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(54) Benævnelse: **System og fremgangsmåde til styring af monteringsudstyr til vintertjenestekøretøjer**

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[0001] The invention relates to a system and method for controlling mounted implements for winter service spreading vehicles, in particular spreading apparatus.

[0002] Mounted implements for winter service vehicles, such as for example spreading devices on winter service spreading vehicles, are operated by means of hydraulic motors. A hydraulic motor is connected to a hydraulic pump via pressure lines, is driven by hydraulic oil conveyed by the hydraulic pump and converts the energy of the hydraulic oil to mechanical (motion) energy. The hydraulic pump is in turn driven by an auxiliary motor different from the vehicle engine, such as a diesel engine, a gasoline engine or an electric motor. The control of the power of the hydraulic motor is effected by means of valves that either feed the hydraulic oil conveyed by the hydraulic pump to the hydraulic motor or guide it back into a tank when power is not required. A system according to the preamble of claim 1 is described in DE 2011894 A.

[0003] It is the object of the present invention to improve such a system for controlling mounted implements on winter service spreading vehicles.

[0004] The object is achieved by a system and a method according to the independent claims. Advantageous embodiments and further developments are specified in the claims dependent thereon.

[0005] A system according to the invention for controlling a mounted implement for a winter service spreading vehicle includes the components mentioned at the outset, namely in particular the auxiliary motor, the hydraulic pump driven by the auxiliary motor and the hydraulic motor supplied with hydraulic fluid via the hydraulic pump.

[0006] The system according to the invention is configured to automatically determine and adjust the rotational speed of the auxiliary motor in dependence on at least one operating parameter which is relevant for the operation of the at least one mounted implement, wherein the operating parameters include one or several of the following parameters: spreading width, spreading density of salt, spreading density of brine, brine proportion and driving speed of the vehicle. From these operating parameters the power and oil amount of the hydraulic system required for the operation of the mounted implement can in fact be determined already without additional parameters, for example of the hydraulic system, that are possibly difficult to capture, since the required rotational speeds, i.e. volume flows of the hydraulic motors for a certain operating condition, are known. Further, the volume flow of the hydraulic pump is known. Thus, the required rotational speed of the auxiliary motor can be determined and adjusted.

[0007] Preferably, therefore, the rotational speed of the auxiliary motor is determined and adjusted in consideration of the volume flows of the hydraulic pump and of the at least one hydraulic motor, wherein moreover the rotational speed of the at least one hydraulic motor is taken into account, which is required for driving the mounted implement due to the relevant operating parameters. Thus, the rotational speed of the auxiliary motor can be controlled solely on the basis of parameters that are already known or predetermined in the system anyway, without additional parameters having to be determined or captured that are unnecessary for the conventional operation of the winter service spreading vehicle.

[0008] In contrast, an auxiliary motor in conventional systems always runs at an unalterable, constant rotational speed and correspondingly drives a hydraulic pump with constant power. However, the mounted implement does not require the full power at all times, which is provided by the built-up pressure of the hydraulic pump. Therefore, according to the invention, the rotational speed of the auxiliary motor can be adjusted to the value actually required. This means that, in the system according to the invention, the auxiliary motor runs at a variable rotational speed which is individually determined and adjusted, and which can accordingly be adapted to changing operating parameters.

[0009] Through the power-controlled rotational speed of the auxiliary motor, the inventive system reduces the risk of overheating of the hydraulic oil, since always only that amount of hydraulic oil is conveyed by the hydraulic pump which is required for the operation of the mounted implement. Moreover, the invention achieves a noise reduction in particular when the vehicle stands still, which has a positive effect on the environment. In addition, the lower fuel consumption due to the adapted rotational speed of the auxiliary motor means on the one hand a reduction of the operating costs of the winter service spreading vehicle and on the other hand protection of the environment. Finally, a reduced wear of the auxiliary motor should be mentioned as an advantage, since it frequently runs at a lower rotational speed.

[0010] As mounted implements for a winter service spreading vehicle there are used in particular a conveyor unit for conveying spreading material from a spreading material container and a spreading device for distributing the conveyed spreading material on a surface to be spread. When used in winter service, for example a conveyor belt or a screw conveyor conveys spreading salt onto a spreading disk, which distributes the spreading salt on a road by means of a rotating movement, in order to reduce the risk of slippery roads due to snow and ice.

[0011] To be able to moisten the spreading salt with brine, a brine feed can be provided as a further mounted implement or as a component of a mounted implement. Here, a pump is driven by means of the auxiliary motor via a hydraulic motor, which pumps the brine from a tank to the conveyed spreading salt, so that the brine and the spreading salt are mixed before distribution on the road.

[0012] As mentioned, according to the invention, the rotational speed of the auxiliary motor is automatically determined and adjusted in dependence on operating parameters of the least one mounted implement. The operating parameters therein include one or several of the following parameters: spreading width, spreading density of salt, spreading density of brine, brine proportion and driving speed of the winter service spreading vehicle. These parameters are already known from the control of the mounted implement, such as for example a spreading device. On the basis of these known values alone it is possibleto regulate the rotational speed of the auxiliary motor. No additional parameters through further possibly expensive sensor systems are required that monitor, for example, the hydraulic system, although, as described below, these can be used in addition to the known parameters from the control of the mounted implement for adjusting the rotational speed of the auxiliary motor.

[0013] The spreading width is set depending on the road width or generally the width of the surface to be spread, for example by the driver of the winter service spreading vehicle. To relieve the driver, this can also be done automatically, for example by adjusting the spreading width by determining the position of the vehicle by means of GPS and by comparison with a database that contains information about roads and route sections.

[0014] The spreading density of salt or brine to be adjusted is influenced by the ambient conditions, such as for example temperature, air humidity or road conditions, wherein the spreading density of brine is important in pure liquid spreading. The spreading density can be adjusted manually by the driver or automatically again. For this purpose, again a GPS-based system can be used, which defines the optimal spreading density on the basis of the position of the winter service spreading vehicle and on the basis of weather data. The weather data can be centrally provided by a weather service or by weather stations along the route traveled. The determined parameters can then be evaluated centrally and sent to the vehicle or the evaluation of the data and determination of the spreading density is effected in the vehicle directly.

[0015] To determine the road conditions, in addition to manual input by the driver also road condition sensors can be used. These determine, for example by infrared and/or microwave radiation, whether the road is wet, icy or dry and how large the amount of humidity is. The spreading density is then determined on the basis of this information.

[0016] A further parameter can be the brine proportion, i.e. the percentage of brine in the mixture of salt and brine. Spreading salt is most frequently not spread on the road alone, but in a mixture with brine. This serves on the one hand to moisten the spreading salt, in order to improve the distribution on the road surface. On the other hand, the thawing effect of the spreading salt is improved by mixing it with brine. The brine from a separate tank is therein mixed with the spreading salt before the spreading, depending on parameters that can be determined or adjusted as described above. The quantity of brine can be increased or decreased, wherein usually a mixing ratio of 30 weight percent brine and 70 weight percent spreading salt is employed. Since also for this purpose hydraulic motors are operated, which are driven by means of a hydraulic pump, the rotational speed of the auxiliary motor can be adapted to the amount of brine.

[0017] A further parameter which is captured for determining and adjusting the rotational speed of the auxiliary motor is the driving speed of the winter service spreading vehicle. The faster the vehicle is traveling, the more power is demanded by the mounted implements and the correspondingly higher the power of the auxiliary motor must be. When, during a standstill of the winter service spreading vehicle, for example at a red traffic light, the mounted implement is intended to likewise stand still or run at a lower speed at least, the rotational speed of the auxiliary motor can be reduced correspondingly, resulting in a reduction of noise and fuel consumption. When the winter service spreading vehicle drives at a higher speed, the rotational speed of the auxiliary motor can be increased correspondingly, in order to provide sufficient hydraulic energy for the mounted implements.

[0018] The system preferably includes a reference table in which the associated required rotational speed for the auxiliary motor is stored for different constellations of mounted implements and operating parameters. In this way, the rotational speed of the auxiliary motor can be controlled very easily. The valuesin the reference table can be based on empirically obtained values, for example.

[0019] In an advantageous embodiment of the invention the system is adapted to chose the rotational speed of the auxiliary motor to be higher than the rotational speed required for operating the at least one mounted implement and to convey excess hydraulic oil into a tank. To cushion unexpected power peaks of the mounted implement, a safety margin is chosen for the rotational speed of the auxiliary motor determined from the operating parameters. Thereby also the hydraulic pump runs at an increased rotational speed, thus conveying additional hydraulic oil. Insofar as this is not required, it is conveyed back into the tank. Through this safety margin it is ensured that sufficient hydraulic pressure is always available to the hydraulic motor of the mounted implement.

[0020] After a standstill of the mounted implement it can occur that for starting more pressure is required than for operation. Therefore, the system is preferably adapted to chose the rotational speed of the auxiliary motor after a standstill of the mounted implement to be momentarily higher than the rotational speed determined from the operating parameters. Thereby sufficient pressure is available to the hydraulic system also after a standstill, and possible start-up problems, for example of a screw conveyor, are prevented.

[0021] In a further embodiment of the invention it can be provided to capture the rotational speed of the auxiliary motor. By measuring the rotational speed of the auxiliary motor, a possible overloading of the auxiliary motor can be detected. In this case, the rotational speed of the auxiliary motor is too low and does not supply sufficient hydraulic energy for the operation of the mounted implement. The rotational speed of the auxiliary motor can then be raised. For this purpose, it is possibly necessary to reduce the power demand of the mounted implements until the auxiliary motor has returned to the rotational speed within the operating range. Subsequently, the rotational speed can be raised to a higher range in order to supply the hydraulic motors with sufficient power.

[0022] It can further be provided to capture the rotational speed of the at least one hydraulic motor, so that a possible lack of oil can be detected through a rotational speed of the hydraulic motor which is too low.

[0023] In the following the invention is described by way of example with reference to the accompanying drawings. The figures are described as follows:

[0024] Figure 1 a simplified, schematic representation of an auxiliary motor with a control and hydraulic motors and

[0025] Figure 2 a schematic representation of the electrical and hydraulic components of a winter service spreading vehicle for controlling the mounted implements.

[0026] In Figure 1 the arrangement of an auxiliary motor 1 and a connected control 2 with two hydraulic motors 4, 5 is represented in simplified form. The control 2 regulates the rotational speed of the auxiliary motor 1, for example a diesel engine, a gasoline engine or an electric motor, by processing target values and actual values and operating parameters, determining the rotational speed for the auxiliary motor 1 therefrom. In order to transmit the determined rotational speed to the auxiliary motor 1, the auxiliary motor 1 is connected to the control 2 via an electrical connection 16.

[0027] The auxiliary motor 1 drives a hydraulic pump 3 which conveys hydraulic oil to hydraulic motors 4, 5 via a pressure line 7. The hydraulic motors 4, 5 respectively drive a mounted implement, such as a spreading device. Via the connection 12 the control 2 receives a feedback from the auxiliary motor 1 about its instantaneous rotational speed, which can be included in addition to the other operating parameters when determining the rotational speed of the auxiliary motor 1.

[0028] The functional diagram represented in Figure 2 shows the most important electrical and hydraulic components for the control of the mounted implements of a winter service spreading vehicle. Before the winter service spreading vehicle starts its service, a programming of the operation of the mounted implements is performed in advance on a computer 30 by means of a software. Here, some operating parameters can be preset that are relevant for the operation of the winter service spreading vehicle. The results of the programming are then stored on a memory card 31, for example a compact flash card, in order to be able to transmit them to the control 2 of the winter service spreading vehicle. The memory card 31 is inserted in an operating unit 29 and read out therefrom for this purpose. The operating unit 29 is moreover provided to enable an operator, for example the driver, to make adjustments himself via a keyboard.

[0029] The operating unit 29 can be connected preferably separably to the control 2 of the vehicle via a CAN bus (controller area network) 28. The control 2 receives the pre-programmed adjustments stored on the memory card 31 in this fashion, plus possibly inputs made by the driver via the operating unit 29. These specifications define the target values SW for the mounted implements of the vehicle to be activated. Manual inputs by the driver can for example be the specification of the spreading density or of the spreading width, if these parameters are not determined automatically.

[0030] The functional diagram of a winter service vehicle represented in Figure 2 includes a spreading material container 20 that can receive spreading material, such as for example salt. From the spreading material container 20, the spreading material is conveyed by means of a screw conveyor 19 in the direction of a spreading device 18, such as for example a rotating spreading disk. In order to improve the thawing effect of the salt to be spread, brine is added to the former before distribution on the road surface. The brine passes from brine tanks 21 to the spreading device 18 via a line 22 with a valve 23 and a pump. The spreading device 18, the screw conveyor 19 and the brine pump are each driven by hydraulic motors 4, 5, 6. The hydraulic energy required for this is produced by the auxiliary motor 1.

[0031] For this purpose the auxiliary motor 1 drives a hydraulic pump 3, which conveys hydraulic oil to a hydraulic proportional control unit 26 via a hydraulic pressure line 7. This divides the hydraulic flow out to three pressure lines 8, 9, 10 leading to the hydraulic motors 4, 5, 6 of the respective mounted implements. The drive of the screw conveyor 19 is effected therein through the hydraulic motor 4 connected to the pressure line 8, the drive of the hydraulic motor 5 for the spreading device 18 is effected via the pressure line 9, and the hydraulic motor 6 connected to the pressure line 10 drives a pump for conveying the brine from the brine tank 21.

[0032] To be able to define the required amount of hydraulic oil to be fed to the hydraulic lines 8, 9, 10 via the proportional control unit 26, operating parameters are captured during the operation of the mounted implements18, 19. One operating parameter is the driving speed of the winter service vehicle which is sent to the control 2 via the connection 11. Although the regulation of the rotational speed of the auxiliary motor is likewise possible only with the pre-programmed adjustments and the adjustments that are made via the operating unit 29, the rotational speeds of the hydraulic motors 4, 5, 6 of the spreading device 18, the screw conveyor 19 and of the brine pump, can be included, possibly taking gear ratios into account. These are scanned from sensors with certain pulses and sent to the control 2 via connections 13, 14, 15. In addition, the current rotational speed of the auxiliary motor 1 is measured and transmitted to the control 2 via the connection 12. These operating parameters together result in the actual state of the vehicle and are processed as actual values IW by the microprocessor 27. The microprocessor 27 can additionally receive information from a road condition sensor 24 which measures the temperature of the road surface. The road condition sensor can also determine further information about the condition of the road, such as the presence of snow or ice or the humidity of the road. Information on the position of the vehicle can be supplied by a GPS sensor 25. By means of the position of the vehicle, for example weather data from weather maps can be considered or the road width can be determined by comparison with a database. Thus, the spreading properties can be adapted further to the ambient conditions, without the driver having to make manual adjustments via the operating unit 29.

[0033] From the actual values IW, the target values SW and the data on the position of the vehicle and the condition of the road surface, the microprocessor 27 determines the control variables SG for the hydraulic proportional control unit 26 and sends these via the connection 17. The control variables SG further include the rotational speed of the auxiliary motor 1, which depends on the operating parameters and is transmitted to the auxiliary motor 1 via the connection 16. The rotational speed of the auxiliary motor 1 is subsequently adapted correspondingly, for which reason, possibly taking safety margins in to account to cushion power peaks, the hydraulic pump 3 conveys only the required amount of hydraulic oil and the advantages mentioned at the outset are achieved.

PATENTKRAV

1. System til styring af i det mindste et monteringsudstyr (18, 19) til et vintertjenestekøretøj, omfattende en hjælpemotor (1), en hydraulikpumpe (3), der drives ved hjælp af hjælpemotoren (1), og i det mindste en hydraulikmotor (4, 5, 6), der er forbundet med hydraulikpumpen (3) via trykledninger (7, 8, 9 10), til at drive det i det mindste ene monteringsudstyr (18, 19), **kendetegnet ved**, at systemet er indrettet til automatisk at beregne og indstille et omdrejningstal for hjælpemotoren (1) afhængigt af i det mindste en driftsparameter, der er relevant for driften af det i det mindste ene monteringsudstyr (18, 19), idet driftsparametrene omfatter et eller flere af følgende parametre: spredningsbredde, spredningstæthed af salt, spredningstæthed af saltlage, saltlageandel og vintertjenestekøretøjets kørehastighed.

2. System ifølge krav 1, **kendetegnet ved**, at systemet er indrettet til at beregne og indstille et omdrejningstal for hjælpemotoren (1) under hensyntagen til absorptionsvolumenet for hydraulikpumpen (3), absorptionsvolumenet for den i det mindste ene hydraulikmotor (4, 5, 6) og omdrejningstallet for den i det mindste ene hydraulikmotor (4, 5, 6), der er nødvendigt på grundlag af den i det mindste ene relevante driftsparameter til at drive monteringsudstyret (18, 19).

3. System ifølge krav 1 eller 2, **kendetegnet ved** en referencetabel, hvor systemet er indrettet til at beregne omdrejningstallet for hjælpemotoren (1) på baggrund af en sammenligning af driftsparametrene med værdier fra referencetabellen.

4. System ifølge et af kravene 1 til 3, **kendetegnet ved**, at systemet er indrettet til at indstille omdrejningstallet for hjælpemotoren (1) højere end omdrejningstallet, der er nødvendigt for driften af det i det mindste ene monteringsudstyr (18, 19), og transportere overskydende hydraulikvæske, der transporteres fra hydraulikpumpen, ind i en tank.

5. System ifølge et af kravene 1 til 4, **kendetegnet ved**, at systemet er indrettet til efter en stilstand af det i mindste ene monteringsudstyr (18, 19) i kort tid at indstille omdrejningstallet for hjælpemotoren (1) højere end omdrejningstallet, der beregnes på baggrund af driftsparametrene.

6. System ifølge et af kravene 1 til 5, **kendetegnet ved** indretninger til registrering af hjælpemotorens (1) omdrejningstal.

7. System ifølge et af kravene 1 til 6, **kendetegnet ved** indretninger til registrering af omdrejningstallet for den i det mindste ene hydraulikmotor (4, 5, 6).

8. Fremgangsmåde til styring af i mindste et monteringsudstyr (18, 19) til et vintertjenestekøretøj, hvor det i det mindste ene monteringsudstyr (18, 19) drives ved hjælp af en hydraulikmotor (4, 5, 6), der forsynes med hydraulikvæske via en hydraulikpumpe (3), der drives ved hjælp af en hjælpemotor (1), **kendetegnet ved** følgende trin:

- registrering og/eller fastsættelse af i det mindste en driftsparameter, der er relevant for driften af det i det mindste ene monteringsudstyr (18, 19), hvor driftsparametrene omfatter et eller flere af følgende parametre: spredningsbredde, spredningstæthed af salt, spredningstæthed af saltlage, saltlageandel og vintertjenestekøretøjets kørehastighed,
- beregning af et omdrejningstal for hjælpemotoren (1) afhængigt af den i det mindste ene driftsparameter og
- indstilling af et omdrejningstal for hjælpemotoren (1) afhængigt af det beregnede omdrejningstal.

9. Fremgangsmåde ifølge krav 8, **kendetegnet ved**, at omdrejningstallet for hjælpemotoren (1) beregnes og indstilles under hensyntagen til absorptionsvolumenet for hydraulikpumpen (3), absorptionsvolumenet for den i det mindste ene hydraulikmotor (4, 5, 6) og omdrejningstallet for den i det mindste ene hydraulikmotor (4, 5, 6), der er nødvendigt på baggrund af den i det mindste ene relevante driftsparameter til at drive monteringsudstyret (18, 19).

10. Fremgangsmåde ifølge krav 8 eller 9, **kendetegnet ved**, at omdrejningstallet for hjælpemotoren (1) indstilles højere end et omdrejningstal, der er nødvendigt for driften af det i det mindste ene monteringsudstyr (18, 19), og at overskydende hydraulikvæske transporteres ind i en tank.

11. Fremgangsmåde ifølge et af kravene 8 til 10, **kendetegnet ved**, at omdrejningstallet for hjælpemotoren (1) efter en stilstand af det i det mindste ene monteringsudstyr (18, 19) i kort tid indstilles højere end omdrejningstallet, der beregnes på baggrund af driftsparametrene.

12. Fremgangsmåde ifølge et af kravene 8 til 11, **kendetegnet ved** trinnet, der består i at registrere omdrejningstallet for hjælpemotoren (1).

13. Fremgangsmåde ifølge et af kravene 8 til 12, **kendetegnet ved** trinnet, der består i at registrere omdrejningstallet for den i det mindste ene hydraulikmotor (4, 5, 6).

FIG 1

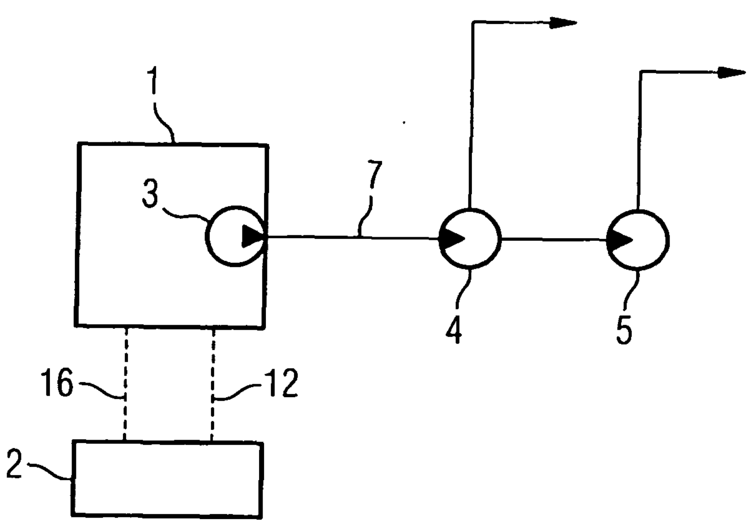
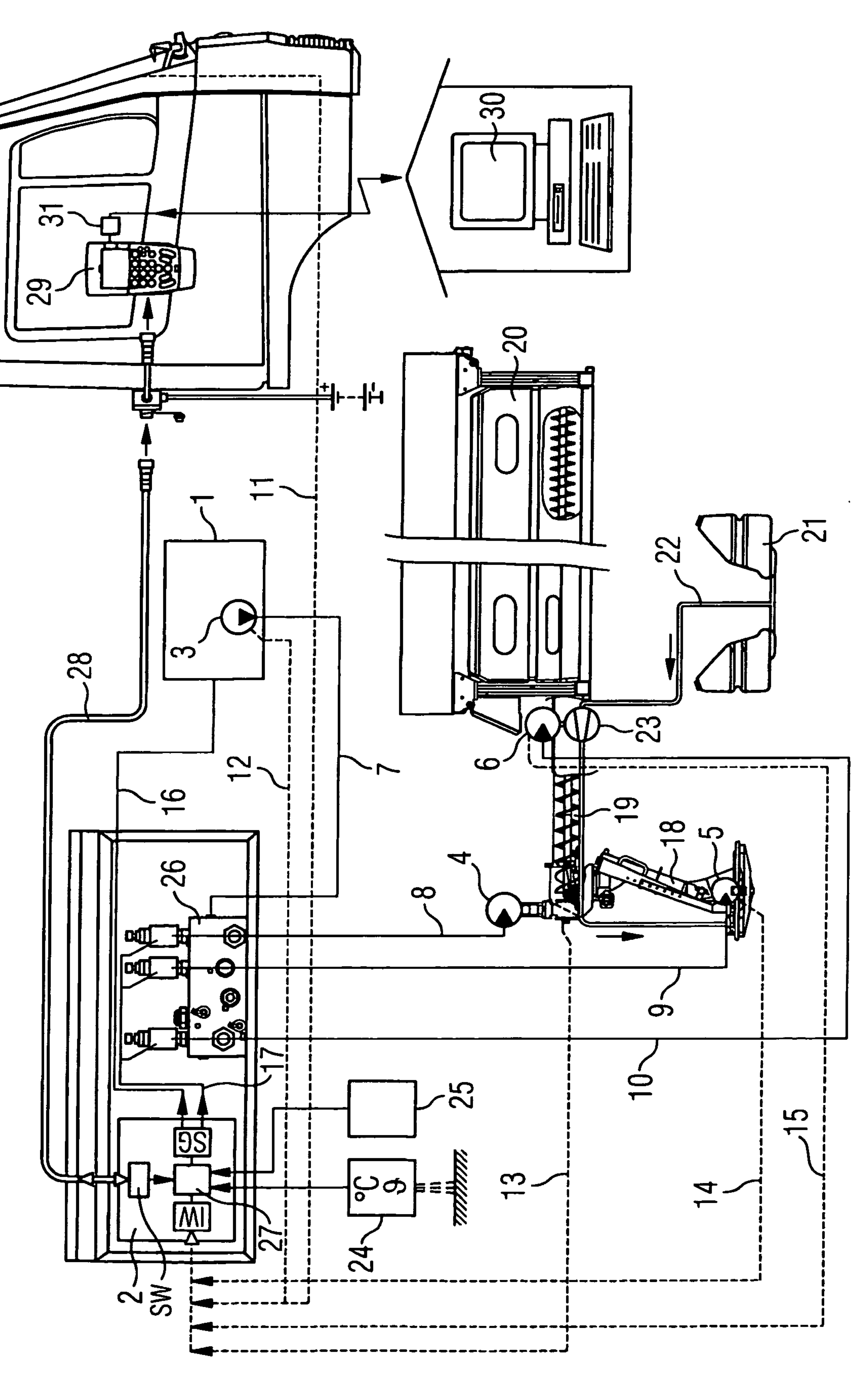


FIG 2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