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Gambini et al.

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[54] **AUTOMATIC CARRIAGE FOR RADIOGRAPHING WELDINGS FROM THE INSIDE OF PIPELINES BY MEANS OF X-RAYS AND RELEVANT DEVICES**

[75] Inventors: **Arnaldo Gambini**, San Donato Milanese; **Giacomo Capitelli**, Milano, both of Italy

[73] Assignee: **Snam-Progetti S.p.A.**, Milan, Italy

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[21] Appl. No.: **497,064**

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[63] Continuation of Ser. No. 332,649, Feb. 15, 1973, abandoned.

[30] **Foreign Application Priority Data**

Feb. 17, 1972 Italy 20661/72

[52] **U.S. Cl.** **250/320;** 250/321; 250/360
[51] **Int. Cl.** **G03b 41/16**
[58] **Field of Search** 250/320, 321, 322, 323, 250/358, 359, 360

[56] **References Cited**

UNITED STATES PATENTS

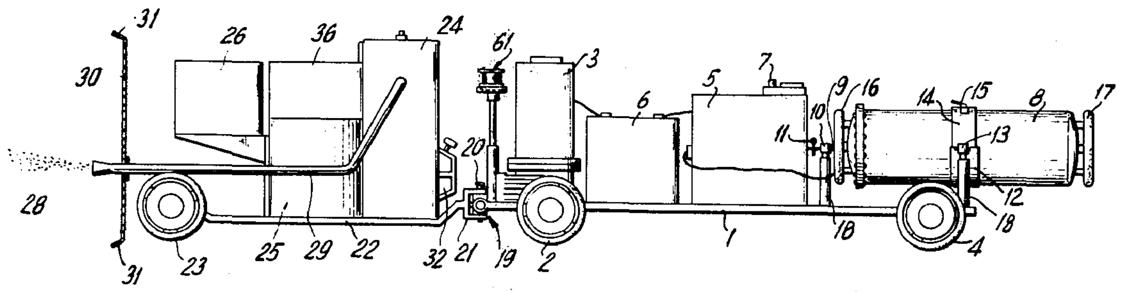
3,087,058	4/1963	Arvanetakes	250/360
3,492,477	1/1970	Arnesen	250/360
3,691,385	9/1972	Ketchbaw	250/360

Primary Examiner—James W. Lawrence
Assistant Examiner—C. E. Church
Attorney, Agent, or Firm—Ralph M. Watson

[57] **ABSTRACT**

A tandem radiography vehicle for use in pipelines includes a carriage assembly, having an internal combustion engine and a dynamo-alternator motor for driving the vehicle, and powering an X-ray tube. Electronic circuitry for controlling the operation and power to the X-ray tube are included. A compass control system on the carriage is activated by a magnet externally positioned on the pipeline for positioning the vehicle at a weld inspection area. Means for segregating exhaust from the engine are also disclosed.

7 Claims, 7 Drawing Figures



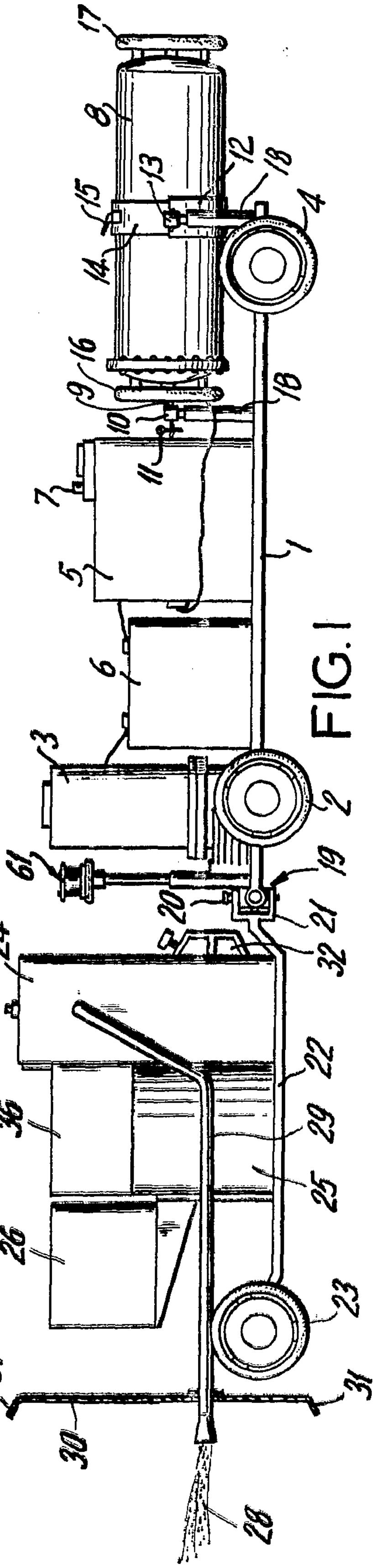

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FIG. 1

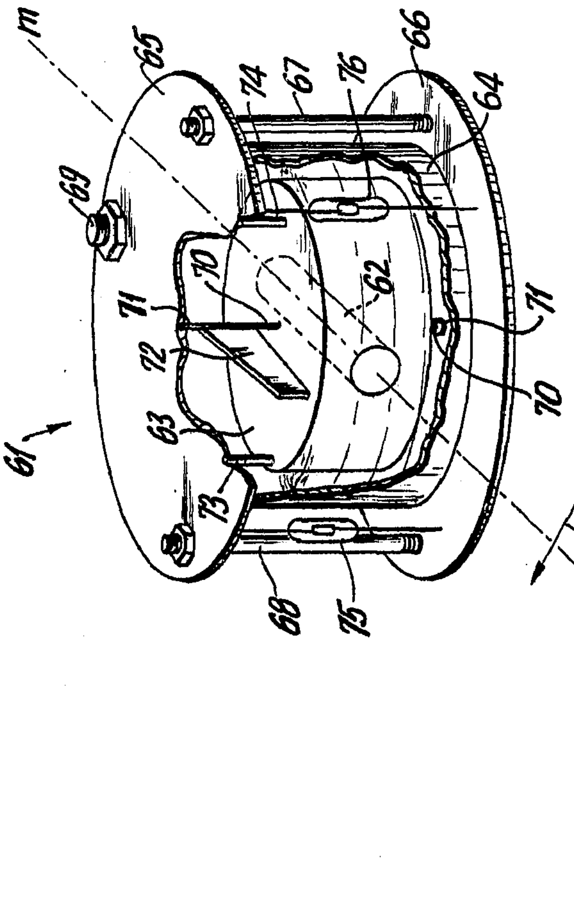
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FIG. 7

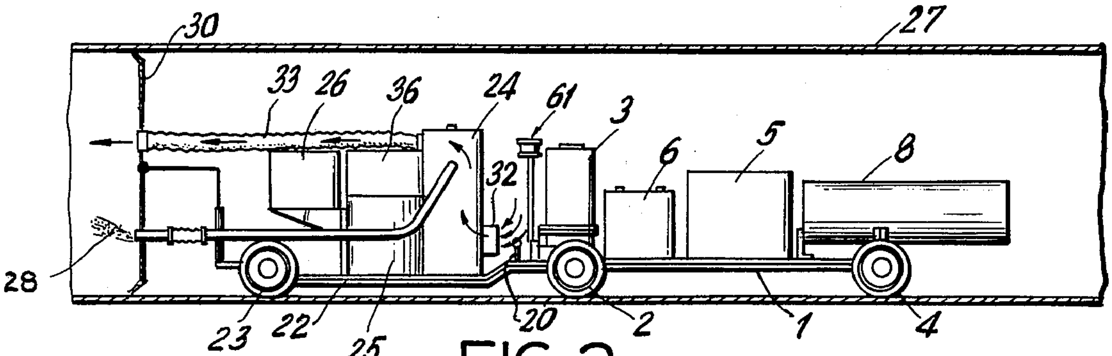

FIG. 2

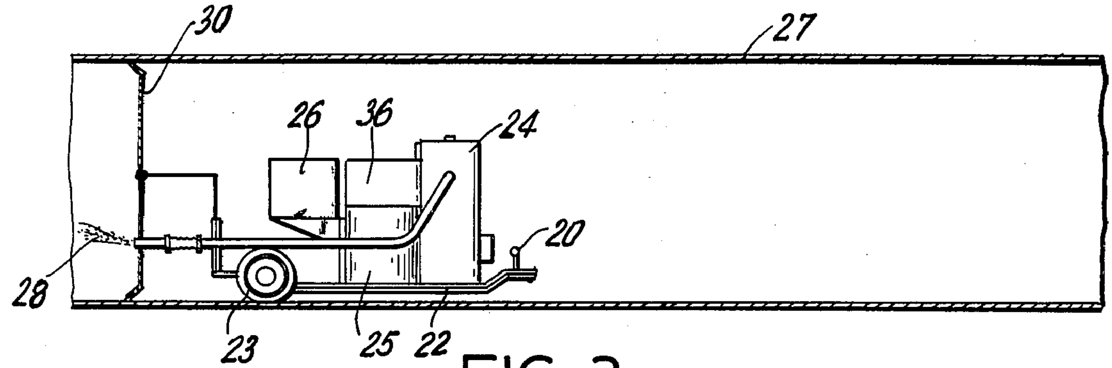

FIG. 3

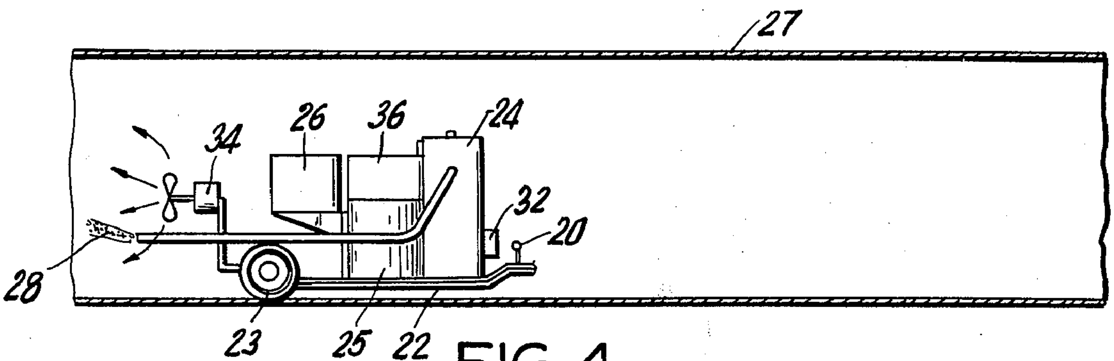

FIG. 4

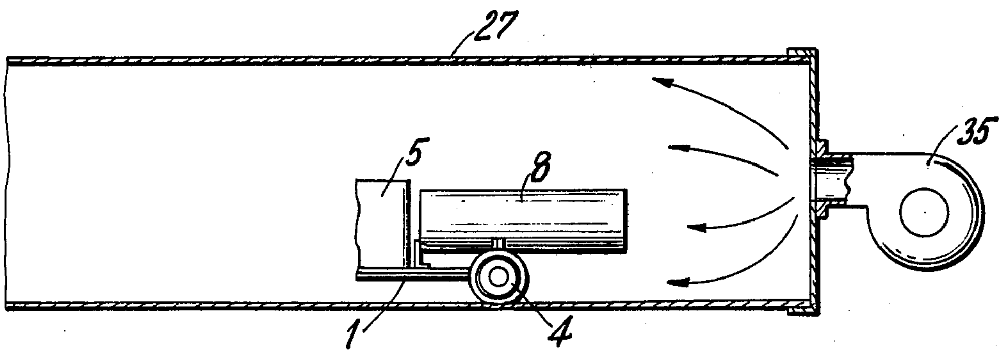

FIG. 5

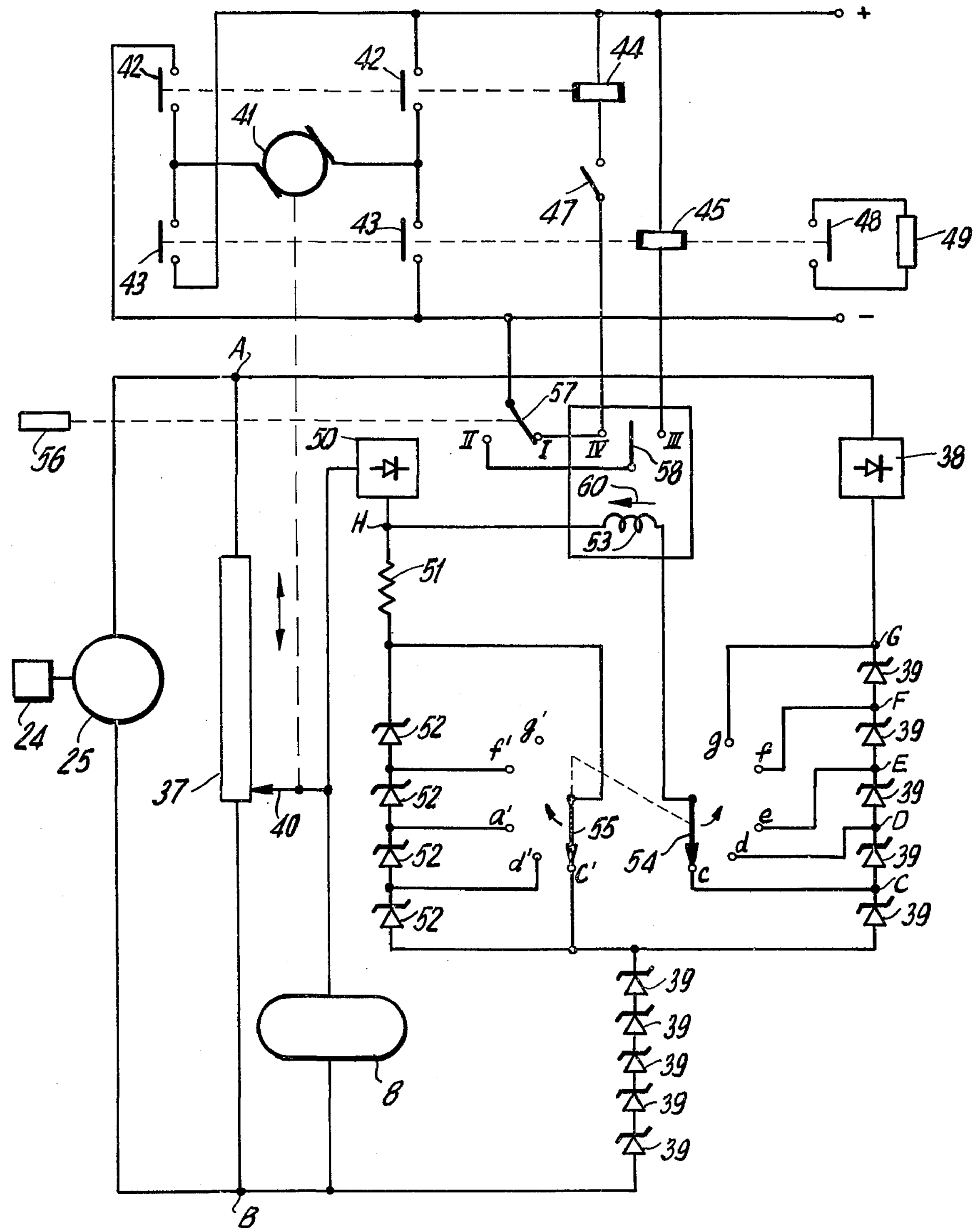
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FIG.6

AUTOMATIC CARRIAGE FOR RADIOGRAPHING WELDINGS FROM THE INSIDE OF PIPELINES BY MEANS OF X-RAYS AND RELEVANT DEVICES

This is a continuation, of application Ser. No. 332,649, filed Feb. 15, 1973 now abandoned.

The present invention relates to an automatic carriage for radiographing Weldings from the inside of pipelines by means of an X-ray source, said carriage having a low weight and size and a high autonomy, as well as to devices relating to the drive of said carriage. The prior art mentions several types of self-motor carriages for radiographing by means of X-rays the Weldings from the inside of pipelines and all these carriages are fed by batteries. Since said batteries have to supply not only the energy required by all the electric and electronic control circuits as well as by the electric traction motor of the carriage, but also the power for operating the X-ray tube, which is very high, i.e. about 1–2 KVA, it will be easily understood said batteries must have relevant size and weight. Furthermore, the X-ray tube has to be fed in A.C. and therefore it is necessary to use a big DC-AC converter able to transform the direct electric energy of the batteries into an alternate energy having the exact nominal tension and frequency of the X-ray tube with a conversion yield which is at the utmost 60–70 percent.

It results therefrom the known carriages present the drawbacks of an excessive weight limiting the handiness and making necessary the use of a power-lift for introducing the carriage into the pipeline, said weight being at least more than 400–500 kg, whose 50 percent is due to the batteries, of a carriage length varying from 4 to 5 meters limiting therefore the carriage manoeuvrability at the curve, and of a limited autonomy requiring the substitution or the recharge of the batteries every 600–700 working meters, this being very far from the normal day's work of a yard, not allowing an economic, rational and continuous utilization of said carriages.

An object of the present invention is to eliminate the above said drawbacks and accordingly to realise a self-propelled carriage for X-rays radiographing the weldings from the inside of the pipelines, said carriage having a low weight and size and high autonomy. This is practically obtained according to the present invention by making use of a power unit comprising an energy generator (a dynamo-alternator-motor) of the type known in the prior art, said generator having a power of some KVA, and being rigidly connected to an internal combustion engine. Said energy generator has the triple purpose of starting the internal combustion engine, by acting as a D.C. motor fed by a single battery of normal type, of supplying the power required for the working of the X-ray tube, by acting as an alternator driven by the internal combustion engine, and of keeping the battery charged, said battery being inserted as a buffer battery and having the task of feeding all the electronic control circuits and D.C. geared motor for driving the carriage. Such a realization, not only eliminates the cumbersome converter DC-AC necessary for the carriages known in the art, and the need of many batteries making thereby possible carriages having reduced weight (about 180 kg) and length (about 2–2,5m), but increases remarkably the autonomy of the carriage because the necessary energy is not fed by the batteries but the electrogen group at the expenses of the internal combustion engine, whereby said autonomy results only function of the capacity of the fuel tank of the internal combustion engine. On the other hand it has to be taken into account that, since the single battery in use is always charged being buffer inserted, this gives the carriage a further emergency autonomy of 4–5 km for the recovery of the carriage self in case of damage of the power unit.

According to a preferred embodiment of the present invention, said power unit is not mounted on the self-propelled carriage supporting the X-ray tube, the engine, control the battery and the geared motor driving the same carriage, but on a little trailer articulated behind said carriage by means of flexible couplings having two degrees of freedom, what allows to overcome steep road bumps or cat's backs and bends. In such a way the power unit may be quickly disjoined from the drive unit for maneuver's sake or substituted in the case of a damage and its vibrations are not transmitted to the X-ray tube. In order to assure the comburent to the internal combustion engine and to avoid therefore the polluting exhaust gases may stop the i.c. engine or increase the X-ray tube temperature above its thermic working limits (maximum temperature about 70°C), according to another distinctive feature of the present invention on the backside of the trailer there is resiliently mounted a circular diaphragm having the same diameter of the pipeline with rubber seals, through which said exhaust gases and also, when the operative conditions are suitable, the cooling air of the i.c. engine are eliminated.

Said diaphragm constitutes therefore a baffle separating the equipment from the polluting exhaust gases and from the cooling hot air of the i.c. engine, causing thereby an air stream into the pipeline.

According to a preferred realization of the invention, the X-ray tube is not fixed on the carriage but is mounted on three elastic supports which allow its positioning on the axis of the pipeline to be radiographed, and fixed by means of a clamping band which allows an easy removal for maneuver's sake or safety during the transport.

While the frequency stability of the feeding of the X-ray tube, supplied by said energy generator operating as an alternator driven by the i.c. engine, is assured by means of an automatic i.c. engine speed governor of the type known in the prior art, the feeding tension of the X-ray tube is on the contrary stabilized, according to another distinctive feature of the present invention, by a suitable electronic stabilizer whose circuit diagram will be described thereafter, which besides bringing and keeping the feeding tension within about ±0.3 percent of the X-ray tube operating tension for the whole ratiographic exposure time, starts said exposure only when one achieves the nominal operating conditions of the X-ray tube, what assures in such a way a perfect exposure. All the self-propelled carriages known in the prior art of the X-ray radiograph operate in an automatic way by means of an outside control given by a radioactive source of same *m*. Curie which co-operates with a Geiger Muller detector connected to the electronics. A further feature of the present invention is characterized in that the outside control is now given by a horseshoe permanent magnet or by an electric magnet whose magnetic field, which may be reversed rotating the magnet of 180°, acts on a magnetic compass having three positions assembled on the carriage and connected to the electronics.

The adoption of such a magnetic system, better explained there after, besides not dissipating electric energy and presenting remarkable advantages of arrangement simplicity, strength, price and easy running, interests mainly the safety of the operator, who is not obliged to make use any longer of a radio-active source which is always dangerous even if suitably screened.

The invention will now be described with reference to the enclosed drawings illustrating a preferred practical embodiment given only as an unrestrictive example since technical and constructive variations can practically be effected without departing from the limits of the present invention. In said drawings:

FIG. 1 shows in a longitudinal section the self-propelled carriage for the radiograph of Weldings from the inside of pipelines by means of X-rays according to the present invention;

FIG. 2 shows the carriage of FIG. 1 during the running inside pipelines;

FIG. 3 shows schematically the carriage of FIG. 1 when applied to a sealine;

FIGS. 4 and 5 show two forced circulation systems of cooling air of the X-ray tube, which are employed in very hot climates for working without intermittences;

FIG. 6 shows the circuital diagram of the electronic stabilizer of the feeding voltage of the X-ray tube, according to the invention;

FIG. 7 shows in cross perspective the magnetic compass director with three positions, according to the invention.

With reference to the figures, 1 indicates the bearing body of the carriage, on the backside of which are assembled two driving wheels 2 operated by a geared motor 3 fed in D.C., which allows the forward and reverse running of the carriage.

Frontally there are other two wheels 4 mutually rigidly paired, which may be made driving wheels by means of transmission members known in the prior art. The stability of the carriage on the pipeline bottom is assured by means of four wheels 2 and 4 which are of a self-adjusting type according to the teachings of our previous Italian Pat. application No. 24463A/71 which allow to overcome any bending radius in the two directions of running.

In the middle part of the carriage there are the electronic devices 5 for programming and driving the operative cycles of the carriage and a battery 6 of the normal type for cars, connected respectively to the electronic devices and to motor gear 3.

A pushbutton 7 allows to feed the motor gear 3 by battery 6 and to let thereby advance in such a way the carriage with all the equipments out. The X-ray tube 8 for longitudinal or panoramic radiograph is mounted on the carriage frontside and is supported by three triangle-arranged shock absorbers. More precisely, a pin 9 foreseen in the backside of the X-ray tube is inserted in the back shock absorber 10 and there locked by means of a lock pin 11 which is inserted in a hold of the said pin, while the body of the pipe is leant on the semicircular metallic support 12 supported by means of other two frontal shock absorbers 13 (one of these is not shown in figure being opposite the one shown).

The tube is kept in position and fixed by means of a leather clamping band 14 with a spring-catch quick hooking 15. In such a way, by hooking the spring-catch 15 and disconnecting the pin 9 from shock absorber 10, the X-ray tube may be easily removed for maneuver's sake or safety during the transport, the tube being provided at this purpose of two side handles 16 and 17 of the steering wheel type covered with rubber, which are used also as a protection for the tube self. The three shock absorbers 10, 13 are supported by telescopic systems 18 which may vary the position in height, allowing in such a way the positioning of the X-ray tube just on the axis of the pipe to be radiographed. On the back side of body 1 of the carriage there is a cardan joint 19, whose bushes are constituted by shock absorbers, on which joint we articulate, by means of a through pin 20, the fork 21 of a trailer 22 equipped with two wheels 23 of a self-adjusting type like the wheels 2 and 4 and supporting an power unit.

Such a realization not only makes the power unit rapidly detachable from the carriage for maneuver's sake or replacement in case of damage, but prevents too its vibrations may be harmfully transmitted to the X-ray tube, whereas the two degree of freedom of the articulated cardan joint of the trailer to the carriage allow to the whole equipment to overcome also steep cat's backs, bumps and curves. Said power unit is constituted, according to the invention, by an internal combustion engine 24 rigidly direct-coupled to an electric energy generator 25 having a power of same K.V.A. and constituted by a motor-alternator-dynamo of the type known in the prior art, i.e. by a common D.C. motor-dynamo which besides presenting D.C. rotor windings presents too A.C. rotor windings for its running as an alternator.

While these last windings are connected to a tension stabilizer contained in electronic devices 5 for A.C. feeding the X-ray tube, the D.C. windings are connected to the battery 6 buffer-inserted. The work is evident. Initially the battery 6 supplies the necessary energy for feeding the energy generator 25 which, acting as a D.C. motor starts the internal combustion engine 24. This latter, once started, operates the energy generator 25 as an alternator by supplying the alternating operating power to the X-ray tube, and as a dynamo, by charging battery 6 and by supplying the continuous power required by the electronic control circuits and by the carriage drive geared motor 3. Summing up the whole energy required by the carriage is supplied by the energy generator 25 at expenses of internal combustion engine 24 whereas the battery 6 is always loaded, this meaning that not only autonomy of the carriage is very high depending only on the capacyty of the fuel tank 26 of the internal combustion engine, but the same loaded battery constitutes a stock of energy which gives a further increase of autonomy of 4 or 5 km assuring accordingly the recovery of the carriage in case of damage of the power unit.

In order then to produce an air flow circulation in the pipeline 27 to be radiographed (see also FIG. 3), for assuring the comburent to the internal combustion engine 24 and preventing that the polluting exhaust gases 28 could extinguish the engine or raise the temperature of the X-ray tube above its thermic limits of running, at the back end of the trailer 22, on the exhaust pipe 29 of the internal combustion engine 24 or on a suitable support, we mount elastically a circular diaphragm 30 having the same diameter of the pipeline 27 and provided with a rubber seal packing 31.

Said diaphragm constitutes a baffle which separates the equipments mounted on the carriage and trailer from the exhaust gases **28** of the internal combustion engine, which are discharged beyond said baffle.

In case of laying of pipelines beyond the diaphragm **30** do not discharge only said exhaust gases **28,** but also the cooling air of the internal combustion engine **24** which, sucked by ventilator **32** assembled on the crankshaft of the same i.c. engine, is discharged through flexible pipe **33** (see FIG. **2**) producing thereby a current of air in the pipeline. Moreover it is evident that when one works in warm climates and it is necessary to cool strongly the X-ray tube in order to be able to operate without intermittence, the air forced circulation can be produced by means of auxiliary ventilator **34** assembled backside (see FIG. **4**) or near the X-ray tube, or by means of a ventilator **35** assembled outside on the head of the pipeline **27** (see FIG. **5**), this latter solution being preferable since it allows a strong ventilation without requiring further power from the power unit inside the carriage.

For stabilizing at the nominal value of the X-ray tube the frequency of the feeding voltage of the X-ray tube, supplied by energy generator **25** operating as an alternator moved by the internal combustion engine **24** use is made of a common automatic speed regulator of the internal combustion engine **36** which keeps said engine **24** at the syneronism speed.

The feeding voltage of the X-ray tube is on the contrary stabilized at the nominal value of the tube by means of an electronic stabilizer contained in the electronic system **5,** which moreover controls the timer for starting the radiographic exposure only when are reached the nominal operation conditions of the X-ray tube, assuring thereby a perfect exposure, and turns off entirely the voltage from the X-ray tube at the end of said radiographic exposure. In said stabilizer the outlet alternating voltage from generator-alternator **25** is applied to the connecting terminals of a variac whose wiper is moved by many of a D.C. motor suitably driven by a polarized relay responsive to the voltage difference between the voltage nominal value of the X-ray tube and the voltage on the wiper of the variac which is the one applied to the X-ray tube.

For a better understanding of what above said, reference is made to FIG. **6** which shows the circuital diagram of the electronic stabilizer of the X-ray tube feeding voltage.

The A.C. furnished by generator-alternator **25,** driven by internal combustion engine **24,** is applied to the terminals AB of a variac **37** and, after having being rectified by means of rectifier **38,** to the terminals of a series of n Zener diodes **39** which subdivide the voltage in such a way that in the points C, D, E, F and G there are the different fixed working voltages of the X-ray tube which will be taken as setpoint values. The wiper **40** of the variac **37** is driven by means of D.C. motor **41** whose excitation may be reversed and therefore may turn in such a way to move the wiper **40** downwards or upwards, closing the contacts **42** or **43** respectively. Said contacts are controlled by relays **44** and **45** which may be excited by polarized relay **46.**

On the excitation side of the relay **44** there is a switch **47** which opens when wiper **40** reaches the lower stroke end (variac at zero: as shown by FIG. **6**) whereas the relay **45** controls the excitation contact **48** of a timer **49** which gives the radiographic exposure time.

The A.C. coming from variac **37,** that is the voltage between the wiper **40** and the point B is applied to X-ray tube **8,** is also rectified by rectifier **50** and applied to the terminals of a resistive leg comprising a resistor **51** and a series of (n-1) Zener diodes **52** like Zener diodes **39.**

Winding **53** of the polarized relay **46** is connected to the outlet of rectifier **50** at point H and to index **54** of a switch changing over *c, d, e, f, g* terminals for setting the various operational set point voltages for the X-ray tube, said voltages being present at C, D, E, F and G points respectively.

Correspondingly to the above said commutations of index **54,** a second index **55,** integral with the first one but rotating in an opposite direction, changes over *c', d', e', f'*, and *g'* respectively inserting thereby as many Zener diodes **52** but one as many Zener diodes **39** are inserted by first index **54.**

This is made for limiting the polarization current circulating in the winding **53** and generated by the voltage difference between the point H and one of the points C, D, . . . G selected and for making it to depend only on the difference between the voltage drop at the terminals of the resistance **51** and the voltage drop caused by the first Zener diode **39** which is connected with point *c*, since an increase of the set point voltage determined by inserting another Zener diode **39** is compensated by an equal increase of voltage at point H determined by inserting an equal Zener diode **52.**

The polarized relay **46** is finally present to operate by the electronic programmer **56** of the electronic unit **5** which commutes the switch **57** from position I to position II, connecting in such a way the index **58** of the relay **46** to the negative pole of the feeder of the motor **41.**

The operation is as follows. Supposing that the operational voltage of X-ray tube to be stabilized is that corresponding to point C for which the indexes **54** and **55** must be in the position shown in FIG. **6.**

Initially the wiper **40** of variac **37** is at the lower stroke end and therefore switch **47** is open and the voltage at the terminals of the X-ray tube **8** is zero.

When the electronic programmer **56** receives the order of radiograph exposure, this changes over the switch **57** from position I to position II connecting in such a way the index **5** of polarized relay **46** with the negative pole **59.** The A.C. generated by generator-alternator **25,** rectified in **38,** produces at point C, D . . . G the set point fixed voltages. At point C we have therefore the reference value of voltage which must be stabilized and applied to the X-ray tube. At the same time at point H there is zero voltage, since, as above said, the wiper **40** is in the lower stroke end.

In the winding **53** of relay **46** flows therefore a current from C to H, according to the arrow **60,** which trips the index **58** of the relay **46** in position III exciting thereby the relay **45** which closes the contacts **43** and opens the contact **48.** In such a way the motor **41** is excited and rotates so as to raise the wiper **40** of variac **37.**

When the wiper **40** rises, the switch **47** closes, the A.C. at the terminals of X-ray tube and the D.C. at point H begin to increase. When the D.C. at point H equals the set point voltage of point C and therefore the A.C. at the terminals of the X-ray tube reaches its prefixed nominal value, the current flowing in the winding **53** of relay **46** stops and index **58** assumes again the intermediate rest position, de-energizing in such a way the relay **45** which opens the contacts **43** and closes the contact **48**. The closing of contact **48** allows in such a way timer **49** to start the radiograph exposure phase, which starts only when the voltage at terminals of X-ray tube reaches the nominal value of the tube. On the other hand said voltage is stabilized at this value for the whole period of radiograph exposure, since it, e.g., would tend to increase and bring the potential of point H to a level higher than that of point C, in the winding **53**. We should have a current flowing from C to H, in a direction opposed to arrow **60**, which would commute the index **58** of relay **46** to the position IV. In such a way the relay **44** would be excited which, closing the contacts **42** would allow the motor **41** to rotate so as to lower the wiper **40** of variac **37** and, in such a way we should have a lowering of the A.C. at the terminals of the X-ray tube.

Finally, once the radiograph exposure time is ended the timer **49** sends a signal to programmer **56** which commutes again the switch **57** to the position I.

The relay **44** is thus excited, closes the contacts **42** and excites the motor **41** by letting lower the wiper **4** of variac **37** down to full scale. When the wiper has reached the full scale, the switch **47** opens, the motor **41** is de-energized and the equipment assumes again the initial conditions, ready for a new cycle of stabilization and radiograph exposure. Summing up said electronic stabilizer not only changes the voltage of X-ray tube to its nominal value, stabilizes it and controls the starting of the radiograph exposure, but takes off the voltage of the tube at the end of said radiograph exposure. The control for stopping the carriage at the welding to be radiographed, for carrying out the radiograph and for moving it again is located outside the pipeline in a way already known by the prior art but, instead of making use of a radioactive source cooperating with a Geiger-Muller detector connected to the electronic programmer, use is made of an entirely magnetic system which, besides requiring no energy from the power unit of the carriage for its running and eliminating the use of dangerous radioactive sources, allows also to carry out the backing of the carriage and to switch off the electronic device and the power unit of the carriage for long stays (e.g. during the night). Said control device is substantially a permanent magnet having a horseshoe shape or an electromagnet transversally positioned above the pipeline in such a way its magnetic field, whose polarity can be inverted turning the magnet of 180°, may act inside the pipeline on a magnetic compass detector with three positions **61**, assembled on the carriage, i.e rotating said magnetic compass, which in absence of magnetic field is always oriented along the pipeline, to right or to left for closing either one or the other of two magnetic relays connected to the logic circuits of the electronic programmer.

Said magnetic compass detector with three positions **61** is shown in FIG. **7** and comprises a permanent magnet **62** inserted into a floating cylindric dipped in kerosene as a normal magnetic compass. The whole is contained in a not-magnetic container **64** tightly closed by two not-magnetic covers **65** and **66** clamped by three through bolts, two of which (**67** and **68**) are not-magnetic and the third one **69** of soft iron.

This soft iron bolt **69** has the function of generating a magnetic counteracting torque which obliges the magnet **62**, in absence of outside magnetic field, to assume an orientation always along the axis *m—m* through said bolt. In order to present displacements of the float inside the container and allow only its rotation, a little through shaft **70** of the float is inserted at the ends in bushes **71** supported by covers **65** and **66**.

A plate **72** integral with little shaft **70** co-operates with two shoulder pins **73** and **74** for limiting the angular movements in the right or left direction respectively of the float **63** and therefore of the little magnet compass **62**. In such a way it is possible to individualize three exact positions of the little magnetic compass **62**, of which one is the central or **0** position whith the magnet oriented along the axis *m—m* and the other two the positions of the small magnet at right and left.

In connection with these two last positions of the little magnet, between the two covers **65** and **66** there are two magnetic relays **75** and **76** which are excited by little magnet **62** only when this is opposed to the relays and is located in one of the above said extreme positions. The magnetic relays are furthermore connected with the logic circuits of the electronic programmer which, by means of systems known in the prior art, are able to give the carriage various control signals and therefore to operate the above said different sequential operations. The detector **61** is assembled on the carriage **1** (see also FIG. **1**) in such a way the above said axis *m—m* coincides with the axis of the pipeline to be radiographed, so that the little magnet **62** results alwais oriented in the direction followed by the carriage in absence of outside magnetic fields.

The way of operating of this detector is clear. The transversal positioning above the pipeline, in a desired position, of a horseshoe permanent magnet, produces in that position inside the pipeline a dispersed magnetic field **77** directed transversally to the pipeline and therefore perpendicularly to the above said axis *m—m*.

Due to said field the little magnet **62** will be obliged to rotate from its **0** position to the right side where will excite the magnetic relay **75**.

If said horseshoe-shaped permanent magnet rotates 180° the polarity of its dispersed magnetic field **77** is inverted and the little magnet **62** will rotate towards the left exciting the magnetic relay **75**. Summing up, by means of a control from the outside of the piping, the little magnet **62** excites the magnetic relay **75** or the magnetic relay **76** and gives therefore a sequence of orders to the carriage.

Practically the above said operative sequence is as follows: Positioning in a prefixed point on the pipeline the horseshoe permanent magnet in such a way its dispersed magnetic field is such to rotate the little magnet **62** to right the detector, once reached that point due to the carriage motion inside the pipeline, trips the magnet relay **75** which stops the carriage and prepares the phase of radiograph exposure.

Taking away the horseshoe-shaped permanent magnet from the pipeline, the little magnet **62** comes back into **0**-position, the relay **75** trips again and the radiograph exposure occurs.

By positioning again the magnet in the same way as before, the cycle is repeated and the phase of radiograph exposure takes place again.

Positioning on the contrary the horseshoe permanent magnet on the pipeline in an inverted position, i.e. opposed to the previous one (180° rotation), the detector trips the magnetic relay **76** which stops the carriage and provides the back motion.

Removing the magnet, the little magnet **62** comes back to **0**-position, the relay **76** trips again and the back motion of the carriage occurs.

Placing again the permanent magnet, always in an inverted position, the magnetic relay **76** trips stopping the carriage and switching off the electronic devices and the power unit.

Removing the magnet the whole is switched off (for long stays, e.g. during the night). Placing again the permanent magnet, in an inverted position, there is a new trip of magnetic relay **76** which provides the carriage forward motion.

It is evident, that the above said operative sequence is not restrictive and use may be made of any sequence, the originality of the invention being given by the simplicity and rational way with which a double control is magnetically realized (right-left) which allows to give the carriage a plurality of operative orders.

It is further to be considered that the carriage according to the invention may be used not only for the panoramic or longitudinal radiography of the inside welding of pipeline by means of a X-ray source, this being its main scope, but suitably equipped for cleaning, grinding, painting, etc. of gas pipelines oil-pipelines, waterworks both of metal or other materials, during the construction.

We claim:

1. A device for radiographing weldings from the inside of a pipeline, said device adapted to be controlled by a permanent horseshoe magnet positioned on the exterior of said pipeline at a preselected distance from a welding to be inspected, comprising:

a carriage having self-adjusting wheels; a D.C. geared motor operative with said wheels for driving said carriage; an X-ray tube for longitudinal or panoramic radiography; means removably mounting said X-ray tube on said carriage; electronic programer means for operating said X-ray tube; means for stabilizing the voltage supplied to said X-ray tube at preselected levels; a power supply including an internal combustion engine mounted on said carriage and an electric energy generator operatively coupled to said engine and adapted to power said X-ray tube; a battery electrically coupled to said D.C. geared motor to drive said carriage and to said energy generator, such that said battery supplies power for starting said engine and is charged by said energy generator when the engine is running to maintain an operative charge; and a magnetic compass control sensor mounted on said carriage and adapted to be operated by said horseshoe magnet; said sensor being coupled to said programer means having three positions, a neutral position and two deflection positions, whereby the movement and radiography is controlled.

2. The device according to claim **1**, wherein said engine and energy generator are supported by a trailer having two self-adjusting wheels and a cardan joint whose bushes are constituted by shock absorbers coupling said trailer to the rear of said carriage, whereby said device may accommodate bends in said pipeline and vibrations from said engine are dampened.

3. The device according to claim **2**, including a circular diaphragm of the same diameter as the pipeline to be radiographed and having rubber packings adapted to seal with the inside surface of the pipeline; means for mounting said diaphragm at the backside of the trailer, said diaphragm, and means for discharging the exhaust gases of the internal combustion engine beyond said diaphragm.

4. The device according to claim **1**, wherein said means for removably mounting said X-ray tube includes three shock absorbers located at the front of said carriage, said absorbers being arranged vertically in spaced-apart relationship to define a triangle, two of the absorbers being positioned adjacent opposite sides of the carriage; an upwardly facing semi-circular X-ray tube support member attached at the free ends thereof to the upper ends of said two absorbers and adapted to support said X-ray tube thereon; a flexible quick release clamping band attached at its ends to the upper ends of said two absorbers, said band cooperating with said support member to mount said X-ray tube therebetween; and quick release means coupling the upper end of the remaining absorber to said X-ray tube.

5. The device according to claim **1**, wherein said means for stabilizing the voltage supply to said X-ray tube includes a variac electrically coupled to said energy generator to receive an A.C. voltage output therefrom when said generator operates as an alternator, the wiper of said variac being operatively coupled to a D.C. motor for movement along the variac, said D.C. motor receiving excitation from two relays, said relays being controlled by a polarized relay, which receives controlled power input in response to the voltage difference between fixed nominal values of operating voltage for the X-ray tube and a D.C. voltage proportional to the A.C. voltage supplied from said wiper, said A.C. voltage being the voltage applied to said X-ray tube.

6. The device according to claim **5**, wherein said fixed nominal values are obtained as a voltage drop at the terminals of a first set Zener diodes in series, fed by the output A.C. voltage of said energy generator, operating as an alternator, and rectified by a rectifier;

said D.C. voltage proportional to the output A.C. voltage from the wiper of the variac being obtained as a voltage drop in a resistive leg consisting of a second set of Zener diodes in series, fed by said A.C. output and rectified by a second rectifier; a switch having two integral indexes rotatably in opposite directions for selecting the set point values by inserting n-**1** Zener diodes in said first set and for simultaneously inserting into said resistive leg on Zener diodes of said second set.

7. The device according to claim **1**, wherein said sensor comprises:

a cylindrical non-metallic, liquid-tight container having fluid therein; a permanent magnet, said magnet being carried by a float on the surface of said liquid; a magnetic source on said container, said source being adapted to cause said floating magnet to be aligned therewith in the absence of a magnetic fluid from said horseshoe magnet; means for preventing translational movement of said float relative to said container; and means for permitting limited angular movement of said float between said two deflection positions on either side of said aligned position, said aligned position being parallel to the axis of said pipeline; and reed switches located at said deflection positions and coupled to said programer means, whereby movement of the device and radiography are controlled.

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