OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA

CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE

(12) (19) (CA) **Demande-Application**

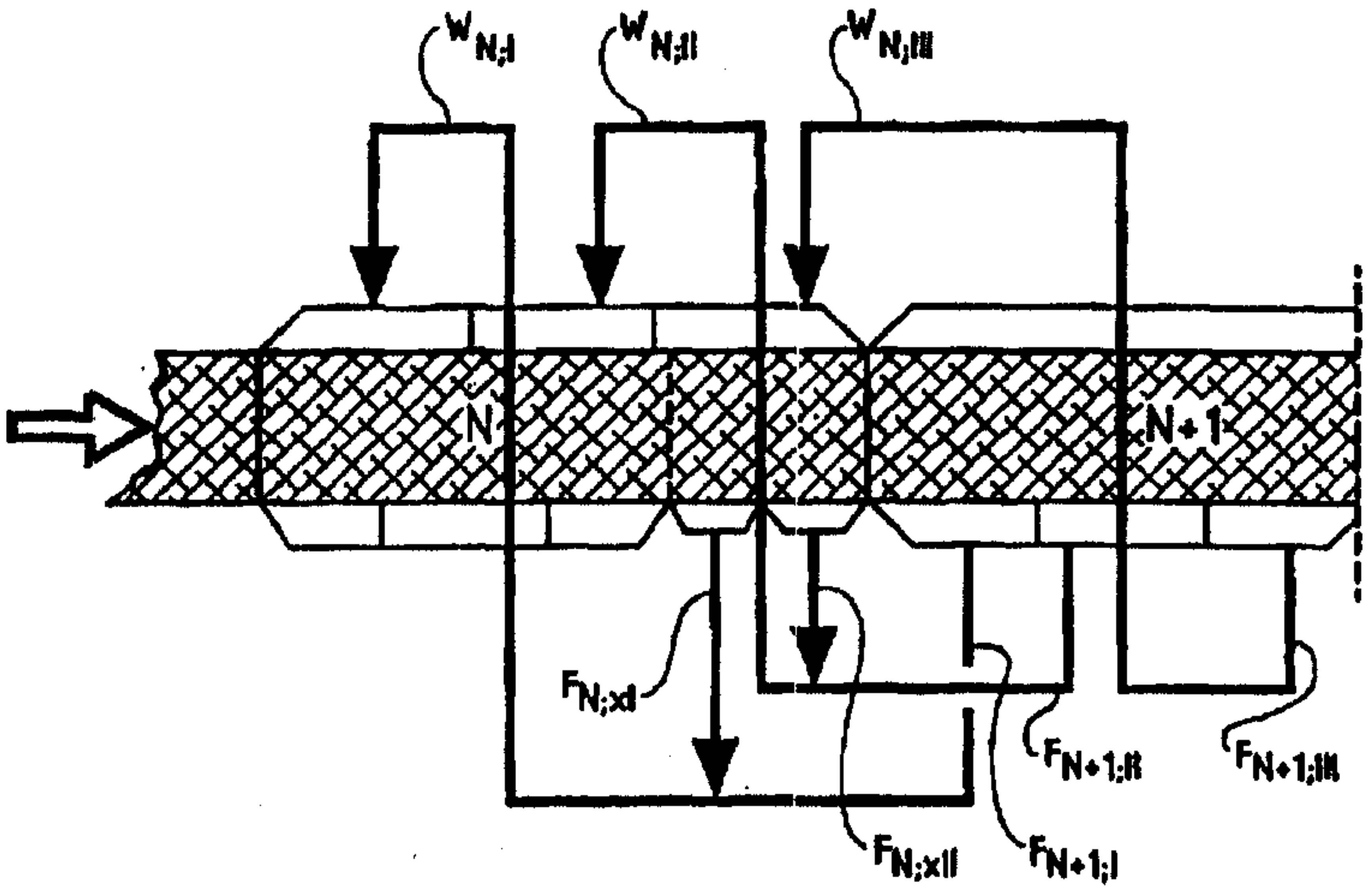
(21) (A1) **2,276,308**
(86) 1998/01/27
(87) 1998/08/06

(72) QVINTRUS, HARRI, US
(72) TERVOLA, PEKKA, FI
(71) AHLSTROM MACHINERY OY, FI

(51) Int.Cl.^{6} D21C 9/02, D21C 9/06
(30) 1997/01/31 (60/037,257) US

(54) **APPORT DE LIQUIDE DE LAVAGE DANS UN APPAREIL DE LAVAGE DE PATE A PAPIER**

(54) **FEEDING OF WASHING LIQUID IN A PULP WASHER**



(57) L'invention concerne un procédé permettant d'intensifier le lavage de la pâte à papier dans divers appareils de lavage. Le procédé de l'invention s'applique particulièrement bien à l'appareil de lavage DRUM DISPLACER ® fabriqué par A. AHLSTROM CORPORATION mais également à certaines presses de lavage. Le procédé de lavage par déplacement, qui consiste à envoyer la pâte à papier dans un système de lavage à un ou plusieurs étages, à laver la pâte à papier dans le système, à l'enlever de ce dernier et à envoyer du liquide de lavage dans le système et à enlever au moins un filtrat du système, se caractérise en ce qu'une partie $F_{N,x}$ du filtrat F_N provenant d'au moins un étage de lavage réel N est renvoyé conjointement avec le filtrat F_{N+1} ou qu'une partie de celui-ci, provenant de l'étage de lavage suivant N+1, est envoyée au même étage de lavage pour servir de liquide de lavage W_N

(57) The present invention relates to a method of intensifying washing of pulp in various washing apparatuses. The method according to the invention is particularly well applicable in connection with a so-called DRUM DISPLACER ® washer by a A. AHLSTROM CORPORATION but also in connection with some washing presses. The method of performing a displacement wash of pulp, which method comprises feeding of the pulp to a washing system having one or more stages, washing of the pulp in the system and removal of the pulp therefrom, and feeding of wash liquid to the system and removal of at least one filtrate from the system is characterized in that part $F_{N,x}$ of the filtrate F_N from at least one actual washing stage N is returned together with the filtrate F_{N+1} or part of it obtained from the next washing stage N+1 to the same washing stage to serve as wash liquid W_N

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : D21C 9/02, 9/06

A1

(11) International Publication Number: WO 98/33972

(43) International Publication Date: 6 August 1998 (06.08.98)

(21) International Application Number: PCT/FI98/00074

(22) International Filing Date: 27 January 1998 (27.01.98)

(30) Priority Data:
60/037,257 31 January 1997 (31.01.97) US

(71) Applicant: AHLSTROM MACHINERY OY [FI/FI]; P.O. Box 5, FIN-00441 Helsinki (FI).

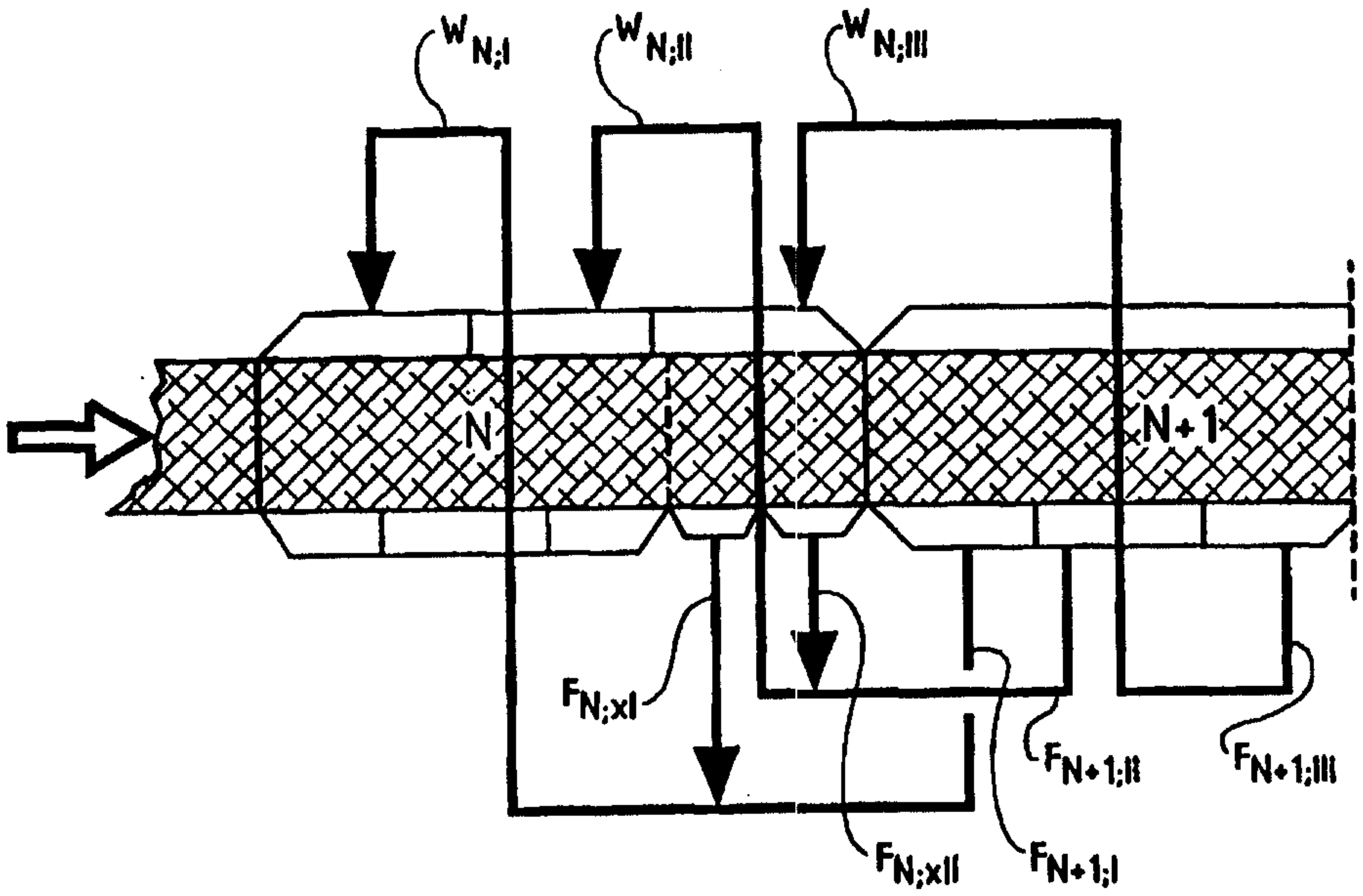
(72) Inventors: QVINTUS, Harri; Ahlstrom Machinery Inc., Ridge Center, Glens Falls, NY 12801-3686 (US). TERVOLA, Pekka; Munkkiniemen puistotie 21 B 19, FIN-00330 Helsinki (FI).

(74) Agent: AHLSTROM MACHINERY OY; Patent Dept., P.O. Box 18, FIN-48601 Karhula (FI).

(81) Designated States: AU, BR, CA, CN, ID, JP, MX, NO, NZ, PL, RU, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: FEEDING OF WASHING LIQUID IN A PULP WASHER



(57) Abstract

The present invention relates to a method of intensifying washing of pulp in various washing apparatuses. The method according to the invention is particularly well applicable in connection with a so-called DRUM DISPLACER® washer by a A. AHLSTROM CORPORATION but also in connection with some washing presses. The method of performing a displacement wash of pulp, which method comprises feeding of the pulp to a washing system having one or more stages, washing of the pulp in the system and removal of the pulp therefrom, and feeding of wash liquid to the system and removal of at least one filtrate from the system is characterized in that part $F_{N;x}$ of the filtrate F_N from at least one actual washing stage N is returned together with the filtrate F_{N+1} or part of it obtained from the next washing stage N+1 to the same washing stage to serve as wash liquid W_N.

FEEDING OF WASHING LIQUID IN A PULP WASHER

The present invention relates to a method of intensifying washing of pulp in various washing apparatus. The method according to the invention is particularly well applicable in connection with a so-called DRUM DISPLACER® washer by A. AHLSTROM CORPORATION but also in connection with some washing presses. The method being applicable also in connection with other washing apparatus, various washers used for the washing of pulp are dealt with in the following.

Several different types of washing apparatus and methods are known from the prior art. Arrangements that can be clearly distinguished from each other include diffusers, drum washers and Fourdrinier wire washers. The pulp is fed into diffuser washers at a consistency of about 10 %. The feeding consistency of drum and Fourdrinier wire washers is 1 - 3 %. Drum washers in use at the moment include a suction washer, a wash press and a pressurized or superatmospheric washer.

A traditional suction washer comprises a drum covered with a wire, which drum rotates in a basin. On the shell of the drum below a perforated plate there are collecting compartments, each of which are connected by means of a tube of its own to a valve system on the shaft at the end of the drum. From the valve the filtrate is led for example into a filtrate tank through a barometric leg or a centrifugal pump generating the kind of suction required. Thanks to the valve arrangement the suction effect of the barometric leg can be directed to desired points of the web formation.

Web formation in a suction washer takes place in such a way that inside the drum rotating in the basin, reduced pressure is generated by means of said barometric leg or another apparatus generating suction, which underpressure sucks pulp suspension against the drum. As the liquid permeates the drum, the fibers of the pulp precipitate upon the surface of the drum. The consistency of the fiber suspension in the basin is about 0.5 - 2 %, whereas the consistency of the layer precipitated on the drum is about 10 - 12 %. The web formation area, i.e. that part of the rim of the drum which is covered by the fiber suspension in the basin, is about 140 degrees. The maximum value of the revolution speed is 2 - 2.5 r/minute, as at higher speeds the collecting compartments of the filtrate and the tubes will not have enough time to empty.

The washing takes place as a displacement wash in such a way that wash liquid is injected onto the surface of the drum protruding from the pulp basin, which wash liquid soaks through the pulp layer and displaces the majority of the liquid originally present in the pulp. Hereby, the extent of the displacement area is about 120 degrees. A typical specific square load is about 5 - 7 BDMT/m^2/d, whereby the thickness of the pulp web is in the order of 25 mm. The square load of the suction washer when used in bleaching is about 8 BDMT/m^2/d, the thickness of the web being about 30 mm.

A wash press comprises a drum covered with a wire or having a drilled perforated plate shell. The feed of the pulp takes place at a consistency of 3 - 4 %, and the knots and the like have to be removed from the pulp before the washer. On the shell of the drum, there are compartments from which the filtrate is led out through a chamber on the end rim. The drum may as well be open, so that the filtrate is collected inside the drum and discharged from the opening at the end.

The length of the web formation is about 90 degrees and that of the displacement stage about 150 degrees. The revolution speed of the drum is about 2 r/minute, the specific square load being about 15 - 20 BDMT/m^2/d. The consistency of the washed pulp may rise up to 35 %. The displacement takes place at a consistency of 10 - 15 %, though, the pulp web being about 30 - 50 mm thick.

As an example of a superatmospheric washer, a washer for example according to FI patent publications 71961 or 74752 may be mentioned, comprising mainly of a rotating drum and a solid shell encircling it. The drum consists of a stationary shell, on the outer surface of which there are ribs attached at intervals of about 200 mm. Between said ribs there are perforated plates attached in such a way that the height of the ribs from said perforated plate outwards is about 40 - 60 mm. Said ribs together with the perforated plates constitute so called pulp compartments. Inside the perforated plates and below the pulp compartments, i.e. in the space confined by said plates, ribs and solid shell, filtrate compartments are formed into which the filtrate displaced by the wash liquid is gathered. At the end of the cylinder drum, substantially on the diameter of the rim of the drum, there is a valve system, through which the filtrate is taken out and directed further. There are several stages, usually 2 - 5, arranged in the washer. This means that the wash liquid is used several times to wash the pulp. In other words, filtrates gathered in the filtrate compartments are led upstream from one washing stage to another. Outside the drum of the washer, constituting a part of the shell of the washer, there are feed chambers for the wash liquid, from which the wash liquid is pressed through flow controllers into the pulp in the pulp compartments so as to displace the liquid therein.

The web formation and washing of the pulp is carried out in such a way that the pulp to be washed is fed through a special feed box into the pulp compartments. The feed box may be such that it dewaters the pulp, whereby axial "bars" of the same length as the drum are formed in the pulp compartments. Immediately after the feed point there is a first washing zone, there being altogether four or five separate stages in the arrangement of said publications. A wash liquid flow is led to each stage and it displaces the liquid present in the pulp layer in the compartments of the wash drum. It was already mentioned above that the filtrates are led upstream from one stage to another. In other words, (cf. FI patent 74752, Fig. 1), a clean wash liquid is pumped to the last washing stage and the filtrate displaced by this liquid is led to the second last washing stage to serve as wash liquid. After the last washing stage, the "pulp bars" are detached from the drum, for example by blowing with pressurized air, and transported further by means of a transport screw.

A specific square load of this kind of superatmospheric washer with four stages may nowadays rise up to about 30 BDMT/m^2/d. The feeding consistency rising, also the specific square load may rise above said 30 BDMT/m^2/d. The thickness of the "pulp bar" is about 50 mm and the consistency may rise even up to 15 - 18 %. The consistency of the pulp fed onto the drum may vary between 3.0 - 10 %. The revolution speed of the drum varies between 0.5 - 3.0 rpm.

The above-mentioned FI patent 74752 corresponding to US patents 4,919,158 and 5,116,423, for example, discloses an arrangement which is somewhat more advanced than the basic approach of FI patent 71961, and by means of which it is possible to achieve a remarkably better washing result than with the basic arrangement of the above-mentioned publications. In the arrangement of said FI patent 74752, each washing stage is divided into two zones in such a way that two wash filtrates with different concentrations are obtained from each stage. Filtrates obtained like this are guided upstream in the way disclosed in the patent. Further, the patent describes how a so called suction filtrate, i.e. the filtrate extracted from the point between the last washing stage and the pulp discharge, is taken with the washing filtrate from the latter washing zone of the last washing stage to the latter washing zone of the second last washing stage to be used as wash liquid.

It is characteristic of all the above apparatus that at least either the feed of the wash liquid or the treatment of the filtrates or both at the same time show drawbacks. These drawbacks may lead to a poorer washing result, for example. If a washer is found not to be able to reach an adequate washing result, the consequence is naturally that a washer with more washing stages or even a washer of a different type is acquired. It may also be necessary to try to solve the problem by increasing the consumption of clean wash liquid, whereby there will be greater demand for steam in the evaporation plant and the capacity of the waste water treatment equipment and partly also the environmental load have to be increased.

The above-mentioned problems have been solved in the way described in FI patent application 954259 and WO patent application PCT/FI96/00316. In other words, in such a way that at least part of the filtrate obtained after the actual suction, press and/or thickening stage is directed to the preceding wash/washing stage to serve as wash liquid. Further, it is possible to solve said problems in such a way that in a multi-stage fractionating wash at least part of the filtrate from the suction, press and/or thickening stage taking place after the actual wash is directed to the first zone of the preceding wash/washing stage to serve as wash liquid.

Further, some mills may have the problem that the evaporation plant is not able to treat as large washing filtrate flows as would be produced by the washing methods according to the above-described patents and patent applications in order to wash the pulp as clean as desired. In other words, when applying said washing methods, the brown stock would have to be washed at a lower dilution factor (i.e. with a smaller amount of wash liquid into the washer) than normally. Conventionally, the dilution factor in brown stock washing has been on the level of 2.0 - 3.5 m^3/ton of chemical pulp produced (ADT). The dilution factor is calculated as a difference between the amount of fresh wash liquid brought to the washer per one ton of chemical pulp to be washed and the amount of liquid discharged from the washer with the washed pulp. The unit of the dilution factor is, as already mentioned, m^3/ADT.

When it is necessary to lower the dilution factor, for example because of the capacity of the evaporation plant, the washing result begins to deteriorate if above-described washing methods are used. Should the washing result achieved in these conditions not be adequate, new washing capacity and/or evaporation capacity have to be added so as to increase the dilution factor sufficiently.

An object of the invention is to solve said problem and to disclose an arrangement applicable to many different types of washers, by means of which arrangement it is possible to further intensify the wash without having to invest or construct more.

The characterising features of the method according to the invention become apparent from the appended claims.

In the following, the method according to the invention is explained in more detail with reference to the appended figures, of which

Figs. 1 - 3 schematically illustrate an operating principle according to a prior art multi-stage washer at various dilution factors;

Figs. 4 - 5 schematically illustrate an arrangement according to a preferred embodiment of the present invention at various dilution factors;

Fig. 6 illustrates an arrangement according to a second preferred embodiment of the invention;

Figs. 7 and 8 illustrate an arrangement according to a third preferred embodiment of the invention at various dilution factors;

Figs. 9 and 10 illustrate an arrangement according to a fourth preferred embodiment of the invention at various dilution factors;

Fig. 11 illustrates yet an arrangement according to a fifth preferred embodiment of the invention; and

Fig. 12 illustrates yet a new method to use a multi-stage washer.

The operation principle schematically illustrated in Figures 1 - 3 has been, at least partly, applied in the DRUM DISPLACER® washer according to FI patent 71961 by AHLSTROM MACHINERY CORPORATION. Figure 1 illustrates how the pulp M_{in} is fed onto the perforated and moving wire surface 10 of the apparatus. The wire may be either cylindrical, a wash drum, or for example a plane-like belt washer. The wire 10 is preferably provided with baffles 12. Opposite the wire surface 10 there are stationary wash liquid feed chambers 14, the bottoms 16 of which, together with the baffles 12 and the wire surface 10, form pulp washing chambers 18. Below the wire surface 10 there are a number of filtrate compartments 20 for collecting the filtrate displaced from the pulp by the wash liquid. The above-mentioned patent also describes in more detail how the filtrate is transported further from the filtrate compartments 20 via a valve device provided at the end of the drum. The Figure shows that there are four washing stages I - IV in the apparatus. There are also corresponding wash liquid feed chambers 14_{I}, 14_{II}, 14_{III}, and 14_{IV}, as well as filtrate compartments 20_{I}, 20_{II}, 20_{III}, and 20_{IV}. It is typical of the operation of the apparatus that a clean wash liquid W_{I} is brought to the fourth washing stage IV, in which the pulp is cleanest. The filtrate F_{IV} from the fourth washing stage is brought to the third washing stage III to serve as wash liquid, and so on, until the filtrate F_{I} from the first washing stage is directed to an evaporation plant, used for dilution in a blow tower, and/or directed to waste water treatment. As can be seen, the apparatus ilustrated in the figure is capable of replacing four conventional one-stage washers. In addition, the Figure illustrates how a so called suction stage is arranged to follow the actual washing stages I, II, III and IV, the filtrate of the suction stage being returned to the second last washing stage with the filtrate from the preceding washing stage. Also, the above-mentioned WO patent application PCT/FI96/00316 discloses a few methods to circulate the filtrate from the suction stage. It is to be understood, however, that in view of the operation of the present invention, the existence of the suction stage is not necessarily required but that the same benefits can be achieved by means of this invention as by the basic process, irrespective of whether there is a suction stage or not.

A more advanced version of the same washer is described in more detail in US patents 4,919,158 and 5,116,423, for example. Hereby, there may still be four washing stages I - IV, each washing stage being, however, internally divided into two zones, from which filtrates with different concentrations are obtained. In other words, clean wash liquid W_1 is brought to the fourth washing stage IV, which liquid displaces filtrate from the pulp. However, due to the fact that in such a displacement wash as was described above the concentration of the liquid decreases relatively evenly beginning from the feed of the pulp M_{in} up until the discharge of the pulp M_{out}, the filtrate compartment of the fourth stage has been divided into two parts, which, as mentioned, produce filtrates with different concentrations. These filtrates are now guided upstream, i.e. to the third washing stage III in such a way that the cleanest filtrate, i.e. the filtrate from the latter zone of the fourth stage is guided to the feed chamber of the latter zone of the third stage III to serve as wash liquid. Correspondingly, the fouler filtrate, i.e. the filtrate from the former zone of the fourth stage is guided to the feed chamber of the former zone of the third stage III to serve as wash liquid. By continuing the whole wash by this method until the end, pulp is produced which is about 15 - 30 % cleaner than pulp produced by the basic arrangement of Figure 1.

Generally, it may be stated that according to the operation principle of a so called fractionating multi-stage washer of this kind, several filtrates from one or more washing stages are received which are then fed to the previous washing stage to the zone having the same ordinal number, to be used as wash liquid. Thus, although a washer with each stage being divided into two zones has been described, nothing prevents the stages from being divided into three zones, for example, whereby three different filtrates are obtained, or even into more zones. Of course, it is also possible to divide the various stages into zones in a different way. In other words, for example only one filtrate may be extracted from a washing stage into which two or more wash liquids with different concentrations have been supplied. The first washing stage of the DRUM DISPLACER® washer is often of this kind, whereby the filtrate obtained therefrom is extracted as one fraction to be transported for dilution of pulp and/or chemical recovery.

Figures 1 - 3 also illustrate how the filtrate from the first washing stage I is guided for example into an evaporation plant, or to another filtrate treatment stage.

In the following, the concept dilution factor is inspected with reference to Figures 1 - 3. As mentioned above, said Figures illustrate a simplified version of the operation of a multi-stage washer. Most often, as a basic rule, the feeding compartments of each of the washing stages I - IV are divided into two parts in such a way that two liquids with different concentrations are both supplied to and taken from each stage. For the sake of simplicity, this is not shown in Figures 1 - 3. In the embodiment of the figure, the pulp is supplied into the washer at a consistency of 10 % and removed from the washer, thanks to the suction stage, at a consistency of 12 %. Figure 1 shows that 9.1 m^3 of wash liquid W_1 is brought into the washer per ADT, and this liquid is assumed to displace the same amount of washing filtrate from the pulp. Hereby, the consistency of the pulp does not change in the washing stage. 1.5 m^3 of suction filtrate is taken from the suction stage following the last washing stage, and hence the discharge consistency of the pulp raised to 12 %, as already mentioned. The washing filtrate from the next last washing stage, 9.1 m^3, is taken together with the suction filtrate, 1.5 m^3, to the third washing stage to serve as wash liquid, the amount of which is 10.6 m^3 per ADT, and the same amount of washing filtrate, 10.6 m^3, is displaced. The procedure is carried on further, so that again 10.6 m^3 of washing filtrate is obtained from the first washing stage, which filtrate is then taken to an evaporation plant elsewhere to be used or treated. Since the consistency of the pulp is regarded as remaining uniform all the way through the different washing stages, there is 8.1 m^3 of liquid in the pulp discharging from the last washing stage, too, i.e. the same amount as in the pulp entering the washer. As 1.5 m^3 of liquid out of the 8.1 m^3 is discharged as suction filtrate, there remains 6.6 m^3 of liquid in the pulp discharging from the washer. Thus, the dilution factor is 9.1 - 6.6, i.e. 2.5 m^3/ADT.

Using the numeric values of Figure 2 a dilution factor of 1.5 is achieved. In other words, by supplying one cubic metre less of wash liquid W_1, the amount of the liquid to be discharged for an evaporation plant or other use or treatment is also decreased by one cubic metre, but at the same time, also the dilution factor decreases to 1.5. In Figure 3, the amount of the entering wash liquid is further decreased to 7.6 m^3, the dilution factor being thus 1.0.

Figure 4 illustrates simply and schematically a washing method according to a preferred embodiment of the invention. This is based on the situation illustrated by Figure 2, in which, for example, an evaporation plant is only capable of treating filtrate below about 10 m^3/ADT. As illustrated by the Figure, filtrate arrangements within the washer enable the raising of the washing efficiency in such a way that the first three stages correspond to a washer having a dilution factor of 2.5. The basis for this operation is that filtrate, for example 1 m^3/ADT, is taken from the first three stages, especially preferably from the final stages thereof, in which the pulp is cleanest, and connected through the filtrate from the following washing stage, to be reused as wash liquid in the stage from which the cleanest filtrate was taken. The washing method of Figure 4 being inspected as a whole, it can be seen that 8.1 m^3/ADT of fresh wash liquid W_1 is supplied to the last washing stage IV; the filtrate displaced by this liquid, 8.1 m^3, the filtrate from the suction stage, 1.5 m^3, and the cleanest filtrate from the second last washing stage III, 1.0 m^3 - altogether 10.6 m^3/ADT - are combined and supplied to the second last washing stage III to serve as wash liquid. This liquid, in turn, displaces 10.6 m^3 of filtrate, of which the cleanest part, 1.0 m^3 is combined with the filtrate of the last washing stage IV and the rest, 9.6 m^3, is taken with the cleanest filtrate from the preceding washing stage, 1.0 m^3, to the preceding washing stage II to serve as wash liquid. This method is carried on until the first washing stage I, a part - 1.0 m^3 - of the filtrate - 10.6 m^3 altogether - from this stage being now combined with the filtrate from the second washing stage, whereby there remains 9.6 m^3 of the filtrate per ton of chemical pulp to be discharged to the evaporator. Paying attention to the amount of liquid flows circulating within the washer, it can be observed that the amount of the wash liquid supplied to the first three stages is 10.6 m^3, which corresponds to the situation in Figure 1 with a dilution factor of 2.5.

In other words, apart from the last washing stage, the washer operates in the same way as a washer run with a dilution factor of 2.5. The whole operation of the washer and the circulation of the wash liquid back to the same stage to serve as wash liquid, as described above, are totally based upon the fact that the concentration of the filter from each washing stage changes remarkably at various points of the stage in question. The filtrate discharging from the beginning of a stage has the strongest concentration and the filtrate discharging from the end of a stage is the weakest. In fact, the filtrate discharged from the end of a stage has a concentration which is closer to the concentration of the filtrate from the beginning of the following stage than to the concentration of the filtrate from the beginning of its own stage.

Figure 5 illustrates a situation corresponding to that in Figure 4, but in such a way that the dilution factor DF in the last stage of the washing is seemingly 1.0, although, thanks to the back-circulation of the first stages (1.5 m^3), the operation of the washer and the amount of the wash liquid to be circulated corresponds to a dilution factor of 2.5. This has been achieved by directing 1.5 m^3 of the filtrates from the end of the first three washing stages to encounter with the filtrate of the next washing stage, and by returning the combined filtrate to the same washing stage to serve as wash liquid. In other words, the amount of the filtrate to be back-circulated is in the order of 15 percent of the amount of the filtrate obtained from the whole stage. As regards a limit value for the filtrate to be circulated, about 5 % could be considered the low limit, because the benefit achieved with a smaller amount would be next to nothing. On the other hand, the upper limit is in the order of 20 - 30 per cent, because the concentration of the filtrate to be circulated is in any case higher than that of the actual wash liquid and with a larger amount of circulation it would have a negative effect on the washing efficiency of the wash liquid to be supplied. Sometimes it is the capacity of the washer itself that limits the amount of back-circulation

Figure 6 further illustrates a washing method according to an especially preferred embodiment of the invention. It is just the kind of method presented in Figure 4, except that it illustrates an operation model for a so called fractionating washer in which two wash liquids with different concentrations are fed to each washing stage and two substantially different filtrates are taken therefrom. In the washing method of Figure 6, 8.1 m^3 of clean wash liquid is brought to the last washing stage (which is in this embodiment stage IV, even if a two-or three-stage washer could be used as well), and the same amount of filtrate F_{IV} is separated to the filtrate compartments. The filtrate compartments of the washing stage IV are in this embodiment divided in such a way that the amounts of the wash liquids $W_{III;I}$ and $W_{III;II}$ led to the washing stage III as separate flows are, after various connections, equal. However, the feed of the wash liquids is also possible with wash liquid flows of different amounts. In this embodiment, though, 3.8 m^3 is taken as the latter filtrate $F_{IV;II}$ and 4.3 m^3 as the first filtrate $F_{IV;I}$ of the last washing stage, because when the suction filtrate F_S, 1.5 m^3, is combined with the latter filtrate $F_{IV;II}$ and the filtrate $F_{III;x}$, 1.0 m^3, to be back-circulated from the second last washing stage is combined with the first filtrate $F_{IV;I}$, the amount of both wash liquid flows $W_{III;I}$ and $W_{III;II}$ to be supplied to the second last stage will be 5.3 m^3. Since the filtrate $F_{N;X}$ to be back-circulated from each stage N, more precisely from the end of each stage, is combined with the first filtrate $F_{N+1;I}$ of the following stage, it is naturally supplied to be used as the first wash liquid $W_{N;I}$ of each stage.

Figures 7 and 8 illustrate embodiments already presented in Figures 4 and 5, except that in Figures 7 and 8 the suction filtrate has been led to the last washing stage (IV in these embodiments) to serve as wash liquid. In Figures 4 and 5 said suction filtrate was led to the second last washing stage (III in those embodiments) to serve as wash liquid. It is also to be observed that, as Figures 7 - 10 illustrate, the suction filtrate is preferably directed to the beginning of the last washing stage to be used as wash liquid.

Correspondingly, the embodiments of Figures 9 and 10 correspond to the arrangement of Figure 6, as far as the two-zone fractionating washer is concerned. In other words, in Figures 9 and 10 the suction filtrate is directed to the beginning of the last stage IV to serve as wash liquid and the last filtrates $F_{N;x}$ from the first three stages I, II and III, respectively, are directed to be returned to the beginning of the same stage to serve as wash liquid, in other words as the first wash liquid $W_{N;I}$, as already illustrated in Figure 6.

At this point, it is worth observing that it is also possible to separate filtrate from the the end of the last (IV) stage, to combine it with the suction filtrate and to return it to the beginning of the last washing stage to be used as wash liquid. In other words, although in the embodiments of Figures 4 - 10 the filtrate from the end of the last stage has not been presented as being combined with the suction filtrate, this may as well be done.

Figure 11 illustrates that it is possible to divide each of the washing stages into more than one parts (in Fig. 11 the washing stage is divided into three zones), whereby it is naturally possible to also take several filtrate fractions from the end of each washing stage and to return them as wash liquid to the same stage in the same order, of course combined with the filtrates of the next washing stage. For example, if each washing stage is divided into three parts - whereby three main filtrates with different concentrations are taken from each washing stage and also three wash liquids are supplied to each stage - it is possible to take two different filtrates $F_{N;xI}$ and $F_{N;xII}$ from the end of washing stage N and to combine these with the first two filtrates $F_{N+1;I}$ and $F_{N+1;II}$ of the next washing stage N+1 to form two wash liquids $W_{N;1}$ and $W_{N;II}$, which wash liquids are supplied to stage N as the first two wash liquids. It is possible to do quite the same when the stages are divided into more than three zones. Naturally, the stages can also be divided into more than two zones according to the method of the invention and still take only one single filtrate $F_{N;x}$ from the end of stage N and to combine it with the first filtrate $F_{N+1;I}$ from the next stage N+1, as illustrated by the basic version of our invention in Figure 5.

Finally, it is worth observing that although it is described above how a filtrate from the end of a stage is returned to the beginning of the same stage to serve as wash liquid, in some cases it may be possible or necessary to take part of a filtrate from the beginning of a stage and to guide it together with the filtrate from the preceding stage or part of it past said preceding stage to serve as wash liquid in the stage preceding that stage. For example, filtrate may be taken from the beginning of the fourth washing stage, and this filtrate may then be combined with the majority of the filtrate from the third stage and returned to the second stage to be used as wash liquid. Such circulation of wash liquids is by no means due to an effort to achieve maximum washing efficiency but to a situation where there is too little washing area relative to the amount of the wash liquid that should get through the pulp. Directing part of the wash liquid more rapidly through the washer (in the above-mentioned example part of the filtrate is led directly from the fourth stage to the second stage) decreases the internal dilution factor and makes the washing area sufficient. Figure 12 illustrates a situation where the external dilution factor of the washer is 2.5, in other words 6.6 m^3 of liquid discharges per ADT, and 9.1 m^3 of fresh wash liquid per ADT is fed to the fourth stage. Figure 12 shows, firstly, how the filtrate, 1.5 m^3, from the suction/pressing stage is connected with the majority, 8.1 m^3, of the filtrate from the fourth washing stage IV and how the obtained filtrate, 9.6 m^3, is led to the third stage III to serve as wash liquid. Further, Figure 12 shows how 1.0 m^3 of filtrate is taken from the beginning of the fourth washing stage and combined with the majority, 8.6 m^3, of the filtrate from the third washing stage and how the obtained filtrate, 9.6 m^3, is taken to the second washing stage II to serve as wash liquid. The procedure is carried on in the same way, until part of the filtrate, 1.0 m^3, from the second washing stage II is guided together with the filtrate from the whole washing stage I, 9.6 m^3, out of the washer. A corresponding procedure can naturally be applied to so called fractionating washers, whereby, as mentioned, at least two filtrates with different concentrations are supplied to at least one stage and filtrates with different concentrations are taken at least from one stage.

As can be seen from the above description, by means of our invention it is possible to develop washing processes in the wood processing industry so that they become more economical and environmentally friendlier than before. It has to be understood, however, that all embodiments described above, except the illustration of Figure 12, represent only a few preferred embodiments of the invention, and they are not, by all means, intended to restrict the scope of the invention from what is presented in the appended patent claims. Thus, it is obvious that although the above figures illustrate a four-stage washer alone, it is possible that there are 1 - n washing stages, whereby n is only limited by the production technique available and/or the requirements set for the washing efficiency. Thus, it is quite possible that n may be above four. The present-day possibilities and requirements may reach up until 5 - 7, but in the future even these values may be exceeded.

Claims:

1. A method of performing a displacement wash of pulp, which method comprises

- feeding of the pulp to a washing system having **at least two stages**,
- washing of the pulp in **said washing** system and removing the pulp therefrom, and
- feeding of wash liquid to **said washing** system and removing at least one filtrate from the system,

characterized in that part $F_{N;x}$ of the filtrate F_N from at least one actual washing stage N is returned together with the filtrate F_{N+1} or part of it obtained from the next washing stage N+1 to the same washing stage to serve as wash liquid W_N.

2. A method as recited in claim 1, **characterized** in that said part $F_{N;x}$ of the filtrate F_N is taken from the end of at least one actual washing stage N.

3. A method as recited in claim 2, **characterized** in that said part $F_{N;x}$ of the filtrate F_N from washing stage N is combined with the first filtrate $F_{N+1;I}$ from the next washing stage N+1 and is returned to stage N to serve as wash liquid W_N.

4. A method as recited in claim 1, **characterized** in that said wash liquid W_N is taken to the same washing stage N to serve as the first wash liquid $W_{N;I}$.

5. A method as recited in claim 1, **characterized** in that two different filtrates $F_{N;xI}$ and $F_{N;xII}$ are taken from the end of washing stage N, combined with the first two filtrates $F_{N+1;I}$ and $F_{N+1;II}$ from the next washing stage N+1, and returned to stage N to serve as the first two wash liquids $W_{N;I}$ and $W_{N;II}$.

6. A method as recited in claim 1, **characterized** in that the amount of the filtrate to be circulated is 5 - 30 % of the amount of the filtrate obtained from the stage in question.

7. A method as recited in claim 1, **characterized** in that several different filtrates $F_{N;xI}$, $F_{N;II}$,... are taken from the end of washing stage N, combined with several filtrates $F_{N+1;I}$,

AMENDED SHEET

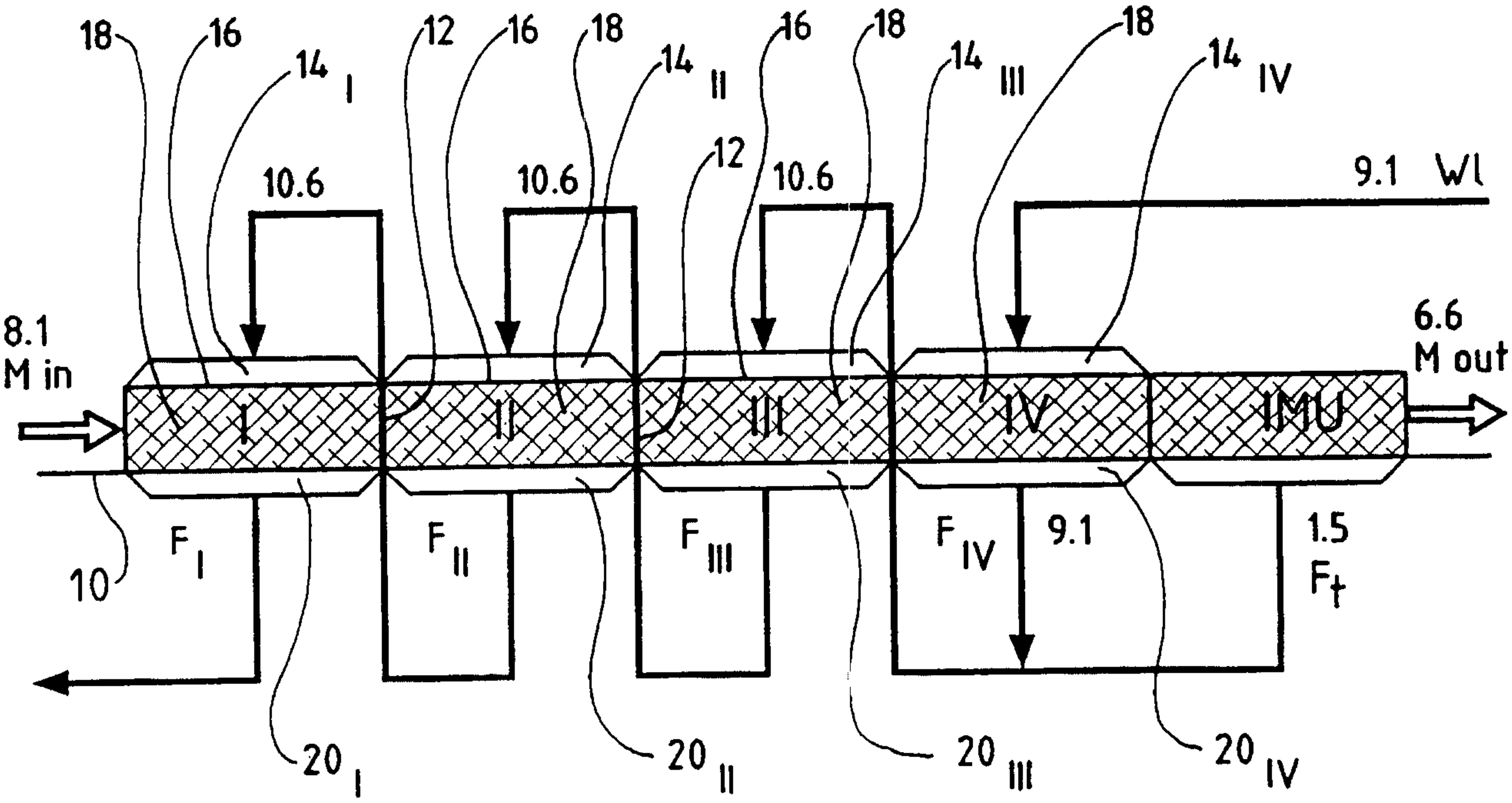


Fig. 1 DF = 2.5

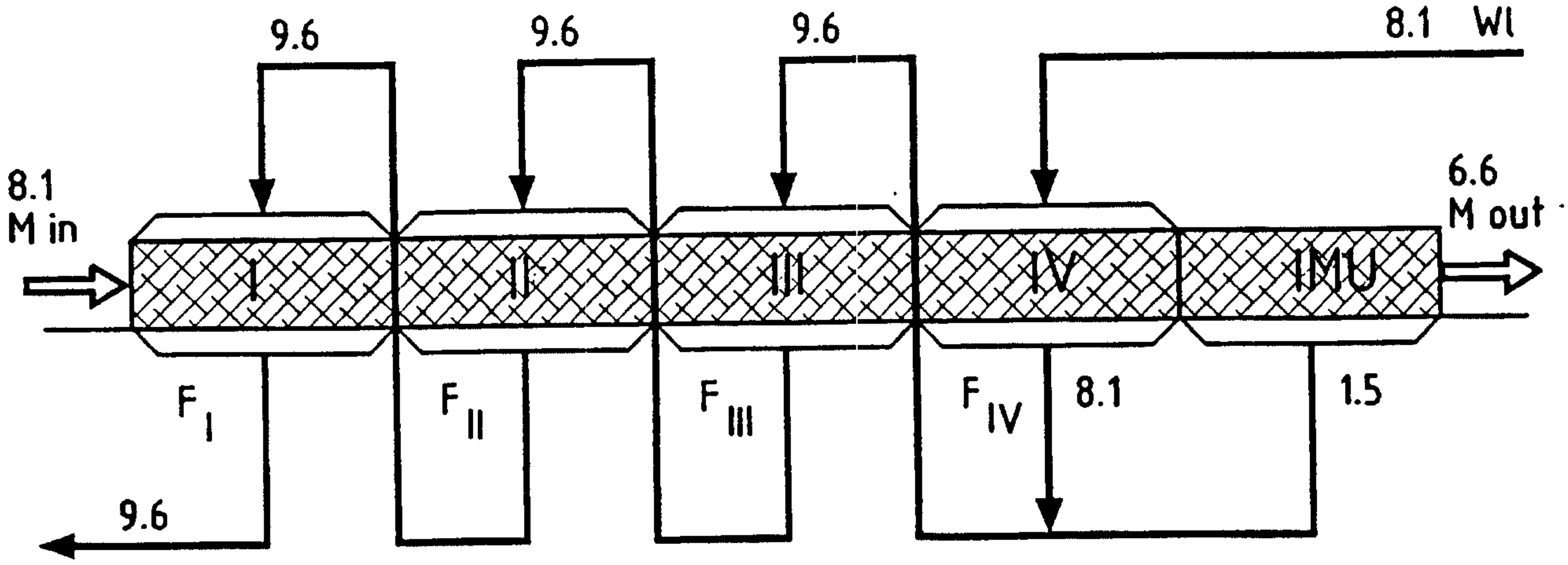


Fig. 2 DF = 1.5

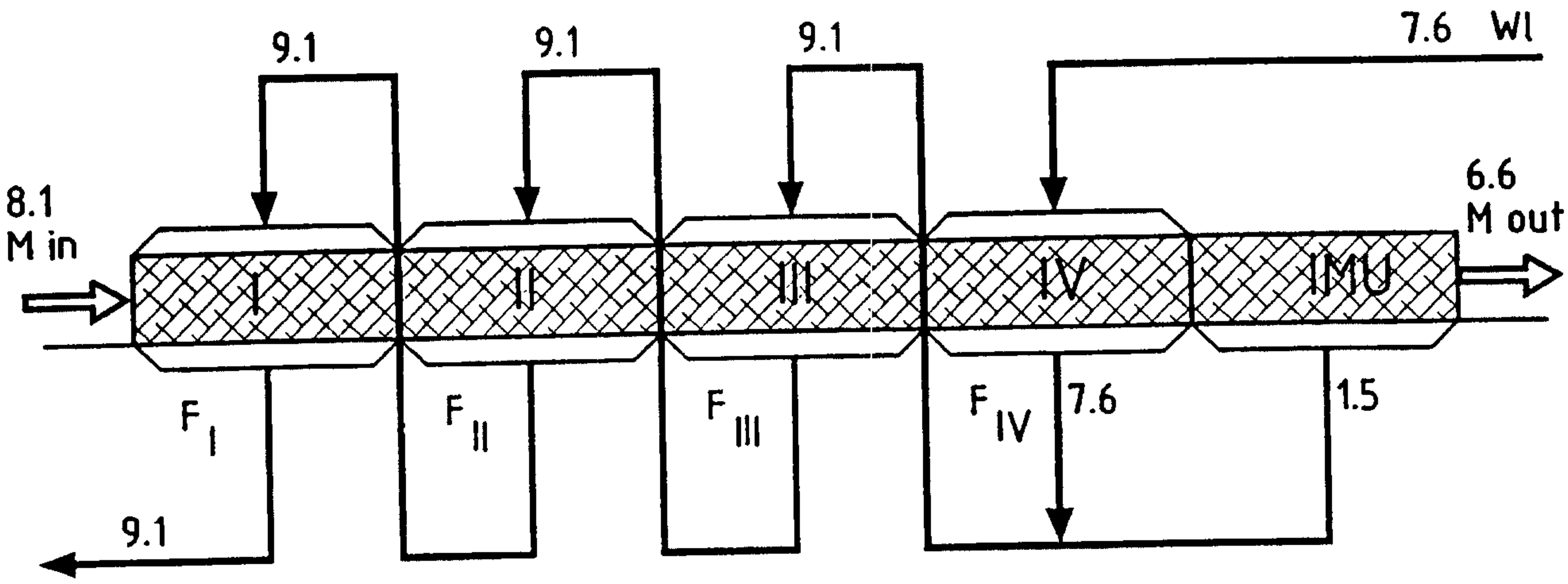


Fig. 3 DF = 1.0

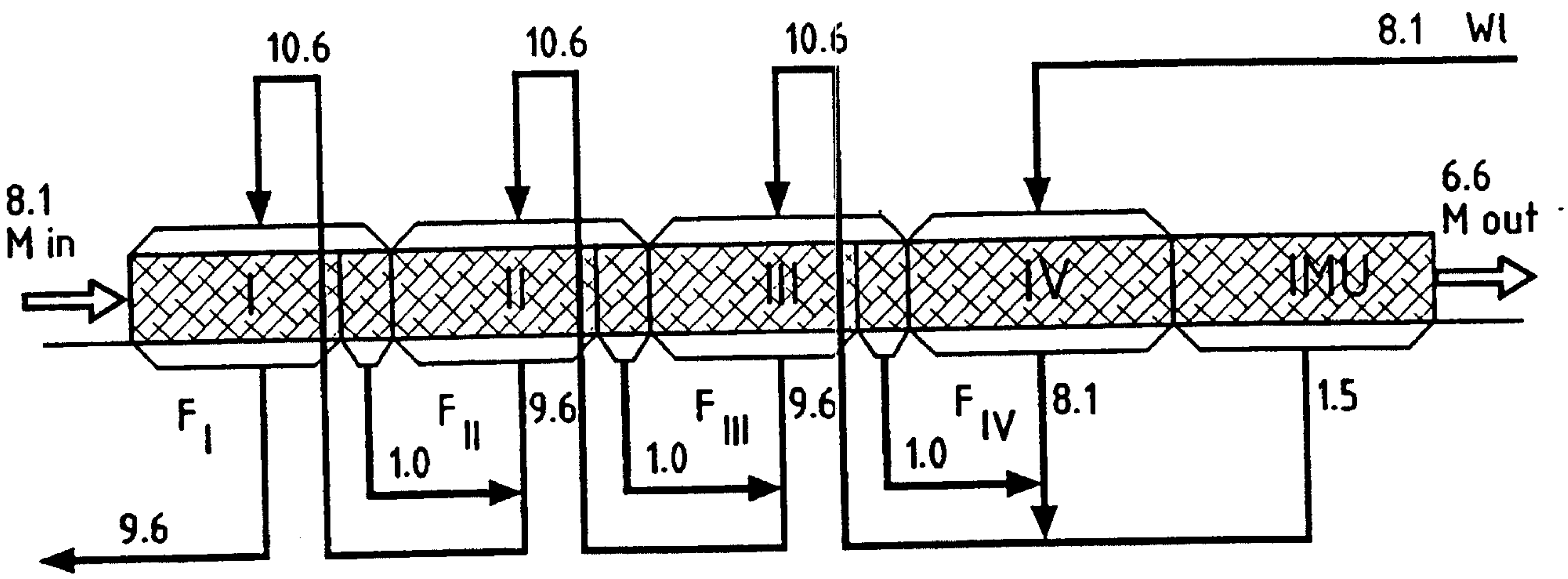


Fig. 4 DF = 1.5

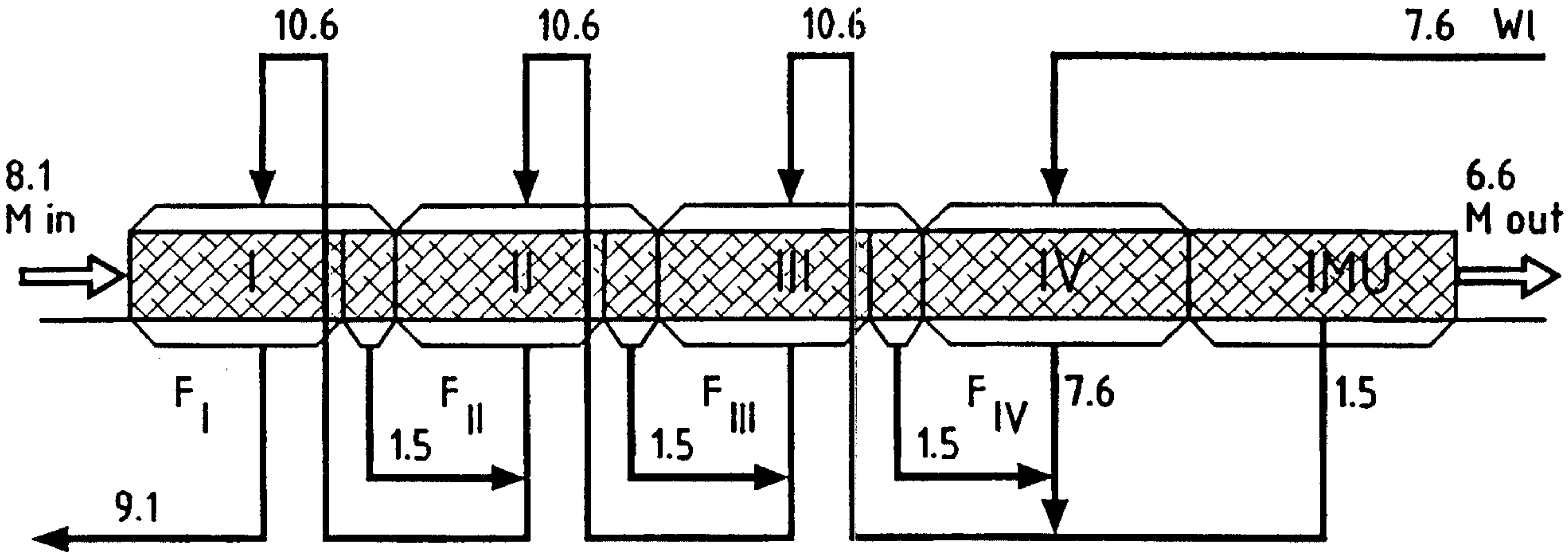


Fig. 5 DF = 1.0

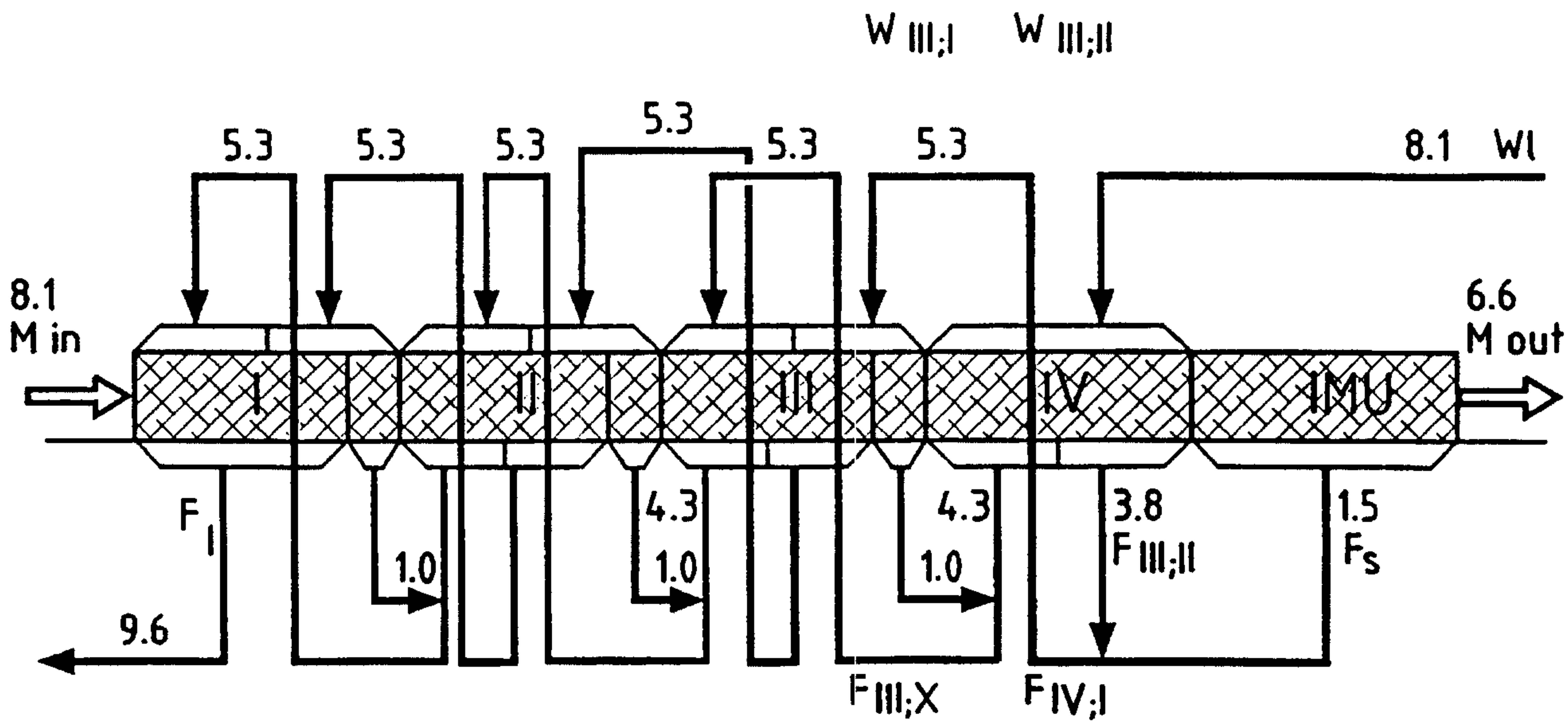


Fig. 6 DF = 1.5

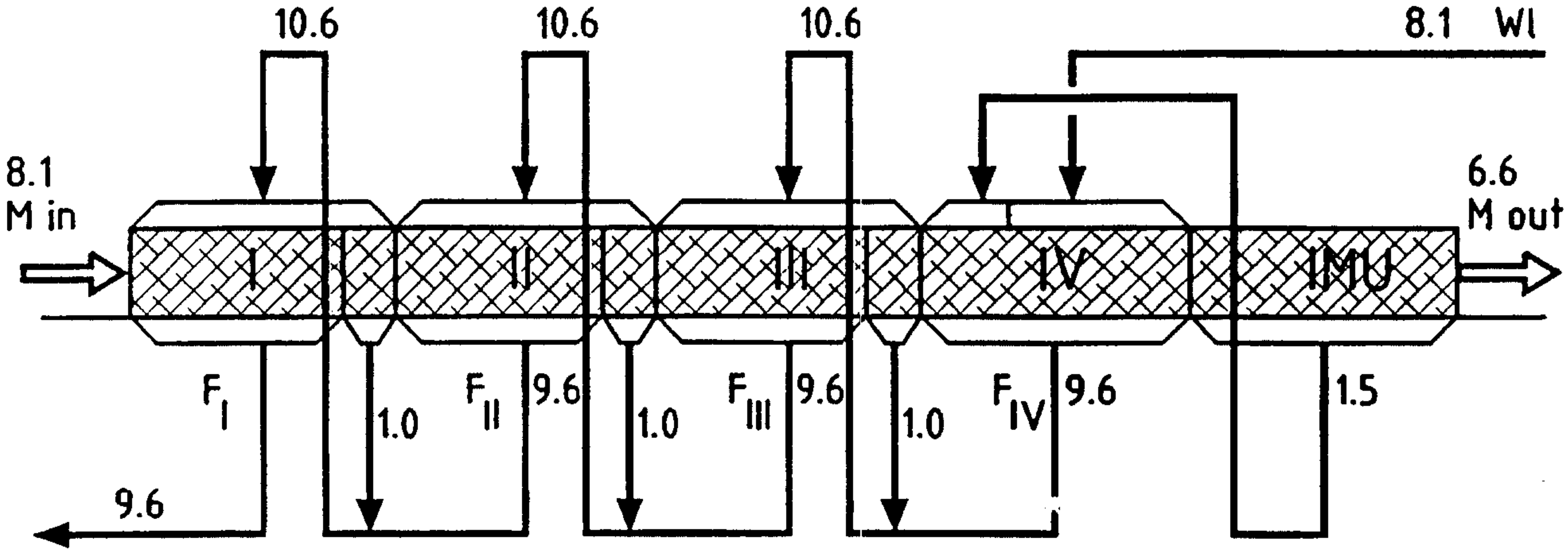


Fig. 7 DF = 1.5

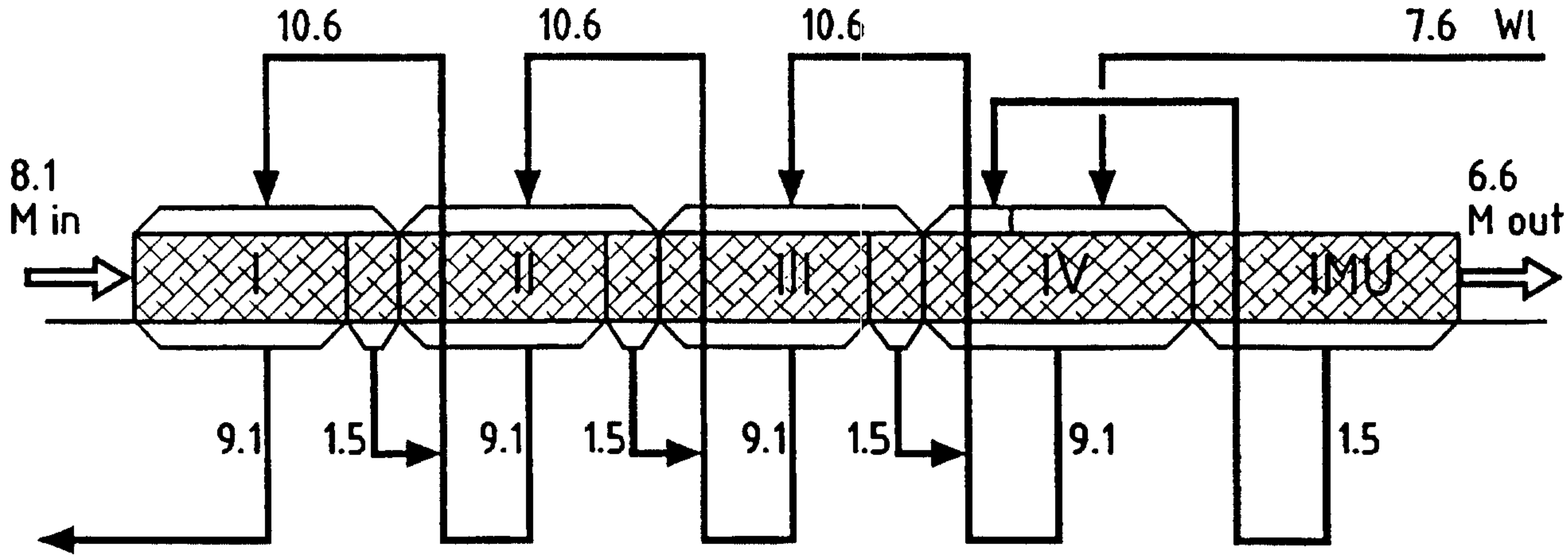


Fig. 8 DF = 1.0

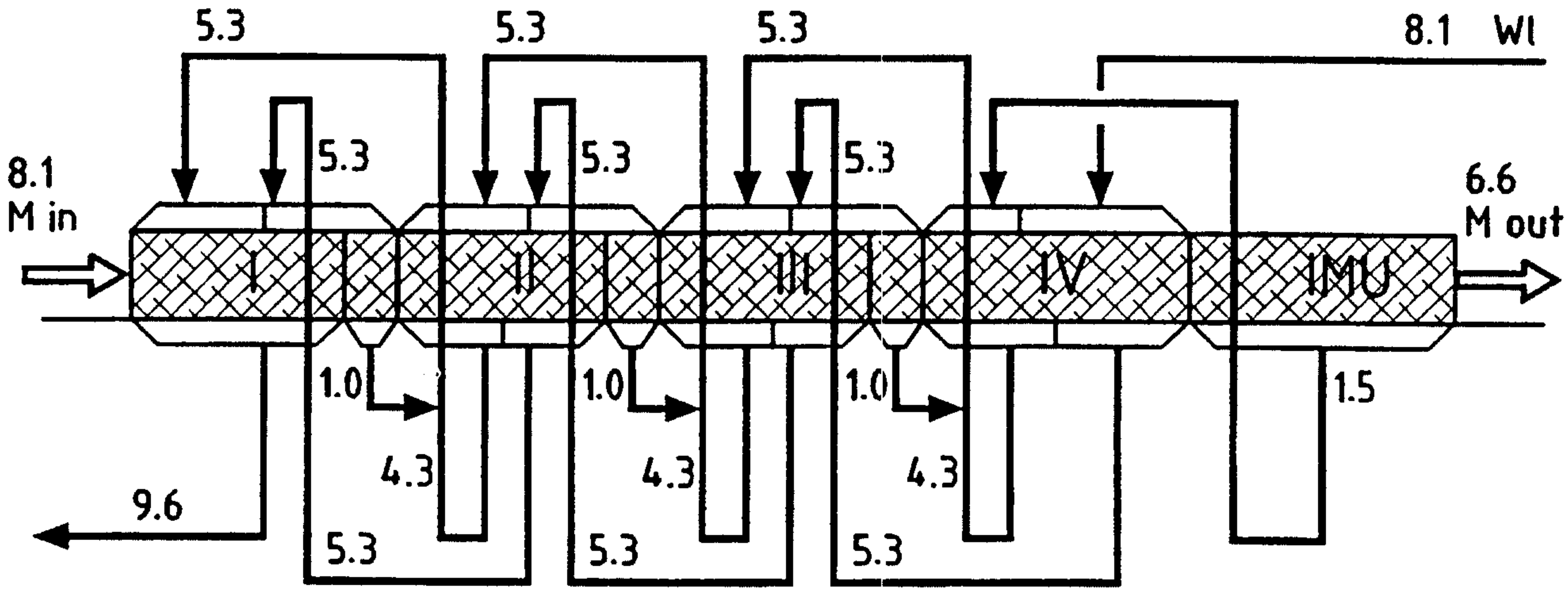


Fig. 9 DF = 1.5

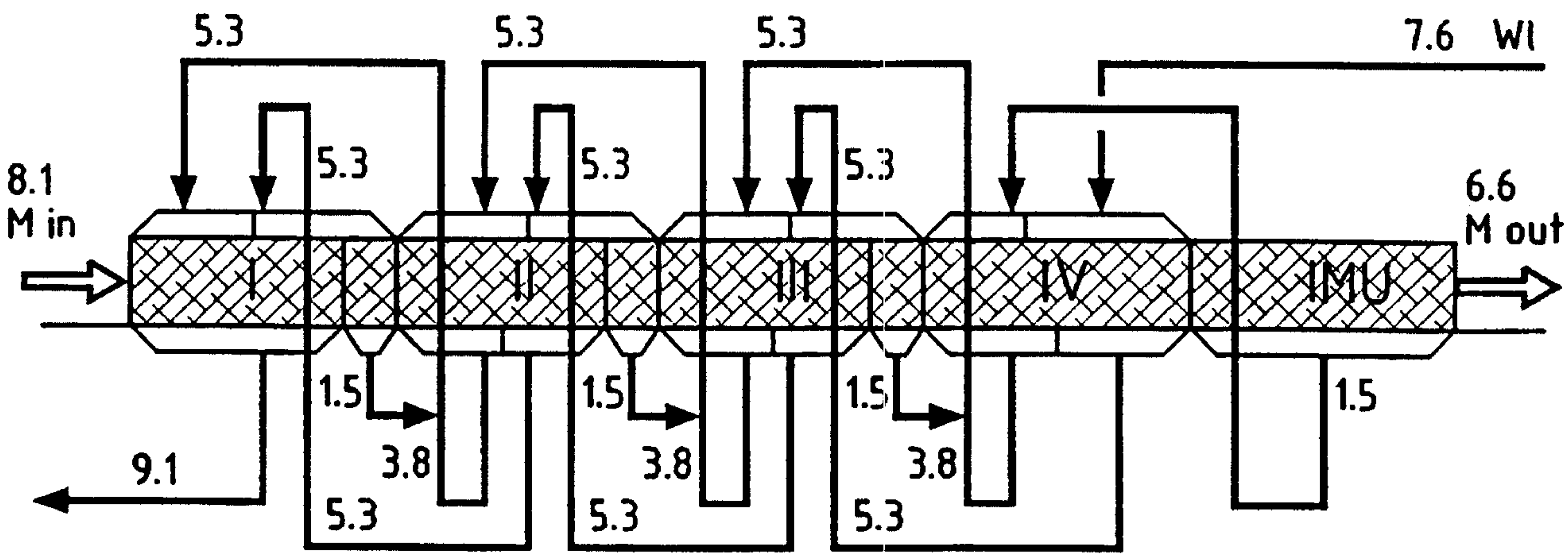


Fig. 10 DF = 1.0

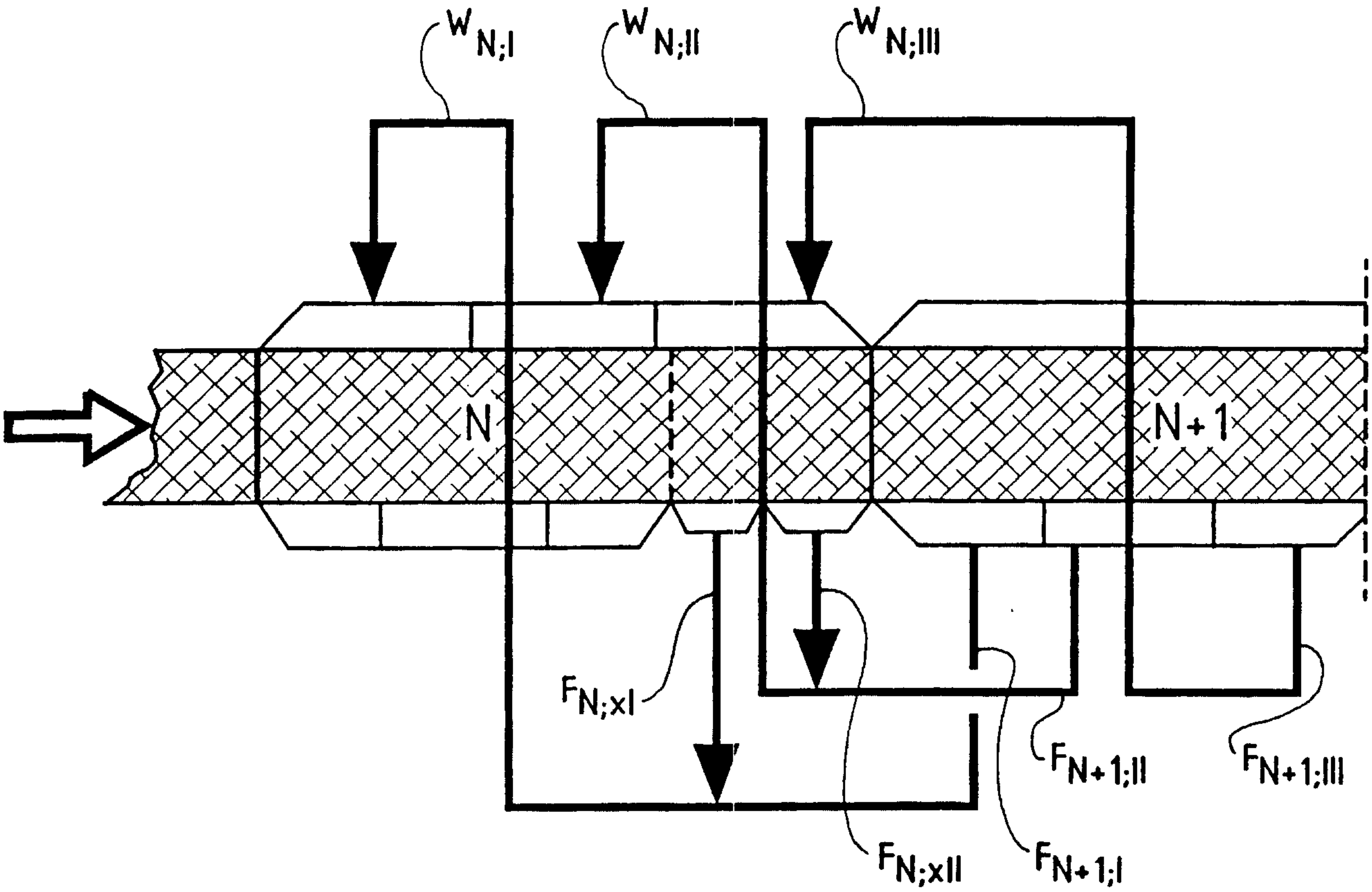


Fig. 11

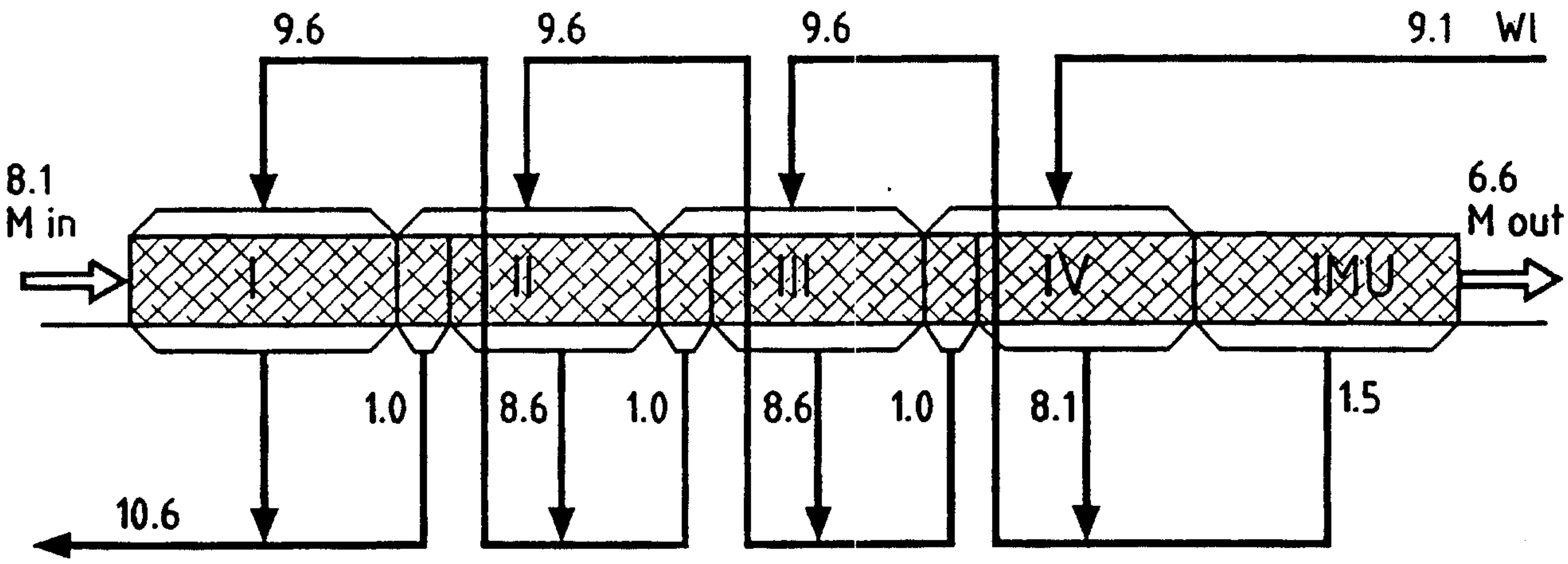


Fig. 12 DF = 2.5