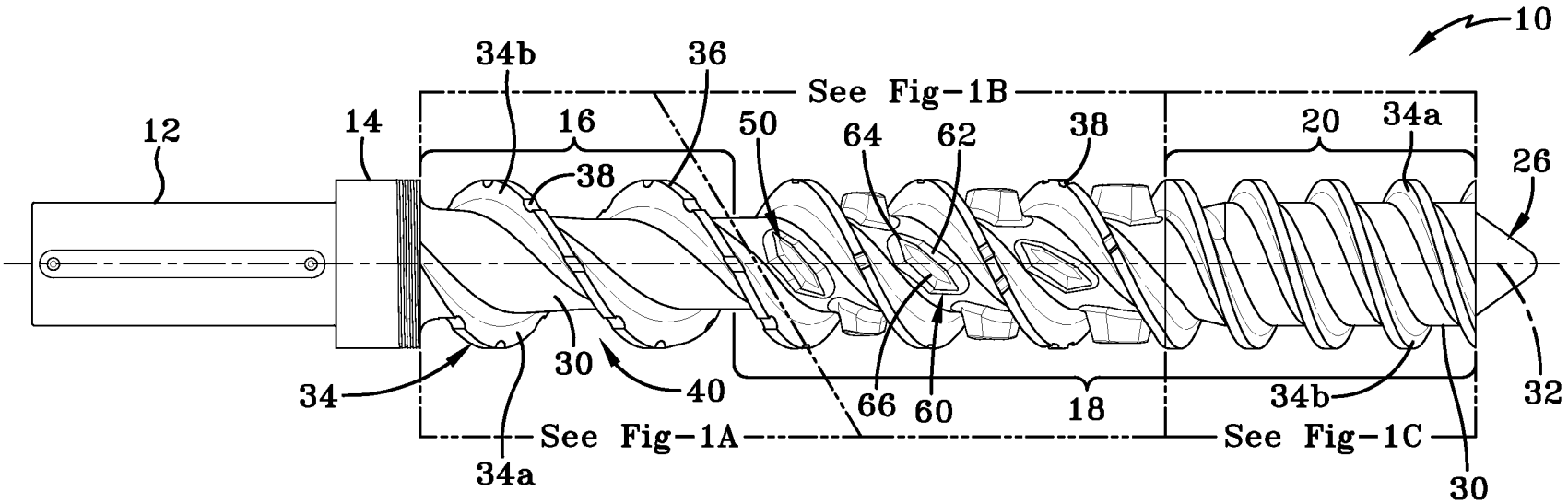


FIG-1

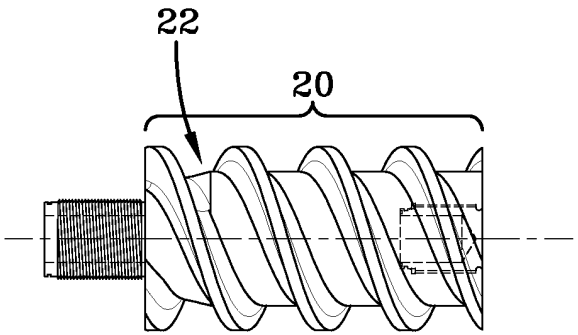


FIG-2

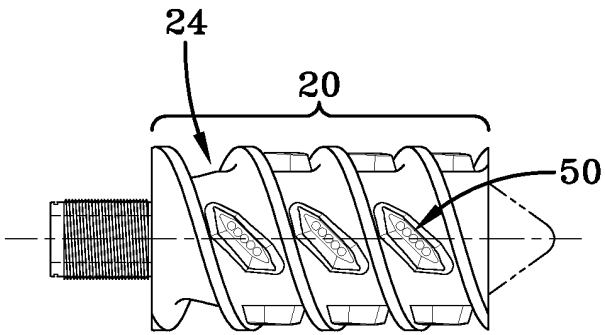


FIG-3

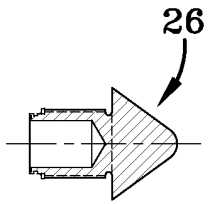
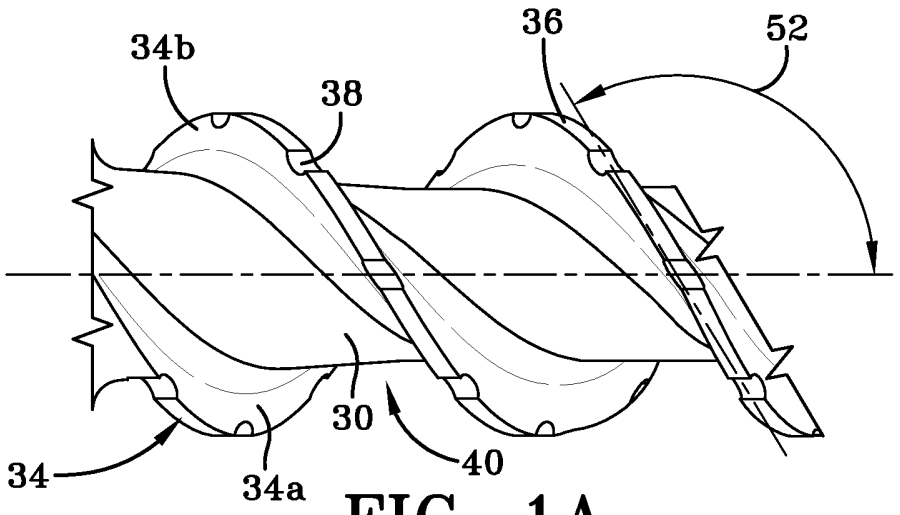
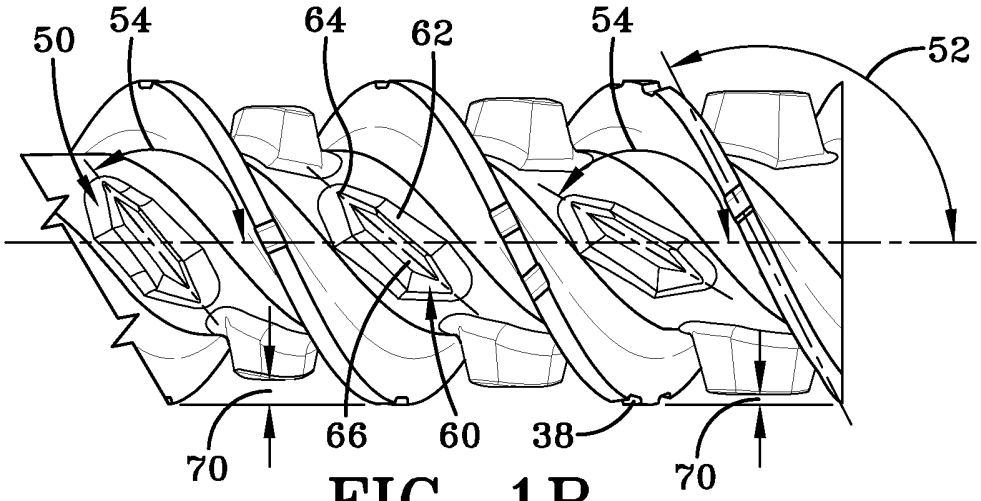


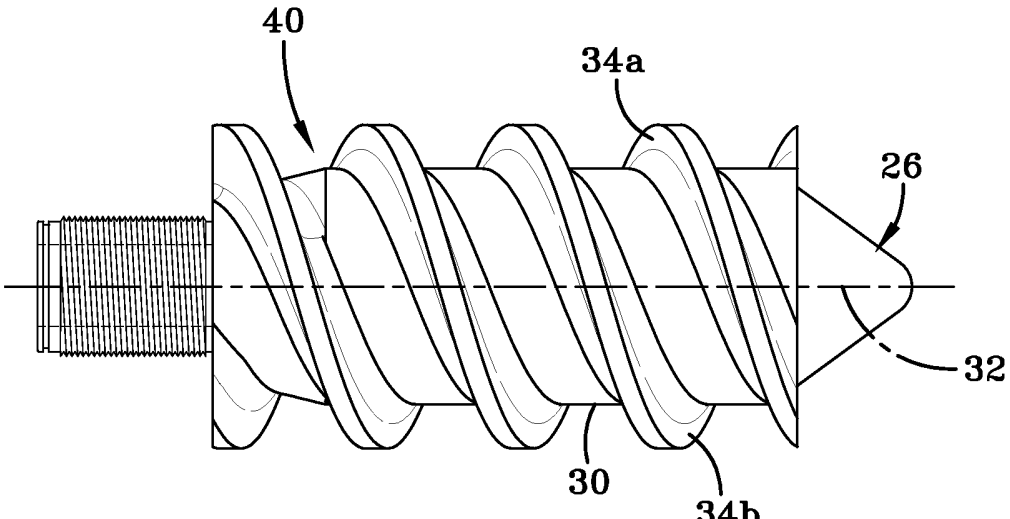
FIG-4



FIG–1A



FIG–1B



FIG–1C

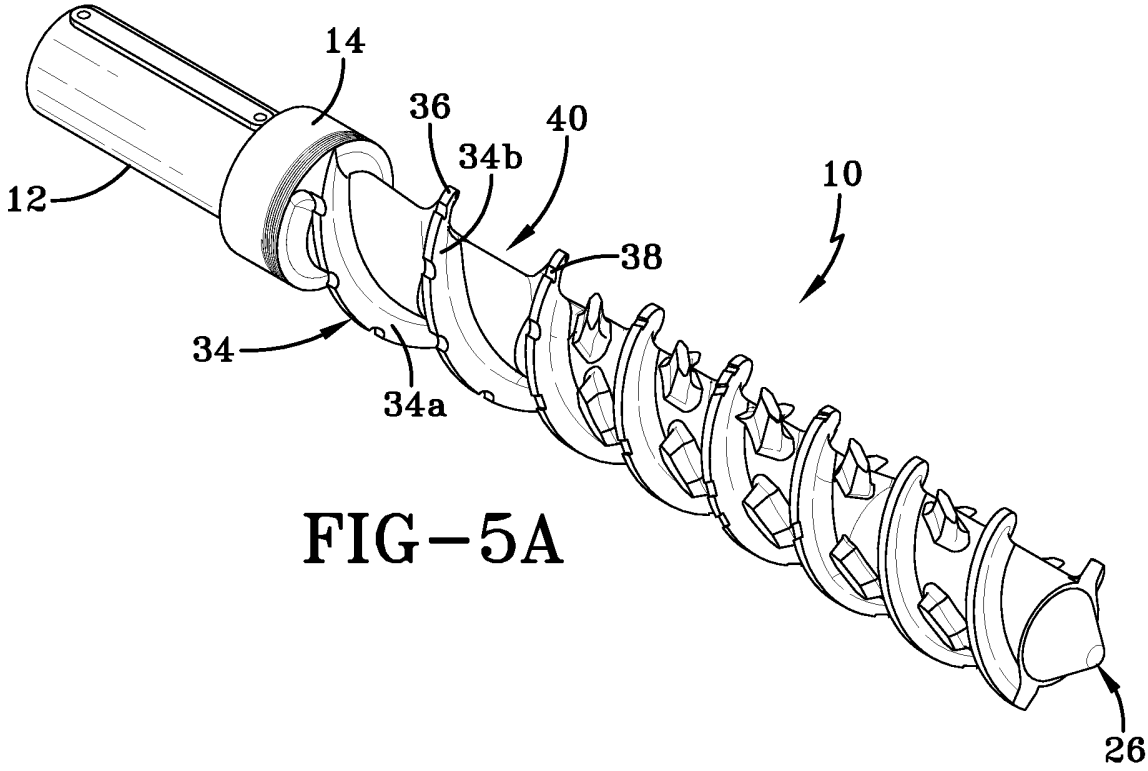


FIG-5A

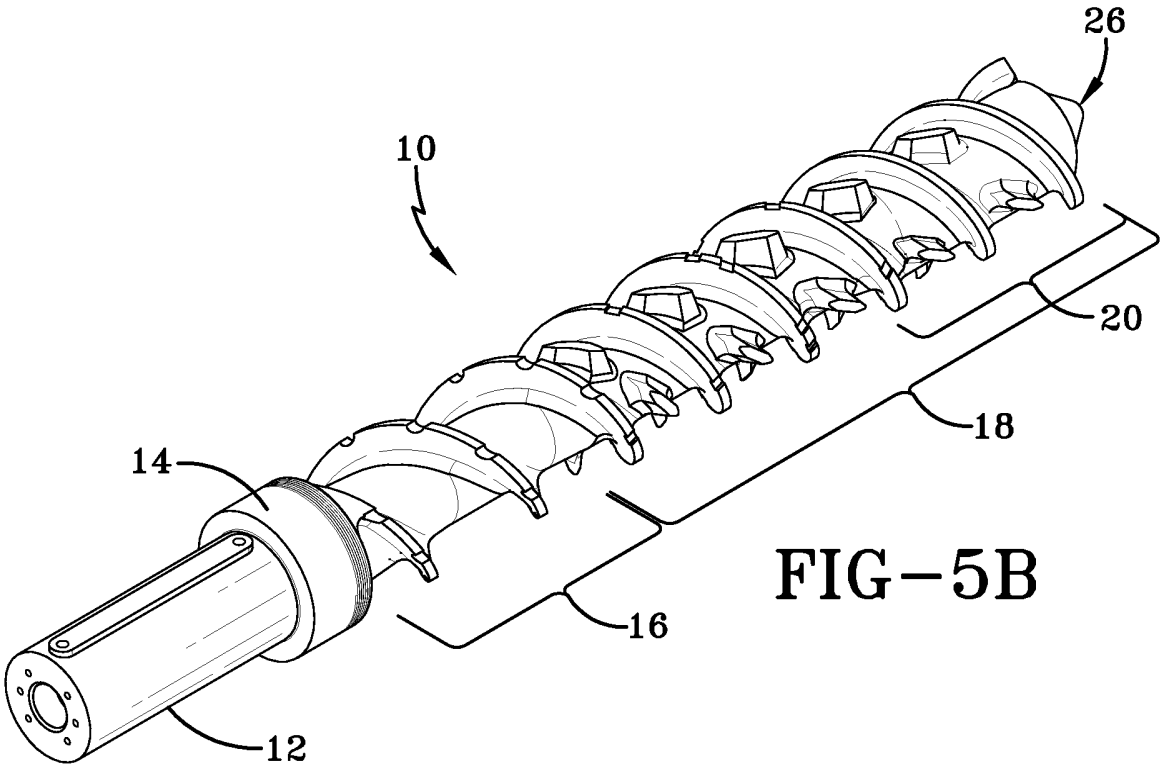


FIG-5B

Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

Octrooiaanvrage 2006334

Classificatie van het onderwerp[1]: B29C47/60	Onderzochte gebieden van de techniek[1]: B29C
Computerbestanden: EPODOC, WPI	Omvang van het onderzoek: Volledig
Datum van de onderzochte conclusies: 3 maart 2011	Niet onderzochte conclusies[2]:

Van belang zijnde literatuur

Categorie[3]	Vermelding van literatuur met aanduiding, voor zover nodig, van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr.:
X	JP 55053543 A (MATSUSHITA ELECTRIC WORKS), 19 april 1980 * PAJ samenvatting, figuren *	1-12
X	JP 51121072 A (KAWAGUCHI TETSUKOU), 22 oktober 1976 * WPI samenvatting, figuren *	1-12
X	JP 50126066 A (SUMITOMO ELECTRIC IND), 3 oktober 1975 * WPI samenvatting, figuren *	1-12
L	JP 2113918 A (HITACHI CABLE), 26 april 1990 * PAJ samenvatting, figuren *	1
L	JP 48100479 A, 18 december 1973 * figuren *	1

Datum waarop het onderzoek werd voltooid: 11 juli 2012	De bevoegde ambtenaar: Dr. M.W. de Lange **NL Octrooicentrum**

[1] Gedefinieerd volgens International Patent Classification (IPC).
[2] Voor motivering zie toelichting in de schriftelijke opinie.
[3] Verklaring van de categorie-aanduiding: zie apart blad.

Categorie van de vermelde literatuur:

X: op zichzelf van bijzonder belang zijnde stand van de techniek
Y: in samenhang met andere geciteerde literatuur van bijzonder belang zijnde stand van de techniek
A: niet tot de categorie X of Y behorende van belang zijnde stand van de techniek
O: verwijzend naar niet op schrift gestelde stand van de techniek
P: literatuur gepubliceerd tussen voorrangs- en indieningsdatum
T: niet tijdig gepubliceerde literatuur over theorie of principe ten grondslag liggend aan de uitvinding
E: octrooiliteratuur gepubliceerd op of na de indieningsdatum van de onderhavige aanvrage en waarvan de indieningsdatum of de voorrangsdatum ligt voor de indieningsdatum van de onderhavige aanvrage.
D: in de aanvrage genoemd
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie; corresponderende literatuur

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN OCTROOIAANVRAGE NR. 2006334

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooigeschriften genoemd in het rapport. De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per 19 juli 2012

De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door NL Octrooicentrum gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

In het rapport genoemd octrooi-geschrift		datum van publicatie	overeenkomend(e) geschrift(en)	datum van publicatie
JP55053543	A	1980-04-19		
JP51121072	A	1976-10-22		
JP50126066	A	1975-10-03		
JP2113918	A	1990-04-26		
JP48100479	A	1973-12-18		

SCHRIFTELIJKE OPINIE

Octrooiaanvrage 2006334

Indieningsdatum: 3 maart 2011	Voorrangsdatum: 11 maart 2010
Classificatie van het onderwerp[1]: B29C47/60	Aanvrager: RMS Equipment LLC

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

☑ Onderdeel I	Basis van de schriftelijke opinie
☑ Onderdeel II	Voorrang
☐ Onderdeel III	Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
☐ Onderdeel IV	De aanvraag heeft betrekking op meer dan één uitvinding
☑ Onderdeel V	Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
☐ Onderdeel VI	Andere geciteerde documenten
☐ Onderdeel VII	Overige gebreken
☐ Onderdeel VIII	Overige opmerkingen

De bevoegde ambtenaar:

Dr. M.W. de Lange

NL Octrooicentrum

[1] Gedefinieerd volgens International Patent Classification (IPC).

Schriftelijke Opinie

Octrooiaanvrage **2006334**

Onderdeel I Basis van de schriftelijke opinie

Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

Onderdeel II Voorrang

Deze schriftelijke opinie is opgesteld onder de aanname dat eventueel ingeroepen voorrang geldig is, tenzij hieronder anders is aangegeven. Controleren van de voorrang maakt geen deel uit van het reguliere onderzoek naar de stand van de techniek.

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies	2-12
	Nee:	Conclusies	1
Inventiviteit	Ja:	Conclusies	
	Nee:	Conclusies	2-12
Industriële toepasbaarheid	Ja:	Conclusies	1-12
	Nee:	Conclusies	

2. Literatuur en toelichting

D1 = JP 55053543 A (MATSUSHITA ELECTRIC WORKS), 19 april 1980
D2 = JP 51121072 A (KAWAGUCHI TETSUKOU), 22 oktober 1976
D3 = JP 50126066 A (SUMITOMO ELECTRIC IND), 3 oktober 1975
D4 = JP 2113918 A (HITACHI CABLE), 26 april 1990
D5 = JP 48100479 A, 18 december 1973

Uit D1 is bekend een extruderschroef geschikt voor opname in een behuizing van een extruder, omvattende:
- een kern die zich uitstrekt van een afdichtend uiteinde tot een neuskegel-uiteinde;
- tenminste één schroeflint dat zich radiaal vanaf de kern uitstrekt met een quasi-spiraalvormig verloop, waarbij tussen opeenvolgende schroeflintdelen kanalen worden gevormd; en
- een aantal langwerpige nokken ('jetty-like projections' 3) die zich vanaf de kern radiaal uitstrekken en die in de genoemde kanalen zijn geplaatst.

Zie PAJ abstract, figuren.
Conclusie 1 is niet nieuw in het licht van D1.

De nokken bekend uit D1 staan onder een nokhoek ('β') ten opzichte van de lengte-as, en elke nok omvat twee tegenover elkaar staande lengtezijden die met elkaar zijn verbonden door tegenover elkaar staande uiteinden, waarbij de lengtezijden in hoofdzaak zijn uitgelijnd met de aangrenzende schroeflintdelen. Gegeven deze informatie uit D1 en de algemene kennis van de vakman op het gebied van extrusie van visceuze materialen met schroefinrichtingen is voor de resterende volgconclusies geen inventieve vaardigheid vereist.

Verder is de extruderschroef volgens conclusie 1 ook bekend uit D2 (zie 'projections' 2a, 2c) en D3 (zie 'projections' 8).

Figuur 5(b) van D4 en figuur 4 van D5 lijken ook langwerpige nokken voor een extruderschroef te tonen maar zonder een vertaling van de beschrijving kan daar niet met zekerheid een uitspraak over worden gedaan.