This invention relates to a vehicle supported concrete moulding machine of the type wherein a concrete mould is carried by a vehicle and has concrete extruded therefrom as the vehicle travels forward.

One of the problems which has been encountered herefore when attempts have been made to extrude substances such as concrete, sand, clay, bitumen, loam and the like has been that substances of this nature are inherently variable in their flow characteristics, and machines which drive at a uniform rate to extrude these substances will tend to compact the more readily flowable portions more than the stiffer portions, so that the resultant product will have a seriously variable density, and this almost invariably results in weak patches.

The main object of this invention is to provide a means for uniformly compacting substances which may vary in their flow characteristics, and of the extruded product is more nearly uniform than with the same product extruded by constant speed constant drive machines, and for this reason the danger of weak patches throughout its length is substantially reduced. A further object is to reduce the tendency for surface finish variation and to provide means which will, in operation, extrude a product with a surface finish which is acceptable for most purposes without the need for further hand finishing.

I have found that by careful selection of size of concrete motors and pumps, it is possible to sense the pressure within concrete being packed by an hydraulic motor by the pressure drop across the motor, and the main object of this invention is to provide means whereby this pressure drop variation is measured by control of the speed of forward travel of the vehicle which carries the concrete mould.

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A vehicle supported concrete moulding machine according to this invention can comprise a vehicle, land wheels on the vehicle, a variable speed travel motor connected for drive to at least one of the land wheels, speed control means controlling the speed of said travel motor, a concrete extruder on the vehicle, and a mould on the concrete extruder, and may have an hydraulic extruder motor driving concrete extrusion means on the concrete extruder, and pressure responsive means hydraulically connected to and responsive to the input pressure of said extruder motor and actuating said speed control means, whereby forward travel speed of the vehicle is a function of the input hydraulic pressure of said extruder motor.

It is of course desireable that the driven hydraulic pump means should comprise a plurality of pumps so that the travel motor is driven separately from the hydraulic motor which drives the concrete extrusion means, since this will avoid a drop in pressure on the extrusion means hydraulic motor from tending to lower the speed of the forward travel motor. It will of course be seen that it is a simple matter to arrange the forward travel motor to operate at a speed which will be determined by the pressure drop across the concrete extrusion motor, and therefore the pressure within the concrete as it is being packed, so that the range of pressure variation within the concrete being packed is kept within relatively narrow limits which ensures a product of correspondingly consistent strength.

It is found that a machine according to this invention can satisfactorily extrude concrete which varies from a three inch slump to very stiff concrete with an 0.1 water/cement ratio, by merely making adjustments to the extrusion pressure. Since strength is a function of the quantity of water used, it is desirable to ensure that the concrete being extruded by the machine has a low and reasonably consistent water/cement ratio, but provided that the water/cement ratio is kept within normal tolerances, this machine will extrude a high strength uniformly compacted product without weak patches. Even if the water/cement ratio is increased so that the resultant cement is of lower strength, provided the water/cement ratio is maintained within normal tolerances, the machine will nevertheless still extrude a product which will be substantially uniform in its compaction and density and therefore substantially uniform in its strength.

It is usual for high quality concrete to be formed with the assistance of a vibrating device, but it has been found that when a vibrating device is fitted to a machine the speed of forward travel of which varies, the vibrating device will tend to tamper down the concrete which has been laid if the machine carrying the extruder is temporarily stopped or temporarily slowed down, and this of course results in an undesirable depression in the final product.

In order to overcome this problem, this invention has as a further feature a vibrating device which is driven by an hydraulic motor, and the speed of the hydraulic motor is again a function of the pressure across the hydraulic extrusion motor, so that as the pressure builds up due to lower forward travel speed of the vehicle, the frequency and amplitude of vibration is reduced. Conveniently, the same pressure control line can be used for controlling the speed of forward travel and the vibration rate.

An embodiment of the invention is described herein in some detail wherein the vehicle which is utilized to support the concrete moulding machine is a "Land Rover" manufactured by the Rover Co. of England.

This embodiment is described with reference to and is illustrated in the accompanying drawings, in which:

FIG. 1 is a plan view of a vehicle and concrete extruder showing the drive arrangement.
FIG. 2 is a section on line 2—2 of FIG. 1.
FIG. 3 is a plan view of the tray of the vehicle showing the hydraulic pump arrangement.
FIG. 4 shows the hydraulic circuit,
FIG. 5 is a rear elevation of the concrete extruder, and
FIG. 6 is a side elevation of the same.

A "Land Rover" 10 has a chassis 11 which is supported in the usual way by the front wheels 12 and rear wheels 13, the rear wheels 13 being driven by a tail shaft 14 through differential gears housed in the differential gearbox 15, this being the normal construction of the vehicle.

The main gearbox 18 of the vehicle has an outrigger frame 19 which carries on it an hydraulic motor 20, which in this case is the forward travel motor of the vehicle 10. This forward travel motor 20 is coupled to the input shaft 22 of a worm gearbox 23, the output shaft 24 of which carries a spur gear 25. This spur gear 25 is arranged to mesh with an axially slidable idler gear 26 which when moved into mesh engages the driven spur gear 27 and the spur gear 28 at the same time so
that the motor 20 drives the driven spur gear 27 which is coupled to the tail shaft 14. A hand lever 30 is pivoted intermediate its ends and axially engages the idle gear 26. Slidestop 25 is mesh with the spur gears 25 and 27 in the normal way.

The chassis 11 carries on it an outrigger frame 33 which in turn carries on it a tilting and elevating frame 34, this again supporting a concrete extruder 35. The concrete extruder 35 includes a hopper 36 which supports a pair of inducted hydraulic extruder motors 37 each of which is directly coupled to helical packing means 38, the helical packing means 38 depending into the hopper 36. The trailing end of the hopper 36 carries a fluted mould 40, the arrangement being such that concrete is driven through the hopper 36 and the fluted mould 40 so as to be extruded in the form of a concrete article 41 of constant cross-sectional shape as the vehicle 10 travels forward.

In operation the hopper 36 is arranged to be filled by conveyors or a mobile concrete mixer (not shown) as the machine moves forward. The helical packing 38 means are inclined so that their lower ends are effective within the hopper 36 to force the concrete downwardly and outwardly through the mould 40 as the extruded article 41 (see FIG. 6).

The vehicle 10 has a power take-off shaft 45 as part of its general construction, and this carries a sprocket 46 on its rear end. This sprocket 46 (FIG. 1) meshes with a chain 47 which drives a sprocket on a countershaft 48 (FIG. 3). This countershaft 48 drives a first pair of hydraulic extruder pumps 50 and a second pair of hydraulic pumps 51 through the chain 52, and also drives a vibrator pump 53 through the chain 54. The first pair of extruder pumps 50 are coupled to the hydraulic extruder motors 37, one of the pumps of the second pair 51 is coupled to conveyors 56 (not shown) while the other is coupled to the forward travel motor 20, and the third hydraulic pump 53 is coupled to the vibrator motor 57.

Referring now to FIG. 4 which illustrates the hydraulic circuit, an oil tank 60 (shown only in FIG. 3) contains three strainers 61. The first of these strainers 61 strains the induction line 62 into the extruder pumps 50, and each pump 50 directly feeds an hydraulic extruder motor 37. The pressure lines of the extruder pumps 50 are each provided with a relief valve 63 to protect against excessive pressure build up, and the line passes directly through the relief valve 63 in each case, also through the incline check valves 64, and then through the adjustable relief valve 65 to the drain line 66. The adjustable relief valve 65 in this embodiment is manufactured by Vickers-Detroit Hydraulics Pty. Limited of Maribyrnong, Victoria, Australia, and has the part number C1758B. It is normally set to a lower pressure than the safety relief valve 63 and thus provides a pressure control for the hydraulic extruder motors 37.

The pressure lines 67 leading to the motors 37 have joining them pressure control lines 70, and these feed through check valves 71 into a forward travel pressure responsive throttle valve 72. The check valves 71 are arranged so that they do not completely cut off flow of oil into the valve 72 but merely restrict it in one direction, but allow rapid flow in the other direction (shown by the arrows), and the effect of this is to ensure quick deceleration but slow acceleration of the forward travel motor 20. The pressure line 70 also feeds directly a vibrator pressure responsive throttle valve 73 which is of similar construction to the valve 72. In this embodiment the valves 72 and 73 are modified from Vickers-Detroit Hydraulics (Australia) valves part number C440, the modification consisting of the addition of a piston 74 which is formed in two parts, the cross-sectional area of the end part 75 being half that of the inner part 76, and both these parts being subjected to pressure, one to each of the lines 70, so that the thrust of the piston 74 is proportional to the sum of the pressures in the two lines 70. This moves a spool 77 against a spring 78, and spring being part of the normal C440 valve 72 and 73, constitutes the pressure responsive means of the travel motor, and the piston 74, together with the spring 78, constitutes the pressure responsive means to actuate the speed control means.

One of the pumps 51 delivers hydraulic fluid at pressure through the valve 72 to the forward travel motor 20, and the other 50, if present, has a relief valve 63 to protect it against excessive pressure, the straight through line 81 of the relief valve 63 passing through a check valve 64, and this providing a parallel line to the line 82, the line 82 passing through a forward travel variable speed control valve 83 adjustable to control maximum oil flow rate between the pump 51 and throttle valve 72. This then gives two alternative circuits, one for manual control (line 82) and the other for automatic control (line 81). There is also in this circuit a forward travel auxiliary control valve 84 in a bleed-off line 85 which leads back to the drain line 66, but this is not normally used in operation of the machine. This bleed-off line 85 is connected to the pressure line to the forward travel motor 20 through a check valve 86.

The pump 53 feeds a steering cylinder 90, a level control cylinder 91 and a tilt control cylinder 92, but these form no part of this invention, and FIG. 1 does not show the steering control cylinder 90. However, the pump 53 also feeds, through alternative lines 94 and 95, the vibrator pressure responsive throttle valve 73, the circuit being identical to that feeding the forward travel pressure responsive throttle valve 72. The output from the valve 73 feeds directly into the vibrator motor 57 which is arranged to drive the vibrator 94, this being mounted on the fluted mould 40 (FIG. 1). In FIG. 4, for the sake of simplicity, alternative or control circuits are shown in dotted lines.

A consideration of the above embodiment will indicate that the vibration frequency varies according to the travel speed, and that, beyond a minimum or "threshold" pressure, the travel speed is also a function of the pressure in the concrete which is being packed through the mould 40 by the helical packing means 38. It is found in practice that this arrangement provides a very efficient way of achieving consistent high strength in the concrete being formed, and greatly assists in preventing formation of surface flaws caused by surface tension or rapid acceleration of the mould, so that in many instances the concrete article 41 needs no further treatment or finish after extrusion, notwithstanding that there may be variations in the moisture content of the concrete being packed and variations in the forward travel speed.

What I claim is: 1. A vehicle supported concrete moulding machine comprising:

- a hydraulic extruder motor driving concrete extrusion means on the concrete extruder, driven hydraulic pump means on the vehicle hydraulically connected to both the forward travel and extrusion motors, and a forward travel pressure responsive throttle valve in the hydraulic line between said pump means and said travel motor for control of rate of oil flow therebetween, said forward travel pressure responsive throttle valve being hydraulically connected to responsive to the input pressure of the extruder motor,
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5 whereby forward travel speed of the vehicle is a function of the input hydraulic pressure of said extruder motor.

2. A vehicle supported concrete moulding machine according to claim 1 wherein the pressure responsive throttle valve includes a spool valve in the hydraulic line between said pump means and said travel motor for control of oil flow therebetween, and said throttle valve includes a piston operable to urge the spool against a spring under pressure exerted on said piston by connection to the input of said extruder motor.

3. A vehicle supported concrete moulding machine according to claim 1 wherein a plurality of hydraulic motors drive said concrete extrusion means on said concrete extruder, and said pressure responsive throttle valve includes a spool valve in the hydraulic line between the pump means and travel motor, and a stepped piston urges the spool of the valve against spring pressure to thereby open the valve, hydraulic pressure being applied to some or all of the end of the stepped piston and the annular steps thereon from each said extruder motor independently.

4. A vehicle supported concrete moulding machine according to claim 1 wherein a rotary vibrator is secured to the concrete extruder or the mould thereon and driven by a hydraulic vibrator motor, and further characterized by a vibrator pressure responsive throttle valve in the hydraulic line between said pump means and said vibrator motor to control the rate of oil flow therebetween, said vibrator pressure responsive throttle valve being hydraulically connected to and responsive to the input pressure of the extruder motor, whereby speed of rotation of said vibrator motor is a function of the input hydraulic pressure of said extruder motor.

5. A vehicle supported concrete moulding machine comprising:

a road vehicle,
driven rear wheels on the road vehicle,
an hydraulic forward travel motor and gearbox on the road vehicle,
drive means between the speed reduction gearbox and the tail shaft of the road vehicle,
a concrete extruder on the vehicle,
a mould on the concrete extruder,
an hydraulic extruder motor driving concrete extrusion means on the concrete extruder,
a vibrator on the mould,
an hydraulic vibrator motor coupled to the vibrator,
a driven hydraulic extruder pump on the vehicle hydraulically connected to the driven hydraulic extruder pump,
a driven hydraulic forward travel pump on the vehicle hydraulically connected to the forward travel motor,
a driven hydraulic vibrator pump on the vehicle hydraulically connected to the vibrator motor, and
a pair of pressure responsive throttle valves one in the hydraulic line between the forward travel pump and motor and the other in the hydraulic line between the vibrator pump and motor arranged to control rate of oil flow in each said line respectively, said each throttle valve being responsive to the input pressure of said hydraulic extruder motor whereby both forward travel motor speed and vibrator motor speed are functions of the input pressure of said hydraulic extruder motor.

6. A vehicle supported concrete moulding machine according to claim 5 wherein

a pair of hydraulic extruder motors each drives concrete extrusion means on the concrete extruder,
a pair of extruder pumps each feeds a said extruder motor independently,
each said pressure responsive throttle valve includes a spool valve to control flow in each said hydraulic line respectively,
each spool valve is urged against a spring by a stepped piston, the area of the larger portion of the stepped piston being double the area of the smaller portion thereof, the annular step of said piston being hydraulically connected to the input line of one of said extruder motors and the end of said piston being hydraulically connected to the input line of the other extruder motor whereby the thrust on said piston is a function of the sum of input pressures of both said extruder motors in each said throttle valve.

7. A vehicle supported concrete moulding machine according to claim 5 wherein

each extruder pumps each feeds a said extruder motor independently,
each said pressure responsive throttle valve includes a spool valve to control flow in each said hydraulic line respectively,
each spool is urged against a spring by a stepped piston, the annular step of each said piston being hydraulically connected to the input of one of said extruder motors and the end of each said piston being hydraulically connected to the input of the other extruder motor whereby thrust on said piston is proportional to the sum of input pressures on both said extruder motors in each said throttle valve,
each hydraulic line interconnecting the forward travel pressure responsive throttle valve to an input line of a said extruder motor contains a check valve arranged to give free flow of oil from said throttle valve to said input line but restricted flow in the reverse direction whereby the response speed of said forward travel motor to pressure variations in said input lines to said extruder motors includes quick deceleration and slow acceleration characteristics.

8. A vehicle supported concrete moulding machine according to claim 5 wherein

a pair of hydraulic extruder motors each drive concrete extrusion means on the concrete extruder,
a pair of extruder pumps each feeds a said extruder motor independently,
each said pressure responsive throttle valve includes a spool valve to control flow in each said hydraulic line respectively,
each spool is urged against a spring by a stepped piston, the annular step of each said piston being hydraulically connected to the input of one of said extruder motors and the end of each said piston being hydraulically connected to the input of the other extruder motor whereby thrust on said piston is proportional to the sum of input pressures on both said extruder motors in each said throttle valve, and
the hydraulic line between the forward travel pressure responsive throttle valve and forward travel motor includes forward travel auxiliary control valve arranged to bleed hydraulic fluid to a hydraulic drain line.

9. A vehicle supported concrete moulding machine according to claim 5 wherein

a pair of hydraulic extruder motors each drive concrete extrusion means on the concrete extruder,
a pair of extruder pumps each feeds a said extruder motor independently,
each said pressure responsive throttle valve includes a spool valve to control flow in each said hydraulic line respectively,
each spool is urged against a spring by a stepped piston, the annular step of each said piston being hydraulically connected to the input of one of said extruder motors and the end of each said piston being hydraulically connected to the input of the other extruder motor whereby thrust on said piston is the function
of the sum of input pressures on both said extruder motors in each said throttle valve, and the hydraulic line between the forward travel pump and forward travel pressure responsive throttle valve includes a forward travel variable speed valve adjustable to control maximum oil flow rate between said forward travel pump and forward travel pressure responsive throttle valve.