This invention relates to power presses and other similar machine tools (hereinafter referred to as machine tools of the kind specified) wherein a rotary flywheel or other rotary driving member (hereinafter referred to as a flywheel) is required to be clutched to and de-clutched from a driving shaft operatively connected with and serving to drive a moving tool carrying member of the machine.

In power presses the moving tool carrying member is normally a ram or slide mounted in the frame or body of the press for movement towards and away from a bed or table which is adapted to support a further tool for co-operation with that carried by the ram or slide to exert pressure upon a workpiece fed between the two tools, the driving shaft being provided with an eccentric element such as a crank, cam, or eccentric for imparting the requisite reciprocation to the ram or slide.

The machine tools of the kind specified and more especially, but not exclusively, power presses, are frequently required to be operated in such a manner that the flywheel is clutched to the driving shaft at the beginning of and de-clutched from the driving shaft at the end of each cycle of rotation thereof, this mode of working being known generally as simple cycle working. In another mode of working known generally as continuous working the driving shaft is required to perform a plurality of cycles of rotation after the flywheel has been clutched thereto and before it is de-clutched therefrom.

In both modes of working, however, the number of clutching and de-clutching operations performed in a continuous period of operation of the machine extending, for example, over five or six hours or even more, is considerable and the performance of the clutch is a factor which in many cases limits the speed of operation of the machine and hence its output.

In machine tools of the kind specified it has hitherto been the practice to employ two main types of clutch. In one of these, known generally as key clutches, a movable key is provided for engagement in or withdrawal from a key-way according to whether the clutch is required to be engaged or dis-engaged, the key and its operating mechanism usually being mounted on the driving shaft whilst the key-way is formed in the flywheel or in a part secured thereto.

When employing this form of clutch the speed of rotation of the flywheel cannot be raised above a predetermined limit, because otherwise the clutch cannot be engaged. Moreover, the key and its operating mechanism increases to a significant extent the inertia of the driving shaft and the connecting rod and moving tool carrying member operatively connected thereto thus increasing the shock load on the key upon engagement of the clutch and to some extent decreasing acceleration of the driving shaft.

A second type of clutch which has been employed is a friction clutch in which the driving and driven elements of the clutch each comprise an annular lining of non-metallic or sometimes metallic material selected to afford a high coefficient of friction when engaged with its companion clutch element, these clutch elements being moved into contact to engage the clutch and retracted from each other to dis-engage the clutch by a fluid pressure energised actuating device.

In order to avoid excessive wear on these clutch elements they have each hitherto been made of fairly large diameter, so as to increase the total area of contact face afforded by each element and thereby reduce the specific pressure necessary to transmit a given torque through the clutch, but this in turn has led to a substantial increase in the inertia imparted to the driving shaft by the driven element of the clutch fast therewith, with attendant disadvantages as already mentioned in the case of key clutches.

Furthermore, another problem which has been encountered is to dissipate the heat generated in the clutch elements.

The object of the present invention is to overcome or reduce these disadvantageous factors which are inherent in the types of clutch hitherto commonly employed.

According to the invention a machine tool of the kind specified incorporates a clutch which is operatively connected between the flywheel and the driving shaft and which includes driving and driven clutch elements one of which is a smooth faced metal disc, drum or other member affording a smooth faced surface of revolution, and the other of which comprises a plurality of units spaced apart angularly about the axis of said surface of revolution, each such unit including a body and a clutch pad movable under fluid pressure relatively to the body into and out of driving engagement with said surface of revolution, the area afforded by the pads collectively being substantially less than the pad-swept area of said surface of revolution.

The surface of revolution may be afforded by oppositely presented faces of the clutch element concerned and the other clutch element may include pads adapted to engage with both of these faces, the arrangement being such that said other clutch element is not subjected to any substantial loading tending to displace it from its proper position.

In a preferred arrangement one of the clutch elements comprises members presenting annular faces towards each other, and the other of which comprises said units disposed between said members and each including a body and clutch pads movable relatively thereto in opposite directions into engagement with said faces respectively.

The units may be supported collectively on a carrier which is common to some or all of them, such carrier bearing the thrust or reaction, if any, produced on the body of each such unit as a result of engagement between the pad or pads thereof and the other of said clutch elements.

The invention will now be described by way of example with reference to the accompanying drawing illustrating one embodiment of the invention and wherein:

FIGURE 1 is a view in side elevation and in vertical cross section showing one embodiment of the present invention by way of example as applied to a power press.

FIGURE 2 is a fragmentary view in end elevation, part of one of the clutch elements being shown broken away.

FIGURE 3 is a fragmentary view in diametral cross section on the line 3—3 of FIGURE 2.

FIGURE 4 is an end elevation of a power press showing the flywheel on the opposite side thereof.

The power press to which the clutch is applied as shown in FIG. 4 of the drawings may comprise any conventional form of frame including upwardly extending side frame members of which one is indicated at 100, between which is disposed a pad or table intermediate the upper and lower ends of the side frame members.
Above the pad or table the side frame members support a vertically reciprocated slide or ram which is actuated from a driving shaft 101 extending horizontally between the upper end portions of these side frame members, this driving shaft including a crank or eccentric 100A which is coupled to the ram through a connecting rod 100B. The driving shaft 101 has a lateral extension 102 project- ing from one of the side frame members, and jour- nalled on this extension is a flywheel 103 comprising a relatively massive rim portion 104 which is connected integrally to a hub portion 105 by a web portion 106. The reciprocating ram includes a slide or tool carrying member 100C which carries a removable tool or die 100D which cooperates with an anvil 100E which carries a stationary tool or die 100F so that the driving flywheel 104 will operate the die 100D in a manner well understood in the power press art.

The flywheel is mounted on the extension 102 of the driving shaft through the intermediary of journal bearings of the roller type, as indicated at 107 (which bear radial loads only) and which are spaced apart on the extension 102 by a spacer sleeve 108.

The flywheel is driven continuously in any suitable manner as for example from an electric motor.

To transmit the drive from the flywheel to the driving shaft a clutch is provided, one element, the driving clutch element of which is carried by the flywheel and comprises an inner annular plate member 109 which is contiguous with the web portion 106 of the flywheel and an outer plate member 110 of generally annular form.

These two plates collectively afford a surface of revolu- tion consisting of the inwardly presented faces 111 and 112 respectively which are opposed to each other and which are of smooth or plane faced form.

The outer plate 110 is secured to the flywheel by means of fastening elements in the form of studs having nuts 114 at their outer ends and nuts 115 at their inner ends.

Spacer sleeves 116 disposed on the shanks 117 of the studs between the inner and outer plates maintain the required separation between the faces 111 and 112.

Bushes 118 are provided on the shanks of the studs where these pass through holes in the web portion 106 of the flywheel and in the outer margin of the inner plate 109.

The plates 109 and 110 may be made of cast iron, or as a possible alternative a high carbon or alloy steel may be employed selected for its ability to withstand shock loads without fracture and in combination with the pad material, hereinafter referred to, an unredced coefficient of friction in service without the faces 111 and 112 becoming scored.

The outer plate 110 may include at its outer periphery projecting portions 119 which areapertured for the passage therethrough of studs 113, and in between these projecting portions the plate may incorporate a circum- ferentially extending rib 120 connected by webs 121 to the projecting portions 119.

This construction avoids excessive deflection of the plate 112 under the operating load which stresses portions of the plate between successive studs 113 in the manner of a beam.

The other or driven clutch element comprises a plurality of units each including a body 121 including an integral cylinder portion 122 open at both ends, and capable of having hydraulic fluid under pressure ad- mitted thereto by way of a duct 123 (FIGURE 3) com- municating with an inlet fitting in an integral boss or block 124 of the body.

Externally the cylinder portion 122 includes an integral collar 125 which presents an axial face abutting a carrier 126 on which all the units are mounted.

The carrier includes a central hub 127 provided with teeth 128 engaging keyways in the extension 102 of the driving shaft, from which hub radiate a plurality of arms 129 the number of which is dependent upon the number of units provided.

In practice it is desired to achieve the lowest possible moment of inertia for the driven clutch element compris- ing the carrier and its associated units to transmit the max- imum torque required for any particular machine.

The number of arms 129 may thus be two, three, or more, but it is preferred to use an odd number of arms so that only one unit is situated on any one reference di- ameter passing through the axis of the driving shaft.

This avoids imposing a bending stress on the outer plate 113 which would be introduced by an arm along a diameter at right angles to said reference diameter, and therefore in prac- tice it is contemplated that, in general, the carrier will include either three arms or five arms according to the torque requirements, although a greater number of arms may be used if necessary.

The carrier itself is not subjected to substantial stress in an axial direction and the arms 129 may, therefore, be of plate-like form as illustrated.

The bodies 121 of the units may be secured in apertures in the arms in any suitable manner, for example by pro- vision of attachment lugs 130 apertured to enable securing bolts to be passed through them and engage in tapped holes in the arms 129.

The body may further include a bleed duct 131 ter- minating in a bleed nipple 132 which can be screwed in to provide a closure for the bleed duct when not in use.

Each of the bodies contains two clutch pads 133 which are a close sliding fit within the cylinder portions 122.

These pads may be made from a material normally used for the pads of disc brakes on motor vehicles and which is a dense non-absorbent moulded friction material with metallic inclusions.

As a possible alternative metallic friction pads may also be used, in this case the metal employed being somewhat softer than that employed for the plates 109 and 110.

The pressure established between the operative out- wardly presented faces of the pads and the faces 111 and 112 is high, and may typically be about 1250 lbs. per square inch, so that although the employment of metallic pads may result in a somewhat lower coefficient of fric- tion than is obtained when the moulded friction material is employed, the torque required in the case of many appli- cations of the invention to machine tools of the kind speci- fied is nevertheless capable of being transmitted through the clutch.

Each pad 133 is of substantial thickness. The expres- sion "substantial thickness" is to be deemed herein to mean a thickness which is greater than that normally em- ployed in friction clutches for power presses and similar machine tools of the kind specified in respect of the con- tinuous annular clutch linings conventionally used therein.

It is contemplated that the thickness of the pads 133 would be at least half-an-inch and may be increased sub- stantially beyond this up to two or three inches. A typical value, however, would be one-and-a-quarter inches.

In the construction shown each pad is mounted on a pad carrier 134 which may be made of a metal such as mild steel or brass.

It is not essential that each pad 33 should be fixed to its carrier, but if this is required to be done it may be done by any suitable form of adhesive or possibly by bond- ing the pad material directly to the carrier. It is, how- ever, desired to avoid outwardly projecting pins or other elements and therefore the pads and the material in the pads to reduce the effective thickness of each pad which could be used and would lead to premature discard or replacement of pads.

The pad carriers 134 are formed with spigots 135 at their inner faces, and on these spigots are mounted annu- lar sealing members 136 of a suitably yieldable material such as synthetic rubber. The sealing members 137 are an interference fit at their outer edge faces 138 with the walls of the cylinder portions 122, and are also an inter-
ference fit at their inner edge faces 139 with the spigots 135 whereby they effectively prevent any leakage or permeation of hydraulic fluid from the space 140 to the carriers 137 or pads 133 themselves.

In practice the establishment of the requisite pressure in the space 140 by the admission of fluid under pressure, preferably hydraulic fluid such as oil, produces the requisite outward movement of the pads 133 to establish the operative faces of these in driving engagement with the faces 111 and 112, and it is unnecessary to provide any specific means for retracting the pads since a mere relaxation of the pressure of the fluid is sufficient to reduce engagement of the faces 111 and 112 as the case may be and their associated pads to a very light rubbing or intermittent contact which can be tolerated without detriment to any of the component parts of the clutch and does not produce any undesirable torque on the driving shaft.

It will be observed that since the faces 111 and 112 are presented in opposite directions the resultant axial thrust on the flywheel when the clutch is engaged is either zero or a very low value, so that the bearings for the flywheel are not themselves subjected to any significant axial load.

However, thrust elements 141 and 142 are provided at opposite sides of the flywheel hub 105 to bear against the axially presented faces thereof, these thrust elements being backed up in the first case by an abutment in the form of a collar 143 fixed to or integral with the extension 162 of the driving shaft, and in the other case by an axially presented face on the carrier 127 in the region of its hub.

The roller bearings 107 are thus relieved entirely of any axial thrust. The thrust elements 141 and 142 are preferably made of a synthetic resin having the requisite mechanical properties, i.e., ability to withstand some pressure loading and ability to withstand wear by rubbing. A particularly suitable material is known as nylon which does not require normal lubrication by oil.

The thrust elements may be secured to the axially presented faces of the flywheel hub by screws 144 and 148 having heads disposed below the level of the outwardly presented faces of the thrust elements which bear on the collar and on the carrier respectively.

Hydraulic fluid is supplied to the space 140 through pipe 146. This pipe is connected to the rotary part 147 of a running joint assembly whereof the stationary part 148 is connected to a pipe 149 leading to a pressure intensifier.

The pressure set up in the liquid system may be, for example, 1000 lbs. per square inch or even more, and may be derived from a pressure intensifier of generally known construction and energised from a pneumatic supply, furnishing, for example, about 80 lbs. per square inch.

It will be observed that during idle time, that is to say when the flywheel of the press is rotating but the clutch is not engaged, the arrangement illustrated results in the rotary part 147 of the running joint being at rest so that wear, as between components of the running joint which prevent leakage of the liquid fluid, is reduced to a minimum.

What I claim then is:

1. A power press having movable tool carrying members mounted thereon operable from a continuously rotating flywheel freely rotatable on a driven shaft, the improvement comprising a driving clutch element, means to mount said driving clutch element on the flywheel, a driven clutch element on said driven shaft, means for holding said driven clutch element to said shaft, a first clutch member mounted on said flywheel, a second clutch member coaxial with said first clutch member and spaced axially therefrom, the driven clutch element being engaged by said clutch members, a plurality of bodies angularly disposed on said driven clutch element, each of said bodies having a bore therethrough substantially parallel to the axis of said shaft, said bodies extending substantially to the faces of said driving clutch members, the clearance between said bodies and said clutch members being the least amount to allow a substantially friction-free relative rotation therebetween, said second clutch member being supported along only its outer periphery from said flywheel and being spaced from the axis of said shaft providing an access space, manifold means mounted on said manifold shaft, pressure conduits extending from said manifold shaft, pressure conduits communicating with the bores of said bodies, said bores, conduits and manifold means being adapted to be filled with hydraulic fluid, swivel means for providing a supply of said hydraulic fluid under pressure, said manifold means being rotatable and said swivel means may remain stationary, a pair of piston elements engaging the bore of each body, friction pads of substantial thickness exteriorly of each piston and positioned between the piston and the adjacent clutch members and confined in the bore, said structure providing for substantially immediate and substantially positive connection between the driven clutch element and the driving clutch element upon the application of hydraulic pressure in said swivel, manifold, conduit and bores whereby a minimum of heating is obtained and accurate control for the stoppage of the driven clutch element can be obtained without excessive inertia forces.

2. The invention according to claim 1 in which the number of bodies is at least three and the number of bodies is an odd number.

3. The invention according to claim 1 in which the axial bores are cylindrical.

4. A power press comprising supporting structure, tool carrying members mounted thereon for relative movement towards and away from each other, and a driving shaft having eccentric means operatively connected with one of said tool carrying members for imparting said relative movement thereto, a flywheel, a driving clutch element connected thereto, said driven clutch element connected thereto, said driving clutch element connected to said driving shaft, one of said clutch members comprising a radially arranged opposed annular clutch members having opposed clutch faces spaced apart axially and the other of said clutch elements comprising a carrier, a plurality of bodies spaced apart angularly about the axis of said annular clutch members and disposed between them, said bodies each affording an axially extending chamber open at both ends, said bodies extending substantially to the faces of the clutch members, the clearance between said bodies and said clutch members being the least amount to allow a substantially friction-free relative rotation therebetween, clutch pads movably mounted in each of said chambers at each end thereof and having outer faces disposed during operation of the press in substantially co-planar relation to the clutch faces of respective ones of said annular clutch members, and duct means extending to each of said chambers between said clutch pad thereof, said chambers and said duct means being adapted to receive hydraulic fluid under pressure to urge said pads at opposite ends of each said chambers into contact with said clutch faces, said pads having a collective cross section area substantially less than the pad swept areas afforded by said annular clutch members.

5. A power press comprising supporting structure, tool carrying members mounted thereon for relative movement towards and away from each other, and a driving shaft having eccentric means operatively connected with one of said tool carrying members for imparting said relative movement thereto, said driving shaft having an extension projecting laterally of said supporting structure, a flywheel on said driving shaft extension, a driving clutch element on said flywheel at its outer end remote from said supporting structure, comprising a first annular clutch member mounted on one face of said flywheel, a second annular clutch member opposed to and spaced axially from said first annular clutch member, said annular clutch members having respective opposed clutch faces, releasable connecting means at the outer radial
margin of said second clutch member securing it detachably to said flywheel, a driven clutch element comprising a carrier on said driving shaft extent at said outer side of said flywheel, a plurality of bodies in said carrier spaced apart angularly about the axis of said annular clutch members and disposed between them, said bodies each having its ends disposed immediately adjacent to respective ones of said clutch faces, the clearance between said bodies and said clutch faces being the least amount to allow a substantially friction-free relative rotation therebetween and each of said bodies affording an axially extending chamber open at both ends of the body, clutch pads movably mounted in each of said chambers at each end thereof and having outer faces which during operation of the press are substantially coplanar with respectively associated ones of said clutch faces, and duct means extending to each of said chambers between said clutch pads thereof, said chambers and said duct means being adapted to receive hydraulic fluid under pressure to urge said pads at opposite ends of each of said chambers into pressure contact with said annular clutch members, said pads having a collective cross sectional area substantially less than the pad-swept areas afforded by said annular clutch members.

6. In a power press having movable tool carrying members mounted thereon operable from a continuously rotating flywheel freely rotatable on a driven shaft, the improvement comprising a driving clutch element, means to mount said driving clutch element on the flywheel, a driven clutch element on said driven shaft, means to keying said driven clutch element to said shaft, said driving clutch element including a first clutch member coaxial with said first clutch member and spaced therefrom with the driven clutch element between said clutch members, at least one body disposed on said driven clutch element, said body having a chamber open at both ends extending substantially to the clutch faces of said first and said second clutch members, said body extending substantially to the faces of said driving clutch members, the clearance between said body and said clutch members being the least amount to allow a substantially friction-free relative rotation therebetween, pressure conduit means extending to said chamber of said body and communicating with said chamber of said body, said chamber and said pressure conduit being adapted to be filled with hydraulic fluid, said fluid means for providing a supply of said hydraulic fluid under pressure to said pressure conduit while said pressure conduit may rotate and said fluid means may remain relatively stationary, friction pads of substantial thickness movably mounted in each end of said chamber and having the outer faces thereof adjacent the clutch faces of said clutch members and confined in said chamber, said structure providing for substantially immediate and substantially positive connection between the driven clutch element and the driving clutch element upon the application of hydraulic pressure in said fluid, and said pressure conduit whereby a minimum of heating is obtained and accurate control for the stoppage of the driven clutch element can be obtained without excessive inertia forces, said pads having a collective cross sectional area substantially less than the pad-swept areas afforded by said clutch members.

7. In a machine tool of the kind specified the combination of a flywheel rotatable about an axis, a driving clutch element connected thereto, a driven clutch element connected to a driving shaft, one of said clutch elements comprising coaxially arranged axially opposed annular clutch members spaced apart axially and having opposed clutch faces in spaced planes radial to said axis, and the other of said clutch elements comprising a carrier also rotatable about said axis, a plurality of bodies on said carrier spaced apart angularly about said axis and disposed between said clutch members, said bodies each affording an axially extending chamber open at both ends and said bodies each terminating at each end of said chamber at a position substantially co-planar with a respective one of said clutch faces of said annular clutch members, said bodies extending substantially to the faces of the clutch members, the clearance between said bodies and said clutch members being the least amount to allow a substantially friction-free relative rotation therebetween, clutch pads slidably mounted in each of said chambers at each end thereof, said pads having a collective cross-sectional area substantially less than the pad-swept areas afforded by said opposed clutch faces, manifold means, swivel means for providing a supply of said hydraulic fluid under pressure to said manifold means while said manifold means may rotate and said swivel means may remain relatively stationary, conduits extending to each of said chambers and connecting said chambers respectively to said manifold means, said chambers, conduits, manifold means and swivel means being adapted to be filled with hydraulic fluid to provide for substantially immediate and substantially positive connection between the driven clutch element and the driving clutch element upon establishment of pressure in said hydraulic fluid whereby a minimum of heating is obtained and accurate control for the stoppage of the driven clutch element can be obtained without excessive inertia forces.

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