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(54) Benævnelse: **BALLEPRESSER MED HYDRAULIKMOTOR**

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EP-A2- 0 346 586

BALLER WITH AN HYDRAULIC MOTOR

Description

Background of the invention

[0001] The invention relates to the field of machines for producing bales from crops. This type of machine is generally called a "bale press." This invention relates more precisely to a machine for producing bales having a substantially parallelepiped shape. Such bales are most often called "rectangular bales."

[0002] Traditionally, machines for producing bales include:

a pressing chamber;

a feeding device for feeding crops into the pressing chamber;

a piston movable in translation in the pressing chamber to press the crops;

a driving device having a coupling member arranged to be connected to a rotational driving element, the driving device being arranged moreover to drive the piston in translation.

[0003] A machine of this type is described in particular in document EP 0 346 586.

[0004] This type of machine generally includes an eccentric transmission device associated with a flywheel, the eccentric transmission device being arranged to transform a rotation movement, generated by the rotational driving element – most often a tractor power take-off – into a translation movement of the piston.

[0005] Traditionally, the flywheel starts moving and the piston moves in translation as soon as the tractor power take-off begins turning. This allows immediately moving the piston. It is understood that the starting of the machine, and in particular starting the rotation of the flywheel, consumes much energy.

[0006] Moreover, the piston reciprocates in the pressing chamber as long as the flywheel turns, and regardless of the filling rate of the pressing chamber.

[0007] What is more, the power which the rotational driving element must supply, namely the tractor power take-off, has a peak each time the piston compresses the crops

contained in the pressing chamber, which is constraining for the elements constituting the tractor.

[0008] In traditional machines, crops are picked up and are introduced into a pre-pressing chamber. The driving device and the piston operate continuously. The crops contained in the pre-pressing chamber are then pushed into the pressing chamber at the time when the piston is at the lower dead point. Due to an irregular filling speed of the pressing chamber, or due to irregular picking up of the crops, the piston sometimes performs up to 60 reciprocations before the pressing chamber contains a sufficient quantity of crops to form a bale, which constitutes a useless loss of energy.

Object and summary of the invention

[0009] One object of the invention is to propose a machine for producing bales of rectangular shape from crops, requiring less energy than traditional machines for forming bales.

[0010] The invention attains its object by the fact that the driving device also includes:

a hydraulic device comprising

a hydraulic pump connected to the coupling member;

a hydraulic motor supplied by the hydraulic pump;

a driving member driven by the hydraulic motor and configured to move the piston in translation; and

a control device connected to the hydraulic device to control the movement of the piston.

[0011] When the driving element, such as for example the tractor power take-off, is first set in rotation, only the transmission shaft of the hydraulic pump is set in rotation via the coupling member. Consequently, the hydraulic motor is not immediately set in rotation so that the driving member and the piston are not set in movement. Thus the starting of the machine according to the invention requires substantially less power than the machine according to the prior art.

[0012] In addition, the movement of the piston can be commanded when it is desired to carry out the pressing operation, which allows avoiding making the piston operate when the pressing chamber is not sufficiently full or is empty. To this end, the control device

acts on the hydraulic device, particularly on the pump and/or on the motor, in order to actuate the hydraulic motor, which causes the movement of the piston in the pressing chamber. The movement of the piston in the pressing chamber is advantageously commanded when the latter contains sufficient crops, in order to carry out the pressing. A portion of the pressed bale is then obtained. Then, the piston moves in a direction opposite to the pressing direction in order to clear the pressing chamber. Crops are then fed into the pressing chamber until the latter is full. Once the pressing chamber is sufficiently full, the piston is moved in order to press the second bale portion, and so on until a complete bale is formed. It is understood that the complete bale consists of several juxtaposed bale portions, pressed and preferably bound together.

[0013] The control device can be manually actuated, or automatically as explained below.

[0014] The machine according to the invention can therefore be bereft of a flywheel. The machine can also be bereft of a pre-pressing chamber.

[0015] It is understood, moreover, that the control device is configured to control and/or regulate power supply to the hydraulic motor.

[0016] Advantageously, the machine according to the invention also includes at least one sensor, located in the pressing chamber, for determining the filling rate of the pressing chamber, said sensor being connected to the control device, and the control device is configured to actuate the movement of the piston when the filling rate is greater than a predetermined threshold.

[0017] This sensor includes, for example, plates on which the crops press when they occupy a large and predefined volume in the pressing chamber. Without departing from the scope of the present invention, the pressing chamber could be equipped with several sensors.

[0018] The filling rate can also be a filling level.

[0019] Thus, due to the invention, the piston is actuated only starting at the moment where it has been detected that the pressing chamber is sufficiently filled. The machine according to the invention is therefore more efficient than traditional machines, provided that the piston is moved starting at the moment where the sufficient quantity of crops is

present in the pressing chamber to form a rectangular bale, and not uninterruptedly as in the prior art.

[0020] Advantageously, the driving member includes a device of the rod/crank type. Preferably, it includes a wheel or a drum, not necessarily inertial, serving as a crank, which is connected to the piston via a rod.

[0021] Advantageously, the hydraulic pump has a variable flow rate, preferably a variable displacement. One advantage is to be able to modulate the flow rate and therefore the power delivered to the hydraulic motor.

[0022] Preferably, the control device is also configured to modify the displacement of the hydraulic pump.

[0023] Advantageously, the hydraulic motor has a variable flow rate, preferably with a variable displacement, which allows regulating the force delivered to the piston.

[0024] The control device is advantageously configured to adjust the displacement of the hydraulic motor. Preferably, the hydraulic motor is adjustable so that the hydraulic pressure is constant and maximum.

[0025] According to one particularly advantageous aspect of the invention, the hydraulic device also includes at least one accumulator connected to the hydraulic pump.

[0026] Upon starting the machine, the hydraulic pump is set in rotation and charges the accumulator. The piston is not set in movement.

[0027] The accumulator behaves like a power reserve and allows in particular mitigating a power gap between the power consumed by the motor and the power available on the driving device. This allows substantially reducing the power required compared to a traditional machine.

[0028] Advantageously, the hydraulic accumulator is also connected to the hydraulic motor.

[0029] This has several advantages.

[0030] During the return travel of the piston, after the pressing operation, the hydraulic motor can operate in reverse like a hydraulic pump. In other words, the hydraulic motor is advantageously reversible. The hydraulic energy recovered is then stored in the

hydraulic accumulator and can advantageously be re-used during a later phase of movement of the piston. This system allows a substantial reduction in the energy required compared to a traditional machine.

[0031] Energy recovery can also occur in the case of braking the movement of the piston, or during a deceleration phase of the hydraulic motor.

[0032] Advantageously, the control device also includes a measurement device for determining the force applied by the piston to the crops. This force is preferably determined by means of the value of the torque of the eccentric, and of its position and its angular position. The torque of the eccentric is in particular determined by measuring the hydraulic pressure. Inasmuch as the hydraulic pressure can be measured accurately, it follows that the invention advantageously allows accurately determining the force applied by the piston to the crops.

[0033] The determination of the force applied by the piston to the crops advantageously allows determining the density of the bale, which can vary with the humidity and/or the ambient temperature. Thus, the power delivered by the hydraulic motor to the piston can be adjusted depending on the density of the bale being formed.

[0034] According to a preferred, but not exclusive, embodiment the machine is pulled by a tractor, and in that the rotational driving element is a tractor power take-off.

[0035] According to one variant, said machine is self-propelled. In this case, the driving element is a rotation shaft of the machine.

[0036] In known fashion, the machine according to the invention also comprises a binding device for binding the bales by means of wires prior to discharging the bale.

Brief description of the drawings

[0037] The invention will be better understood upon reading the description that follows of a mode of implementation of the invention given by way of a non-limiting example, with reference to the appended drawings, in which:

- figure **1** is a schematic view of the machine according to the invention, pulled by a tractor, the crops being fed into the pressing chamber in order to form a new bale;

- figures **2** and **3** illustrate the machine of figure **1** during a pressing phase by movement of the piston in the pressing chamber, in order to form a first portion of the new bale;

- figure **4** illustrates the return of the piston, and the filling of the pressing chamber;

- figure **5** illustrates a subsequent phase of pressing during which the second portion of the new bale is formed;

- figure **6** illustrates the return of the piston, the new bale being formed while the preceding bale is on the ground; and

- figure **7** is a schematic view of the hydraulic circuit of the machine according to the invention.

Detailed description of the invention

[0038] In figures **1** to **6** are illustrated an example of a machine **10** according to the invention for producing bales **B**, called "rectangular," based on crops **V,** such as straw for example. This machine is movable relatively to the ground **S.** In this example, the machine **10** is pulled by a tractor **12,** otherwise known, which includes in its rear portion a rotational driving element **14,** generally called a "power take-off."

[0039] To allow its movement, the machine **10** includes wheels **11.**

[0040] In this example, the crops consist of stems, previously cut and assembled on the ground in longitudinal piles.

[0041] The machine **10** includes in known fashion a pressing chamber **16** in which the straw is pressed to form a rectangular bale and a feeding device **18** for feeding the crops into the pressing chamber **16.** In known fashion, the feeding device **18** is associated with a pickup device **20** for picking up the straw and directing it toward the feeding device **18.** The pickup device **20** can be constituted by a drum driven in rotation in the direction opposite to the direction of advance of the machine **10.** The feeding devices are otherwise known. It is possible for example to use a comb operating a reciprocating movement to push the straw into the pressing chamber **16.**

[0042] To press the straw and form bales, the machine **10** includes a piston **22** which is movable in translation in a direction D in the pressing chamber. The machine **10** includes, moreover, a driving device **30** which is arranged to drive the piston **22** in translation. This

driving device includes a coupling member **32** arranged to be connected to the rotational driving element **14,** i.e. the power take-off **15** of the tractor **12.**

[0043] In known fashion, the machine **10** includes at least one tension plate **34** located in the upper portion of the pressing chamber **16,** this tension plate having the function of exerting a pressure on the bale being formed. It is also possible to provide lateral tension plates (not illustrated here).

[0044] In conformity with the invention, the driving device **30** also includes a hydraulic device **40,** illustrated in figure **7.** This hydraulic device **40** comprises a hydraulic pump **42** connected to the coupling member **32.** As disclosed above, the coupling member **32** is connected to the power take-off **15** of the tractor. It is therefore understood that setting the power take-off **15** of the tractor into rotation has the effect of setting the shaft **43** of the hydraulic pump **42** into rotation by means of the coupling member **32.** In this example, the hydraulic pump **42** is of the variable displacement type.

[0045] The hydraulic device **40** also comprises a hydraulic motor **44** which is supplied with power by the hydraulic pump **42.** In this example, the hydraulic motor **44** is reversible. It can therefore operate as a pump. In addition, the motor is of the variable displacement type.

[0046] As can be observed in figure **7,** in this example, the hydraulic device **40** also includes at least one hydraulic accumulator **46** which is connected to the hydraulic pump **42,** on the one hand, and to the hydraulic motor **44,** on the other hand.

[0047] Returning to figure **7,** it is observed that the driving device **30** also includes a driving member **60** which is driven by the hydraulic motor **44** and which is configured to move the piston **22** in translation in the direction **D.** In this example, the driving member **60** includes a device **62** of the rod/crank type, which includes a rod **64** mounted in a pivot connection with the piston **22**. The device **62** also includes an eccentric **66,** serving as a crank, which is connected to the rod **64,** on the one hand, and to the hydraulic motor **44,** on the other hand. In this example, a reduction gear **45** is provided between the hydraulic motor **44** and the eccentric **66.**

[0048] In conformity with the invention, the driving device **30** also includes a control device **70** which is connected to the hydraulic device to control the movement of the

piston. In this example, the control device **70** is configured to control the hydraulic pump **42** and the hydraulic motor **44.**

[0049] In this embodiment, the machine **10** also includes at least one sensor **72,** located in the pressing chamber, to determine the filling rate of the pressing chamber **16.** This sensor **72** is connected to the control device. In this example, the sensor **72** includes one or more plates actuated by crops when the pressing chamber is full of straw. The pressure exerted by the straw on the plates is such that it triggers a signal representing a filling rate of the pressing chamber.

[0050] Advantageously, the control device **70** is configured to actuate the movement of the piston **22** when the filling rate measured by the sensor **72** is greater than a predetermined threshold.

[0051] Moreover, the machine also includes a measurement device **74** for determining the force applied by the piston **22** to the crops. To this end, in this example, the measurement device **74** is based on the torque exerted by the eccentric **66** as well as its angular position around its axis of rotation **X.** These values are determined by the appropriate sensors (not illustrated here).

[0052] The operation of the machine **10** according to the invention will now be explained by means of figures **1** to **6**.

[0053] Upon starting the tractor, the pressing chamber **16** being empty, setting in rotation the power take-off **15** has the effect of setting the hydraulic pump **42** in rotation. At this time, the machine does not carry out any movement, the piston remains immobile and the feeding device is also immobile providing that no advance speed is detected. Consequently, there is no or very little energy consumption to operate the machine at that time. In this example, the formation of a new bale **B** is illustrated in figure **1**, it being specified that a first bale **A** was previously formed.

[0054] Upon starting the tractor, the torque of the power take-off **15** increases until the accumulator **46** is completely charged due to the pump **42.** After setting the machine **10** in movement relatively to the ground, the pickup device **20** and the feeding device **18** are actuated and feed the straw into the pressing chamber **16.**

[0055] When the sensor **72** determines that the pressing chamber **16** is sufficiently full, the control device actuates the movement of the piston **22,** as illustrated in figures **2** and **3.** The piston then compresses the crops in order to form a first portion **B1** of the bale **B.** It is understood that the first portion **B1** is compressed between the first bale **A** and the piston. Concomitantly, the tension plate **34** exerts a pressure on the tip of the first portion **B1** of the bale being formed. In other words, as long as the pressing chamber **16** is not sufficiently full, the piston **22** does not move, unlike the prior art where the piston is constantly driven with a reciprocating movement.

[0056] As illustrated in figure **4,** after the first pressing and the formation of the first portion **B1**, the piston reverses in order to free the pressing chamber **16.**

[0057] Once the latter is again sufficiently full due to the feeding means, the piston is actuated in order to compress the crops between the first portion **B1** and the piston, which creates a second portion **B2** of the bale **B**, as illustrated in figure **5.**

[0058] It is understood that the first and second portions **B1** and **B2** are juxtaposed and form the bale **B**. In this illustrative example, the bale **B** is produced at the conclusion of two pressing cycles. In addition, the first and second portions **B1** and **B2** are bound together by appropriate means, otherwise known.

[0059] In practice, it is possible to provide for twenty cycles or so of piston reciprocation in order to form a standard bale 2.4 meters long, 1.2 meters high and 0.9 meters wide.

[0060] As illustrated in figure **5,** during the formation of the second bale **B**, the first bale **A** is progressively pushed toward the downstream outlet of the machine, until the moment when it falls on the ground.

[0061] Figure **6** illustrates the return of the piston after the formation of the bale **B.**

[0062] The bale **B** is progressively bound during its formation due to binders, otherwise known and not illustrated here.

[0063] According to an advantageous aspect, during the return of the piston **22** toward the eccentric, the motor **44** operates as a hydraulic pump and generates hydraulic energy which is stored in the accumulator **46.** This energy can be used for a subsequent pressing phase.

Patentkrav

1. Maskine (10) til fremstilling af baller (B) fra plantemateriale (V), hvor maskinen kan flyttes i forhold til jorden og omfatter:

   et pressekammer (16);
   en tilførselsanordning (18), der er beregnet til at bringe plantematerialerne ind i pressekammeret (16);
   et stempel (22), der kan bevæges translationelt inden i pressekammeret (16) for at presse plantematerialet;
   en drivanordning (30) med et koblingselement (32), som er arrangeret til at blive sluttet til et rotationsdrivelement (14), hvor drivanordningen desuden er arrangeret til at drive stemplet (22) translationelt;
   hvor maskinen er kendetegnet ved, at drivanordningen (30) desuden omfatter:

      en hydraulikanordning (40), der omfatter
      en hydraulikpumpe (42), der er sluttet til koblingselementet (32);
      en hydraulikmotor (44), der forsynes fra hydraulikpumpen (42);
      et drivelement (60), der drives af hydraulikmotoren og er konfigureret til at bevæge stemplet (22) translationelt; og
      en styreenhed (70), der er sluttet til hydraulikanordningen (40) til styring af stempelforskydning.

2. Maskinen ifølge krav 1, **kendetegnet ved, at** den desuden omfatter mindst én sensor (72) til bestemmelse af pressekammerets fyldehastighed, og sensoren (72) er sluttet til styreenheden, og **ved, at** styreenheden (76) er konfigureret til at aktivere forskydningen af stemplet (22), når fyldehastigheden er højere end en forudbestemt tærskel.

3. Maskinen ifølge krav 1 eller 2, **kendetegnet ved, at** drivelementet (60) omfatter en anordning (62) af typen plejlstang/krumtap.

4. Maskinen ifølge ethvert af de foregående krav, **kendetegnet ved, at** hydraulikpumpen (42) har en variabel strømningshastighed, fortrinsvis en variabel forskydning.

5. Maskinen ifølge ethvert af de foregående krav, **kendetegnet ved, at** hydraulikmotoren (44) har en variabel strømningshastighed, fortrinsvis en variabel forskydning.

6. Maskinen ifølge ethvert af de foregående krav, **kendetegnet ved, at** hydraulikmotoren (44) er vendbar.

7. Maskinen ifølge ethvert af de foregående krav, **kendetegnet ved, at** hydraulikanordningen (40) desuden omfatter mindst én hydraulisk akkumulator (46), der er sluttet til hydraulikpumpen (42).

8. Maskinen ifølge krav 7, **kendetegnet ved, at** den hydrauliske akkumulator (46) desuden er sluttet til hydraulikmotoren (44).

9. Maskinen ifølge ethvert af de forudgående krav, som desuden omfatter en måleanordning (74), der er beregnet til at bestemme en indsats, der anvendes af stemplet (22) på plantematerialerne.

10. Maskine (10) ifølge ethvert af de foregående krav, **kendetegnet ved, at** maskinen er trukket af en traktor (12), og **ved, at** det roterende drivelement (14) er et kraftudtag (15) på traktoren.

11. Maskinen ifølge ethvert af kravene 1 til 9, **kendetegnet ved, at** maskinen er motordrevet.

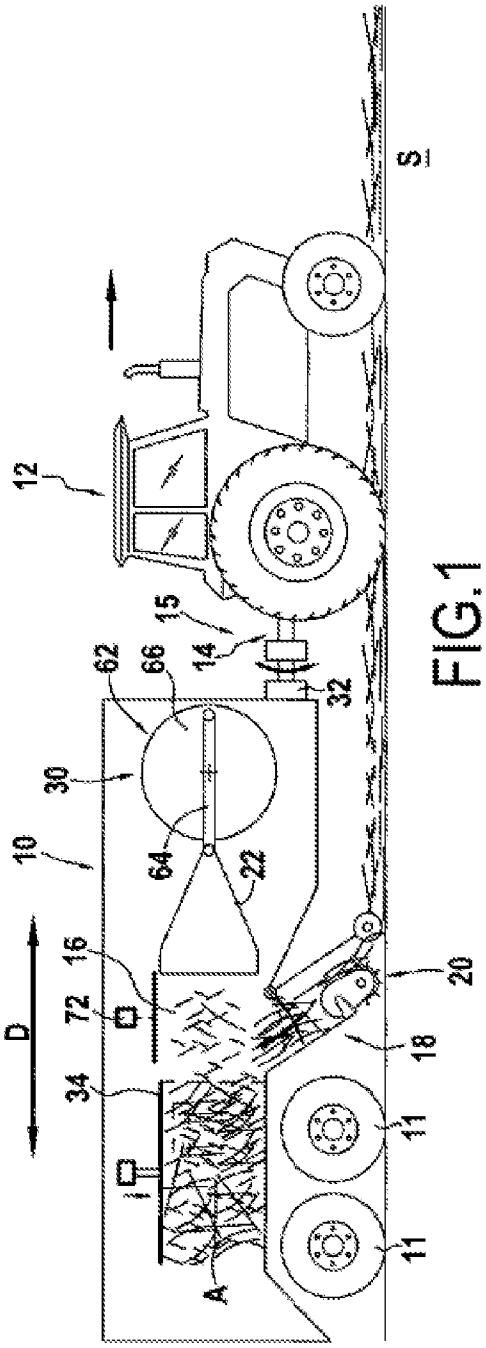
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FIG.1

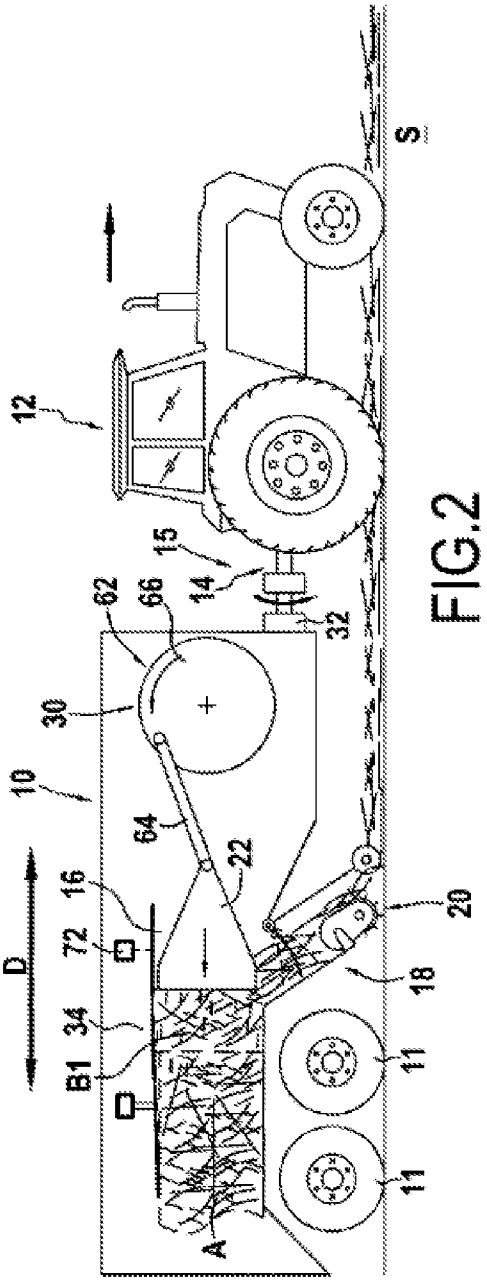
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FIG.2

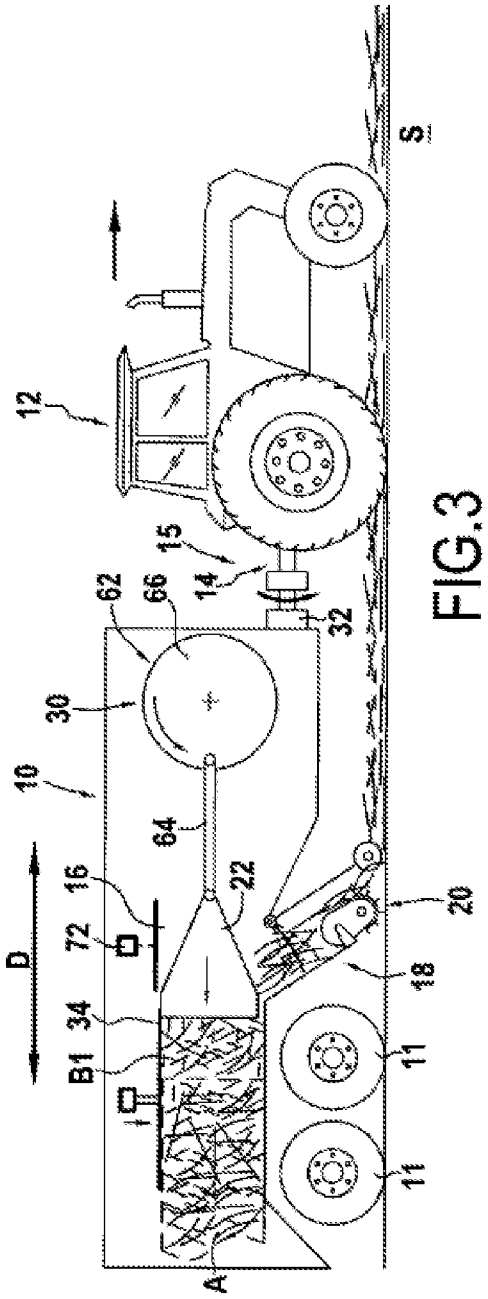
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FIG.3

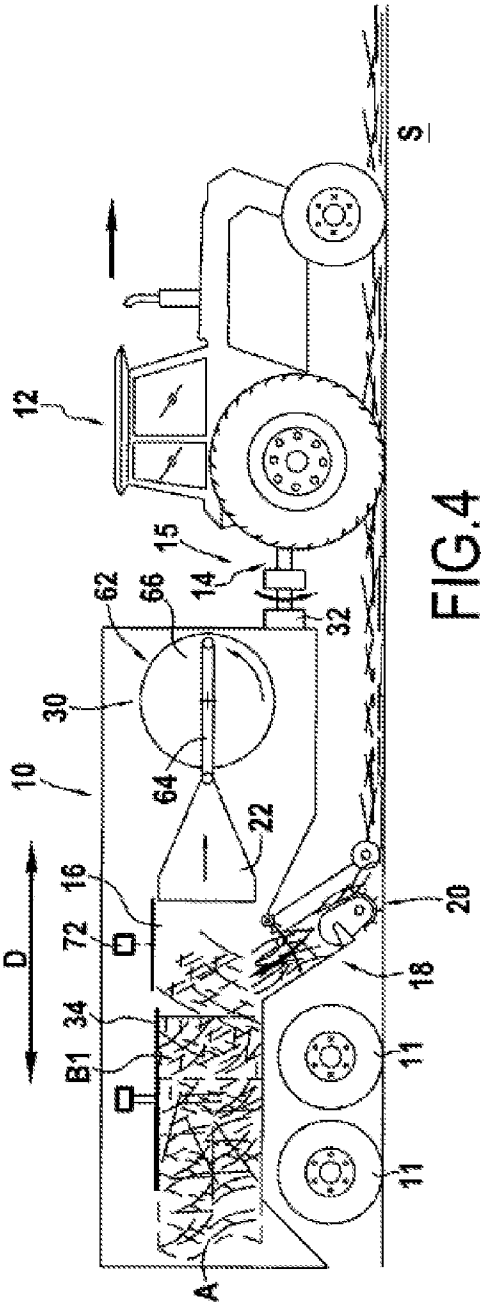
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FIG.4

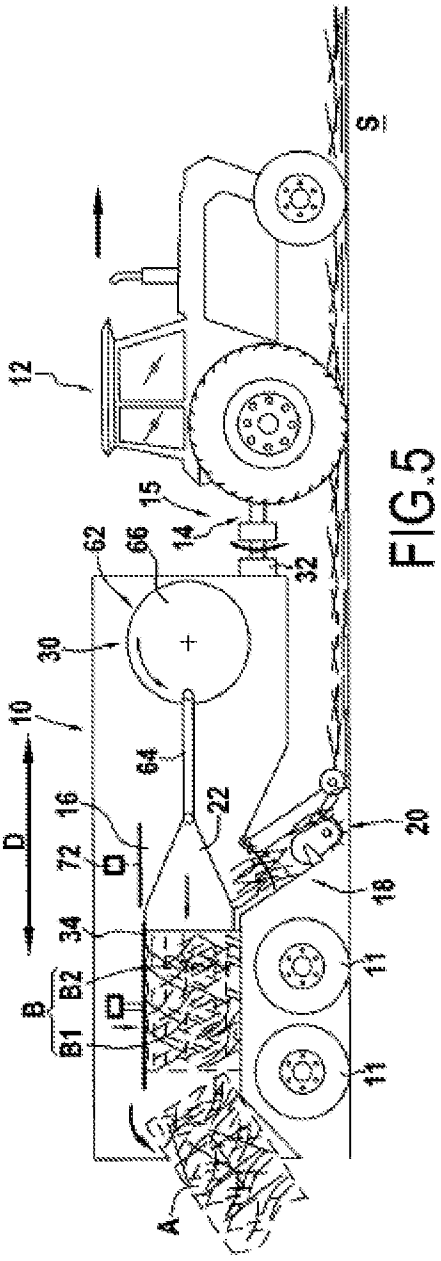
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FIG.5

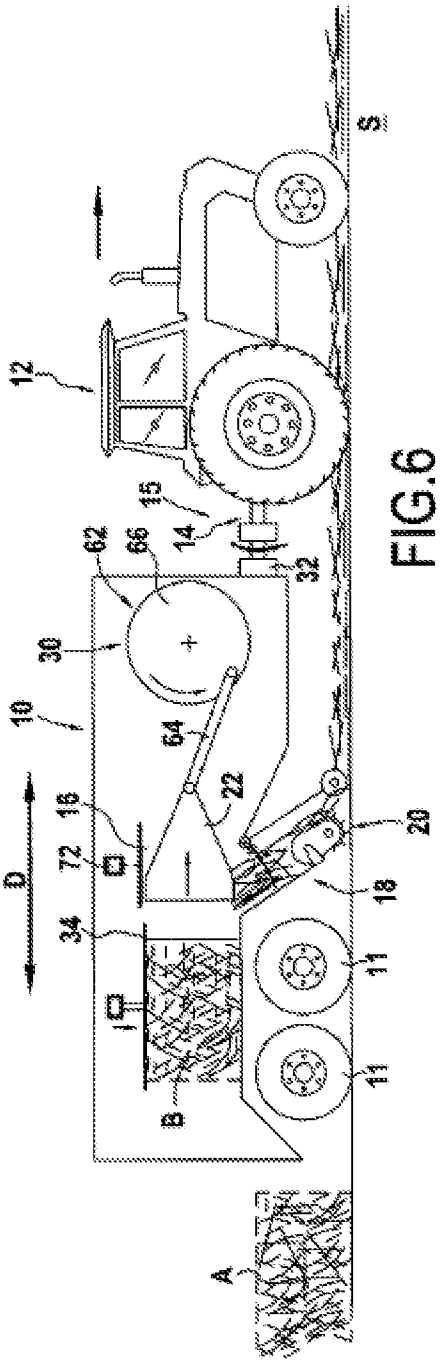
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FIG.6

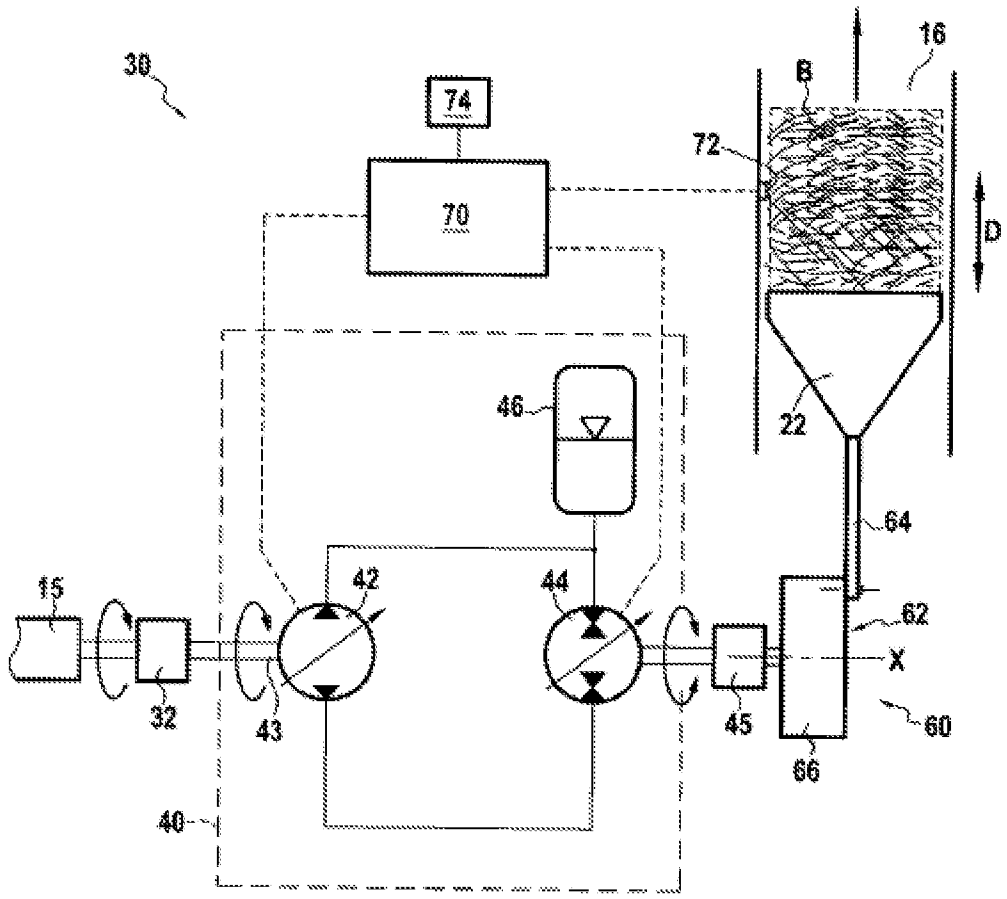

FIG.7