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(54) **A volume-control regulation procedure for plastic processing of material by cross-sectional reduction, and system therefor.**

Verfahren und System zum Steuern eines Ziehverfahrens durch Volumenmessung

Procédé et système de réglage d'un procédé d'étirage par mesure de volume

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EP 0 976 465 B1

Description

[0001] The invention refers to systems and procedures for processing of material without removal of the same and involving a cross-sectional reduction according to the preamble of claims 1 and 5 (see e.g. JP-A-56053817). In the following, reference will be made more in particular to a drawbench system.

[0002] In a drawbench, a metal wire is reduced in diameter by passing through one or more consecutive die plates. The metal wire is drawn through the die plates by tensile force applied by rollers or capstans set between the die plates, in particular after each die plate. To ensure proper operation of the system, it is necessary for the speeds of the capstans to be co-ordinated so that there is not too much slack between one capstan and another, and at the same time there should not be an excessive tensile force applied. The last capstan downstream dictates what should be the speed of the capstan or capstans upstream. The control of speed of the capstans is generally entrusted, in known systems, to a sensing device referred to as "dandy roll", which detects the slack in the wire at a location between one capstan and another. The "dandy roll" device comprises a feeler, generally a roller feeler, which is pushed against the wire or sheet material of the drawing line (or generally reduced-cross section plastic processing line). By detecting the variation in position of the feeler, which depend upon the slack of the material, a correction is made in the speed of the capstan or capstans upstream according to the variation detected. This type of regulation may present some drawbacks; for example, an instability of correction or hunting, which may even, in the case of wire, cause breaking of the wire. In addition, in the case once again of wire, since the "dandy" device has limited extension across the wire, it limits the possibility of filling the capstans, whereas it would be desirable tc have a greater width of filling of the latter for the purpose of cooling the wire. Furthermore, the tension exerted by the action of the "dandy" on the wire itself may in some cases, cause a problem inherent slipping of the wire on the capstan, thus leading to a limitation of the possibility of filling the capstan.

[0003] JP-A 56053817 discloses a system for plastic processing of material by reduction of cross section (wire drawing) comprising a piece of equipment for reduction of section upstream, a piece of equipment for reduction of section downstream, and two wire gauge measuring instruments for measuring the gauge of the wire for controlling the drawing speed. The speed control is based on the assumption that the wire gauge is always indicative of the volume per unit time of wire passing through a location and on the so-called "constant volume principle", i.e. the assumption that the volume per unit time of wire in a first position of the drawing system and the volume per unit time of wire in a second position of the drawing system are identical.

[0004] Actually, the diameter often is not a reliable indication of the unitary volume. The measure of the diameter of a running wire, although taken with improved means, does not allow a sufficient precision for the purposes of speed regulation. Therefore, the principle of constant volume is wrongly applied. Moreover, the regulation errors caused by a measurement of the diameter of the wire not corresponding to the unitary volume can sum up one to the other as time passes, so that the wire becomes too loose or it is subject to an excessive traction, until the wire breaks. In order to measure or monitor the volume per unit time it is in any case necessary to monitor with the utmost precision the effective speed of the wire: this would be difficult for the precision required. For this reasons, the "dandy roll" device has been hitherto used.

[0005] An aim of the present invention is to overcome these drawbacks of the prior art.

[0006] A further aim is to achieve a system for controlling speed of the capstans in a material-processing line with reduction of cross section and without removal of material, in which there is an improved stability and/or in which it is possible to exploit a greater filling width of the capstans. These aims have been achieved with a control or regulation process, as described in Claim 1, and with a system, as described in Claim 5.

[0007] Further characteristics and advantages of the invention are defined in the dependent claims.

[0008] In other words, according to the invention, a volume per unit time of material undergoing processing is used as the control quantity to carry out regulation of capstan speed, and the volume of material per unit time is monitored by counting marks provided on said material. In particular, there is measured a volume of material per unit time that passes in a given point or location upstream of a capstan, the speed of which it is intended to control, and the volume per unit time that passes in a given point or location upstream of a reference capstan (set downstream of the capstan being controlled), and a comparison value or error signal thus obtained is used to regulate the rotational speed of the controlled capstan. The regulation of the speed is obtained generally using a feedback control loop of the PID (proportional-integral-differential) type.

[0009] An examplary embodiment of the invention will be described in the following, with reference to the attached drawings, in which:

Figure 1 is a diagram of a drawing line or system with a regulation or control according to one embodiment of the invention;
Figure 2 is a diagram of a drawing line or system with a variant to the proposed regulation.

With reference to Figure 1, a drawing line or system is designated by the generic reference 10 and is illustrated as comprising a first die plate 12, upstream, a second die plate 14, downstream, a first capstan 16, downstream of the first die plate, and a second capstan 18,

downstream of the second die plate. Capstan 16 is upstream of capstan 18. A wire being formed on the drawing line is indicated by the letter F. In particular, F' is a larger-section wire entering die plate 12, F" is a wire with intermediate cross-section between die plate 12 and die plate 14, and P'" is a reduced cross-section wire downstream of die plate 14.

[0010] It is desired to regulate rotational speed of the upstream capstan 16, according to the rotational speed of the downstream capstan 18. The capstan 16, then, is the controlled member, and the capstan 18 the reference member.

[0011] According to the invention, at a location P_1 upstream of the capstan 16, and at a location P_2 upstream of the capstan 18 and downstream of the capstan 16, the volume per unit time of wire F that passes through each of the said sections is monitored. Reference 31 is a measuring apparatus in P_1, and reference 32 is a measuring apparatus in P_2. Unit volumes V_{u1} measured in P_1 and V_{u2} measured in P_2 are compared. Since the drawing operation takes place without removal of material, for proper running of the system it should be $V_{u1} = V_{u2}$. In practice, however, V_{u1} is frequently different from V_{u2}. The comparison is used to regulate the speed of motor 22 driving the capstan 16, preferably through a feedback loop control (not illustrated herein) of the PID type. In the figure, reference 20 is a differential error amplifier, and reference 21 is a driving circuit for motor 22.

[0012] The volume V_u passing per unit time in a given section may be measured in various ways. To provide an unrestrictive example, a marking is provided at intervals along the wire, obtained by visual means (for example, paint marks sprayed on), or electrical means, such as magnetization. The system illustrated in Fig. 1 is particularly suited for marking by paint-spraying, the paint being applied at a location M upstream of the die plate 12. In practice, by marking the wire F' at regular intervals upstream of the die plate 12, a marking is also obtained, at different regular intervals, of the wire F" upstream of the die plate 14. Counting the number of stretches of wire passing per unit time at location P_1 and the number of stretches of wire passing per unit time at location P_2 gives the values of volume per unit time V_{u1} and V_{u2}. Counting can be done using known means; for example, 31 and 32 may be counters of electric pulses coming from optical (or magnetic) sensors which detect the passage of the marks (stored in memory) on the wire.

[0013] As has been said, the system illustrated in Fig. 1 is particularly suitable when there is a paint-type marking.

[0014] Figure 2 illustrates a system that is particularly suited for operating with a magnetic-type marking. In the system of Fig. 2, the same notation used in Fig. 1 for corresponding parts has been maintained. For this reason, said parts will not be described any further. In this case, marking is made at a location M downstream of the first die plate 12, and the first reading of volume per unit time is made at a location P_1 downstream of the first die plate and of the marking, and upstream of the first capstan 16. The location P_2 of the second reading of unit volume is set downstream of the controlled capstan 16, i.e., upstream of the die plate 14, as in the previous drawing line.

[0015] Variants to what has been described are possible.

[0016] As far as the application of the marking and/or marking-detection devices is concerned, it may be pointed out that it makes no difference whether they are set at the entry point or at the exit point of the die plates, provided that they are set in the immediate vicinity of the die plates. This possibility exists in so far as the volume of the material coming into the die plate is exactly the same as the outgoing material.

Claims

1. A procedure for regulating the rotational speed of a controlled capstan (16) on the basis of the rotational speed of a reference capstan (18), in a system for continuous plastic processing of material by reduction of cross section thereof, wherein for said regulation of the rotational speed the following is monitored:

   - a first volume per unit time of said material passing a first location (P_1) of the system upstream of the controlled capstan (16);
   - a second volume per unit time of said material passing a second location (P_2) of the system, spaced from said first location (P_1) of the system, and downstream of the controlled capstan (16); the procedure **characterized in that** for said regulation of the rotational speed said first and second volume per unit time of material are monitored by counting marks, said marks provided on said material upstream of said first location (P_1).

2. A procedure according to Claim 1, **characterized in that** said first location (P_1) is downstream of a first piece of equipment (12) for reduction of section, and the said second location (P_2) is upstream of a second piece of equipment (14) for reduction of section.

3. A procedure according to Claim 1, **characterized in that** the said first location (P_1) is upstream of a first piece of equipment (12) for reduction of section, and the said second location (P_2) is upstream of a second piece of equipment (14) for reduction of section.

4. A procedure according to Claim 1, **characterized in that** said marks are applied to said material up-

stream of said first location and comprise one or more of the following: -magnetic marks, -visual marks.

5. A system for continuous plastic processing of material by reduction of cross section thereof comprising a piece of equipment (12) for reduction of section upstream, a piece of equipment (14) for reduction of section downstream, a first drawing capstan (16) downstream of the first piece of equipment for reduction of section, a second drawing capstan (18) downstream of the second piece of equipment for reduction of section and of the first capstan, **characterized in that** it further comprises two monitoring apparatuses (31, 32) for monitoring volumes per unit time of said material respectively upstream (P_1) and downstream (P_2) of one of said capstans (16), the speed rotational of which is to be controlled, a marking device (M) located upstream of said first monitoring apparatus, and the monitoring apparatuses comprise counters.

6. A system according to Claim 5, **characterized in that** the marking device (M) is a paint-marking device, that the marking device and the first monitoring apparatus (31) are set upstream of the first piece of equipment for reduction of section, and **in that** the second monitoring apparatus (32) is set upstream of the second piece of equipment for reduction of section.

7. A system according to Claim 5, **characterized in that** the marking device (M) is a magnetic-marking device, that the marking device and a first counter are set downstream of the first piece of equipment for reduction of section, and **in that** a second counter is set upstream of the second piece of equipment for reduction of section.

8. A system according to Claim 5 for a wire drawing line, in which said first piece of equipment and said second piece of equipment are drawing die plates.

Patentansprüche

1. Verfahren für die Regelung der Umdrehungsgeschwindigkeit eines gesteuerten Rollenantriebs (16), auf der Basis einer Umdrehungsgeschwindigkeit eines Bezugs-Rollenantriebs (18), in einem System für die stufenlose plastische Verarbeitung von Material durch die Reduzierung des Querschnitts desselben, in dem für die genannte Regelung der Umdrehungsgeschwindigkeit wird folgendes überwacht:

- ein erstes Volumen pro Zeiteinheit des genanten Materials, das durch einen ersten Punkt (P1) des Systems stromaufwärts vom gesteuerten Rollenantrieb (16) verläuft;
- ein zweites Volumen pro Zeiteinheit des genannten Materials, das durch einen zweiten Punkt (P2) des Systems verläuft, der vom genannten ersten Punkt (P1) entfernt ist und stromabwärts des gesteuerten Rollenantriebs (16) liegt; das Verfahren **dadurch gekennzeichnet, daß** die genannten ersten und zweiten Volumen pro Zeiteinheit des Materials für die genannte Regelung der Umdrehungsgeschwindigkeit überwacht werden, indem die Markierungen gezählt werden, wobei diese Markierungen an dem genannten Material stromaufwärts vom genannten ersten Punkt (P1) vorgesehen sind.

2. Ein Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, daß** der genannte erste Punkt (P1) stromabwärts von einer ersten Einrichutng (12) für die Reduzierung des Querschnitts liegt, und der genannte zweite Punkt (P2) stromaufwärts von einer zweiten Einrichtung (14) für die Reduzierung des Querschnitts liegt.

3. Ein Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, daß** der genannte erste Punkt (P1) stromaufwärts von einer ersten Einrichtung (12) für die Reduzierung des Querschnitts liegt, und daß der genannte zweite Punkt (P2) stromaufwärts von einer zweiten Einrichtung (14) für die Reduzierung des Querschnitts liegt.

4. Ein Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, daß** die genannten Markierungen stromaufwärts von dem genannten ersten Punkt auf das genannte Material aufgebracht werden und eine oder mehrere der folgenden umfassen: magnetische oder Sichtmarkierungen.

5. Ein System für die stufenlose plastische Verarbeitung von Material durch die Reduzierung des Querschnitts desselben, das eine Einrichtung (12) für die Reduzierung des Querschnitts stromaufwärts, eine Einrichtung (14) für die Reduzierung des Querschnitts stromabwärts, einen ersten Zieh-Rollenantrieb (16) stromabwärts von der ersten Einrichtung für die Reduzierung des Querschnitts, einen zweiten Zieh-Rollenantrieb (18) stromabwärts von der zweiten Einrichtung für die Reduzierung des Querschnitts und dem ersten Rollenantriebs umfaßt, **dadurch gekennzeichnet, daß** es außerdem zwei Überwachungsgeräte (31, 32) umfaßt, um die Volumen pro Zeiteinheiten des genannten Materials jeweils stromaufwärts (P1) und stromabwärts (P2) von einem der genannten Rollenantriebe (16) zu überwachen, dessen Umdrehungsgeschwindigkeit kontrolliert werden muß, sowie eine Markierungs-

vorrichtung (M), die stromaufwärts vom genannten ersten Überwachungsgerät angeordnet ist, wobei das Überwachungsgerät Zähler umfaßt.

6. Eine Vorrichtung gemäß Anspruch 5, **dadurch gekennzeichnet, daß** die Markierungsvorrichtung (M) eine Farb-Markierungsvorrichtung ist und daß die Markierungsvorrichtung und das erste Überwachungsgerät (31) stromaufwärts von der ersten Einrichtung für die Reduzierung des Querschnitts angeordnet sind, sowie dadurch, daß das zweite Überwachungsgerät (32) stromaufwärts on der zweiten Einrichtung für die Reduzierung des Querschnitts angeordnet ist.

7. Ein System gemäß Anspruch 5, **dadurch gekennzeichnet, daß** die Markierungsvorrichtung (M) eine magnetische Markierungsvorrichtung ist, daß die Markierungsvorrichtung und ein erster Zähler stromabwärts von der ersten Einrichtung für die Reduzierung des Querschnitts angeordnet sind, sowie dadurch, daß ein zweiter Zähler stromaufwärts von der zweiten Einrichtung für die Reduzierung des Querschnitts angeordnet ist.

8. Ein System gemäß Anspruch 5 für eine Stahldraht-Ziehstraße, bei der die genannte erste Einrichtung und die genannte zweite Einrichtung Ziehformplatten sind.

Revendications

1. Une procédure pour régler la vitesse de rotation d'un roue de tirage contrôlé (16) sur la base de la vitesse de rotation d'une roue de tirage de référence (18), dans un système pour le traitement plastique en continu de matériel, par réduction de la section transversale de celui-ci, dans lequel pour ladite régulation de la vitesse de rotation ce qui suit est surveillé :

- un premier volume par temps unitaire dudit matériel passant une première position (P1) du système en amont de la roue de tirage contrôlée (16),
- un second volume par temps unitaire du dit matériel passant une deuxième position (P2) du système, espacée par rapport à la première position (P1) du système, et en aval de la roue de tirage contrôlée (16); la procédure **caractérisée** du fait que pour ladite régulation de la vitesse de rotation lesdits premier et deuxième volume par temps unitaire de matériel sont surveillés en comptant les marques, lesdites marques fournies sur ledit matériel en amont de ladite première position (P1).

2. Une procédure selon la revendication 1, **caractérisée** du fait que ladite première position (P1) est en aval d'un premier élément (12) pour la réduction de la section, et ladite seconde position (P2) est en amont d'un second élément (14) pour la réduction de section.

3. Une procédure selon la revendication 1, **caractérisée** du fait que ladite première position (P1) est en amont d'un premier élément (12) pour la réduction de section, et ladite seconde position (P2) est en amont d'un second élément (14) pour la réduction de section.

4. Une procédure selon la revendication 1, **caractérisée** du fait que lesdites marques sont appliquées sur ledit matériel en amont de ladite première position et comprennent un ou plusieurs des suivants: - marques magnétiques - marques visuelles.

5. Un système pour le traitement plastique en continu du matériel par réduction de la section transversale de celui-ci comprenant un élément (12) pour la réduction de la section en amont, un élément (14) pour la réduction de la section an aval, une première roue de tirage (16) en aval du premier élément pour la réduction de section, une seconde roue de tirage (18) placée en aval du second élément pour la réduction de section et de la première roue de tirage, **caractérisé** du fait qu'il comprend en outre deux autres dispositifs de contrôle (31, 32) pour le contrôle des volumes par temps unitaire dudit matériel respectivement en amont (P1) et en aval (P2) d'une desdites roues de tirage (16), dont la vitesse de rotation doit être contrôlée, un dispositif de marquage (M) situé en amont dudit premier dispositif de contrôle et les dispositifs de contrôle comprennent des compteurs.

6. Un système selon la revendication 5, **caractérisé** du fait que le dispositif de marquage (M) est un dispositif d'application de peinture, que le dispositif de marquage et le premier dispositif de contrôle (31) sont placés en amont du premier élément pour la réduction de la section, et du fait que le second dispositif de contrôle (32) est placé an amont du second élément pour la réduction de section.

7. Un système selon la revendication 5, **caractérisé** du fait que le dispositif de marquage (M) est un dispositif de marquage magnétique, que le dispositif de marquage et un premier compteur sont placés en aval de la première pièce d'équipement pour la réduction de section, et du fait qu'un deuxième compteur est placé en amont de la seconde pièce d'équipement pour la réduction de section

8. Un système selon la revendication 5 pour une ligne

de tirage de fil, dans laquelle ledit premier élément et ledit second élément sont des plaques de filière.

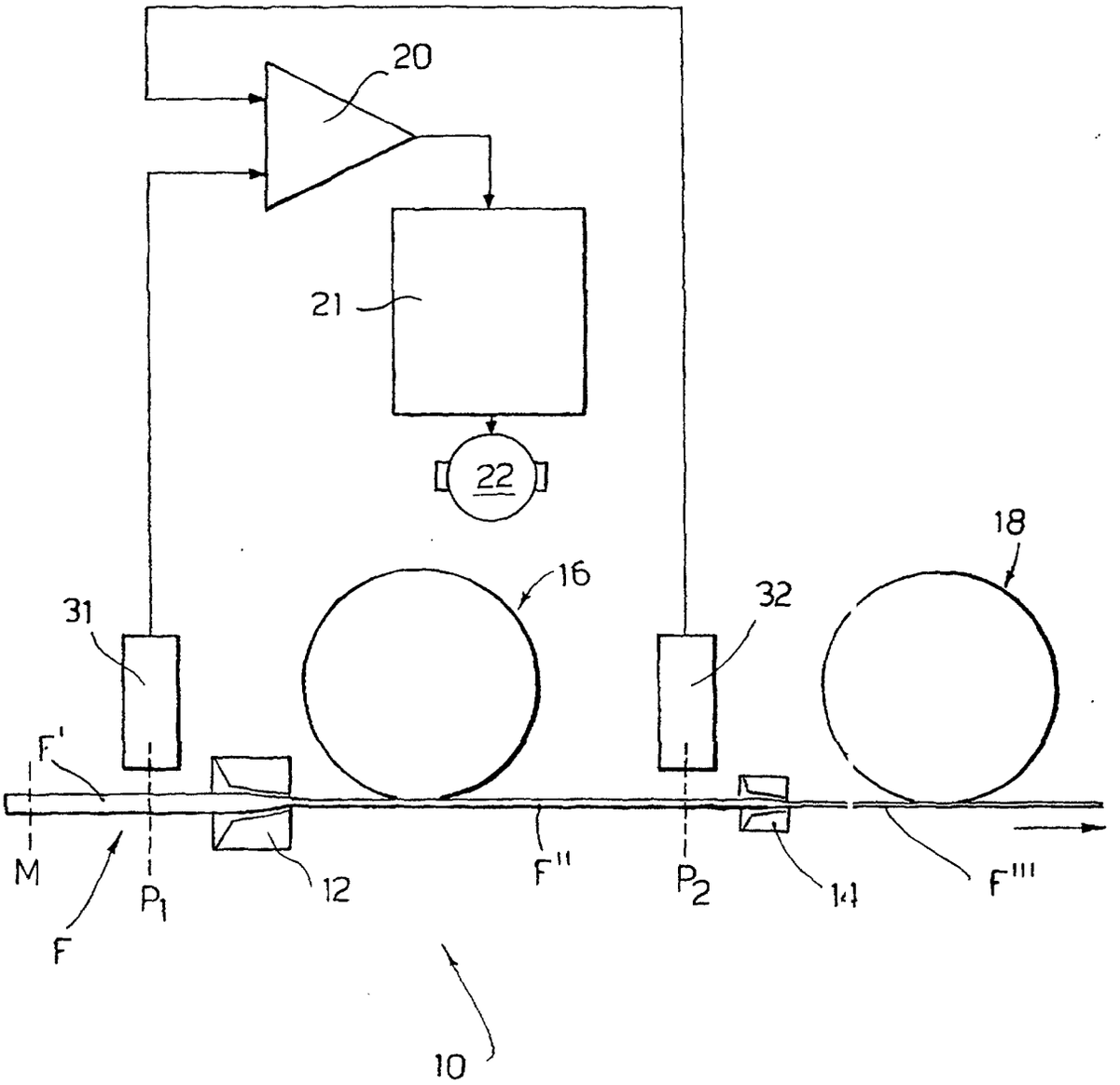

FIG .1

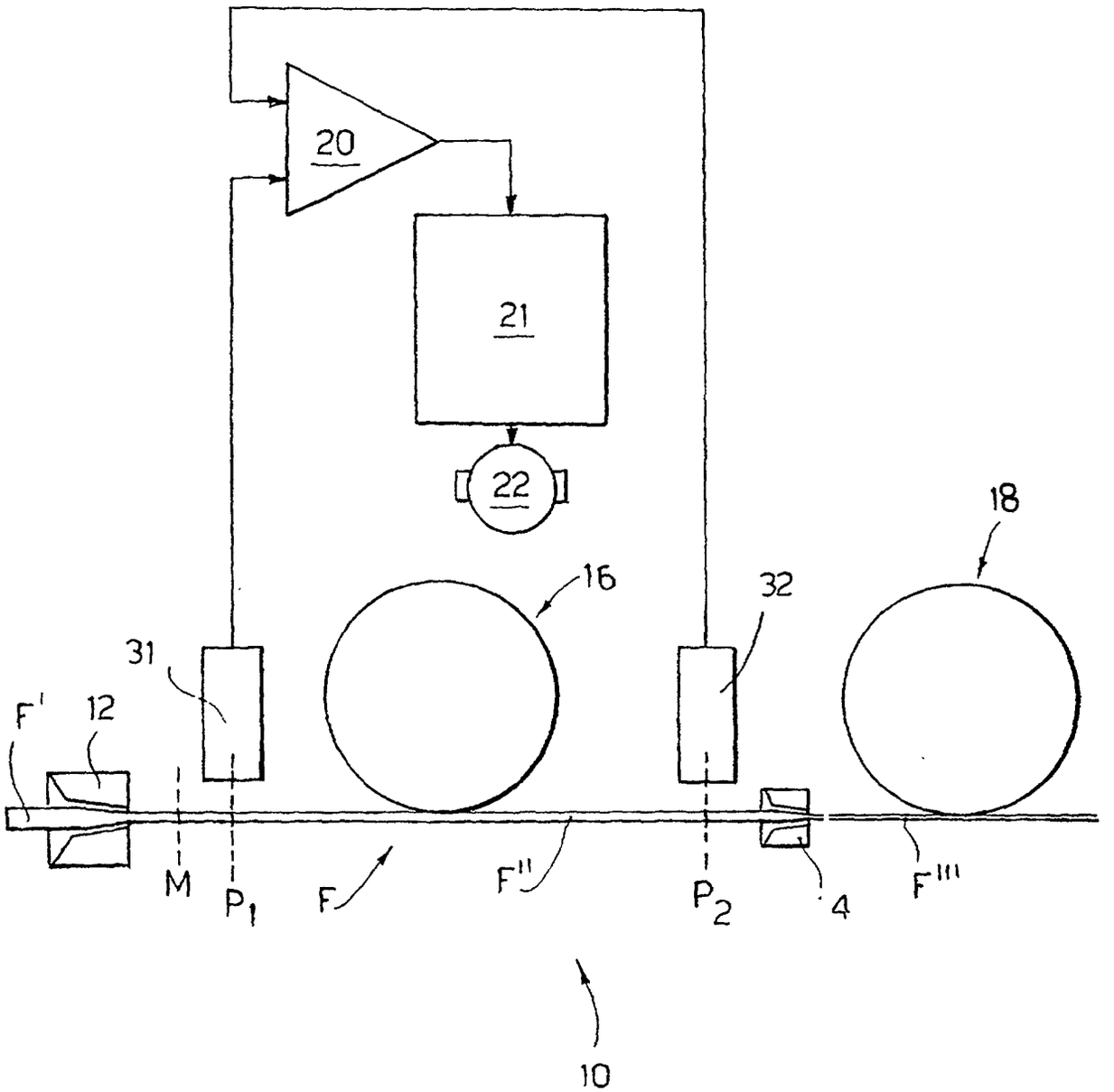

FIG. 2