

## **POWER INCLINES at Oakeley**

Most of the later Oakeley Inclines driven by steam engine, and latterly electric motors, were of the “clutched drum” variety. That is, the winding drums were loose on power driven axles, being “clutched-in” as required. Full wagons were thus hauled up by power and empties allowed to run back down by gravity, under the control of an individual brake on the drum.

However, several of the earlier inclines, particularly those of the W.S.Co. and Hollands’ were “carriage inclines” - similar in all respects to the double acting water balances, except that the carriages were moved by the power of the steam engine applied through the drums to the ropes, rather than the weight of water. The K Trwnc was the only one of these to survive into the present century.

Power inclines could be operated with any number of tracks, odd or even, although the “best” number was felt to be four, as this allowed almost continuous working. One wagon could be being “hooked-on” at the bottom of one track, another unhooked at the top, a third be on its way down while a fourth was being hauled up! Such an incline could be handled effectively by a team of two “drivers” at the top, and two hookers each at top and bottom with a single stoker/engine attendant, giving seven men.

A typical clutch drum incline consisted of a boiler house equipped with one or more Cornish single-flue boilers, the more efficient twin-flue Lancashire type boiler not finding favour at Oakeley, a horizontal duplex engine with flywheel on the crankshaft driving the main drum shaft through gearing. It is interesting to note that the 5:1 gear ratio used by the 200h.p. electric winding motors appears to have been that used by the steam engines.

The drums were loose on the main shaft and were equipped with individual dog-clutches and band brakes, both of which were operated by long levers extending in front of the drums towards the incline crimp. The drums themselves were either built up on iron frames, much as the gravity inclines were, with wooden lagging, or were made from paired castings bolted together. The drumshaft, and its bearings were usually supported by massive timber beams bolted together and supported in turn by equally massive slab walls at either end. Later underground inclines tended to use steel joists, supported either by the chamber walls or masonry. The Middle Quarry main surface incline was probably unique in that it used I-beams bolted together to form stronger I-beams still.

In front of the drums, either above or below shaft level, was the operating platform or “stage”, where the “drivers” stood. Above the stage ran shafts and levers which controlled the throttle valve of the winding engine, and possibly a steam brake on the main shaft. The actual winding engine thus being driven by “remote control” from the stage.

Arrangements of sidings etc. at the top and foot was similar to that used by gravity inclines, although more complex as befitted the larger number of tracks. Again, cramped locations could invoke the use of turntables at head or foot, with consequent slowing of operations. Where possible, the levels of the various tracks were arranged to allow gravity to assist the movement of wagons away from the crimp at top and bottom.

Operation or “driving” - the term “crewling” seems to have been reserved for gravity inclines - was an art in itself, the particular “knack” being in gauging the speed of the ascending loaded wagons so that they breasted the crimp at the right speed, allowing the driver to put on the brake. This, together with the slackness of the rope, enabled the unhooker at the top to flip the chain clear of the wagon hook and with a well-timed shove to assist the wagons to ride down to the reception sidings or to the weighing machine under their own momentum.

Too little speed and the wagons might hang “tight on the rope” and would have to be inched over the crimp and then pushed manually away. Too much speed and the unhooker might not be able to get the rope clear and a derailment might result, with stoppage to that incline track at least.

It is not clear whether there were any brakes on the drum shaft itself, or on the engine main shaft, although there may well have been instances, they were certainly only used as a last resort or when the incline was shut down for maintenance. One characteristic of the steam driven inclines which changed when they were converted to electric drive was the operation of the throttle levers. With steam, the “speed control” lever operating on the throttle valve of the engine meant that maximum torque was achieved with the throttle wide open, but with the large induction motors, as will be seen, maximum torque was achieved with the lever in virtually the opposite position...

The actual conversion of the principal steam inclines to electric drive in 1906 was clearly planned to disturb operations as little as possible, and also to be of such a nature that, wherever possible, the steam plant could be retained as a reserve in the advent of any failure of the new electric machines.

In the case of the surface inclines at Middle Quarry, Bonc Coedan and Ffridd, conversion simply involved the construction of an electric motor house on the opposite side of the drum house to the existing steam plant, connection being made by a large cast coupling between the drum shaft and the geared output from the motor. Complex linkages connected the existing control shafts to the motor controls.

The other inclines taken in hand at the same time: Twr Babel, the Upper Quarry Untopping Incline, the HIK "Arches" incline and the K Trwnc all involved removing the steam plant to accommodate the electric motor and its associated controller. The alterations to the existing DC incline and plant have been described in the main historical narrative.

### **The "C" Incline**

As the last surviving power incline in which the controls, linkages etc. remained intact long enough to be recorded, the Bonc Coedan to DE floor incline - "The C Incline" is worth considering in detail as "typical" of the large Oakeley electric inclines. The following description should be read in conjunction with the drawings of motor and drum house.

The motor house consisted of two floors. The Main or Upper floor contained the 200H.P. motor mounted on a cast bed which also supported the main gear and coupling to the drum shaft. This bed in turn was mounted on a massive slab and masonry plinth which occupied a considerable portion of the lower floor. The 3-phase 500V electrical supply entered the building through ceramic tubes just under the eaves, after which it passed through lightening arrestors before terminating in a Siemens totally enclosed oil switch. The stator of the motor was fed from the output from this switch which passed in a duct beneath the timber floor. Immediately in front of the oil switch was the liquid resistance controller. This contained an electrolyte and by raising and lowering iron plates in the solution, a variable resistance could be inserted into the rotor circuit. The controller plates were connected to the rotor through a reversing switch mounted in front of the controller and then through brushes and slip rings to the rotor coils themselves. At a later date, the reversing switches were removed as the motors were never used in the reverse direction.

Originally the oil switch lever and the lever operating the resistance plates were connected by a slotted link and thence to the speed control levers on the stage. In this form, the first movement of the speed control levers closed the oil switch (which was sprung loaded) further movement lowering the plates into the electrolyte, thus gradually reducing the resistance in the rotor circuit. When fully inserted, contacts on the plate supports connected with other contacts in the controller, thus shorting out the rotor, supposedly when full speed had been reached.

The design of the motors was such that when the oil switches were closed initially, a very heavy current flowed to magnetise the stator coil, which, with the frequency of operation of the inclines was undesirable. For this reason, the arrangement was modified and the actions of switch and controller divorced from one another. A new set of levers was thus provided on the stage for the sole purpose of switching the stator on and off. This meant that the stator could be switched on at the beginning of a period of work, and only switched off again at the end. The Middle Quarry main incline seems, however, to have had this arrangement from the beginning.

The original design of the controllers meant that even with the controller lever in the "off" position the plates were slightly inserted in the electrolyte. This meant that there was a high resistance in the rotor circuit and so current would flow. To avoid this the controller was modified so that in the "off" position, the plates were lifted clear of the electrolyte. This achieved in typical quarry fashion by placing a shaped slab of slate under the cast support for the "wheels" on top of the controller, effectively raising them. The problem of the inadequacy of the controllers for dealing with the "normal" quarry operation of the 200 h.p. motors has already been described in the historical narrative. Initially a small diameter water pipe allowed for topping up of the tank, but this proved inadequate for the Oakeley inclines and so additional tanks were connected by large diameter pipes to the controller, allowing the overheated solution to circulate and cool.

On the end of the motor shaft was a five feet diameter brake wheel, with wooden pads. These were latterly faced with ferrobestos. They were activated by a hydraulic brake adapted for air operation, developing a force of 3000 lbs. They were operated by a shaft high above the floor, connected through links to a new set of levers on the stage. A further linkage allowed this brake to activate or be activated by a set of "stop-blocks" at the crimp. At a later date, current meters were installed in the motor house to monitor the consumption of the hauler.

The lower floor of the motor house was, as already mentioned, physically occupied by the massive motor plinth, the remaining space being used as a spares store for electrical bits and pieces, while the "roof" also supported the linkages between the "stop-blocks" and the motor brake.

Passing through to the drum house itself, the C Incline had four drums of the built up variety - the two end sections of each drum had been slid over the shaft and then bolted together by curved plates which were then covered with timber lagging. The brake rims bolted onto one end of the drum and the dog-clutch bolted onto the other. Keyed onto the shaft, but free to slide on it, were the clutches themselves. These were simple hoops of steel, able to be moved by the "fingers" of the clutch levers. Other inclines, possibly of more modern construction, had "square" clutches, made from two parts bolted together around the shaft. The drum shaft itself was in two parts, two drums to each section, with a simple flange joint in the centre. There were three bearings, one at each end of the shaft and a third offset to one side of the central joint.

The stage was set just below the level of the main drum support beams, the individual clutch and drum brake levers extending almost the whole of the way across it. Thus, to operate the incline, the driver had to stand in front of the drum he was operating, an exercise not without some danger as latterly the ropes from the drums passed over the stage! Rope burn marks on the beams show that on this incline at least, the direction of rotation of the drums has been altered at some time in its history, as they are deeply worn into the underside of the beams as well!

The drum brake levers moved in a vertical plane, in simple pivots, being lifted to release the brakes and pressed downwards to apply them. Again, unlike arrangements elsewhere, there was no provision to "lock" the brakes in the "on" position. The clutch levers moved horizontally, their pivots being mounted on wooden blocks immediately in front of the clutch itself. On the front of the main beam was a slotted plate in which the lever moved. This had two holes in it, allowing a peg to be dropped into place, holding the clutch "in" or "out."

Immediately above the front edge of the stage, which had both a foot board and a tubular handrail to prevent accidents, were three sets of levers, the largest, curved levers operated the controller in the motor house. These were counterweighted at the controller to return to the "off" position when released. The other two short levers controlled the main oil switch and the motor shaft brake respectively. In the centre of the stage, jutting up on a pedestal was a wheel which controlled the supply of air to the motor shaft brake.

The stage gave a clear view of the crimp of the incline and also a view down the incline to the foot on DE floor. Attached to the old engine house wall was weight operated gong, connected by a wire to the foot, presumably for operation in conditions when the incline foot could not be seen. The stage gave access directly to the motor house by a door. From the stage a narrow and steep flight of steps against the motor house wall led down to the tracks while a broader flight of slab steps against the old engine house wall gave access to a door on what must have been the old engine floor level and to the ground.

Running along the motor house wall, down the steps, was an iron link connecting the motor brake to the stop blocks which were sited just under the engine house roof, hard by the crimp. These consisted of short hinged sections of rail which, when lifted, prevented wagons running over the crimp and onto the incline. However, they were arranged so that they would be depressed by wagons running over them the other way, from the incline direction. One must assume that the original intention was for them to be raised by a counter weight at one end of their operating rod. How they were to be lowered is uncertain, unless the motor brake lever was intended to perform this function. Thus wagons arriving at the top would depress the stop blocks and automatically apply the brake to the motor. Unfortunately insufficient of the linkage survives to be certain, and in any case, nearly all photographs of the incline show the counter weight to be propped up by a piece of rail, holding the stop blocks in the "down" position, out of use.

The No. 5 Incline stop-blocks show a similar arrangement, but here they were operated by foot pedals on the stage, or by a lever at the crimp. A similar arrangement also survived at Maenofferen, but using levers on the stage as well. One manager went on record as saying that the stop blocks were only used at night.

Operation of the incline was straight forward. To return empty wagons, or other non-damageable goods to the foot of the incline, the unhookers would attach the rearmost wagon of the run to the incline rope. Then the driver would hold the brake of that particular drum "on", with the clutch "out" as the wagons were pushed forward towards the crimp. The stop-blocks (if working) would be moved out of the way and the wagons pushed over the crimp to hang tight on the rope. With the stop blocks returned to their safe position, the run could then be allowed to descend the incline under the control of the drum brake, the drum turning freely on the drum shaft.

With men or other equally valuable or vulnerable cargo on board, the drum was usually clutched into the shaft and pinned, allowing the motor brake to be used if required, man carrying vehicles, unless a temporary adaptation of a waste wagon by adding planks, had additional attachment points for chains to safeguard against the failure of the wagon hook. This type of operation interrupted the normal sequence of events as the incline could not haul up while the motor brake and shaft were being used in this way.

Hauling on the incline was achieved by the hookers at the foot attaching the incline rope to the foremost of the run. The driver would release the motor brake (assuming it was on in the first place), clutch "in" and pin the drum, and with all ready would operate the speed lever to gradually lower the plates in the controller into the electrolyte. It was a natural, but incorrect, reaction, if a load proved difficult to get moving, to move the lever further. Unlike the old steam throttle, this reduced, not increased, the torque being applied and simply increased the current through the rotor with little effect. No wonder then that the controllers contents boiled merrily.

Assuming all went well, the wagons would accelerate up the incline and over the crimp, depressing the stop block(!) and applying the motor brake. One can imagine that this safety measure was felt to be an encumbrance by the men and an obstacle in their operation of the incline - hence blocks of slate and bits or scrap rail would probably find their way into the linkage.

In later years, as the motors aged, it became the practice to have a spare motor mounted so that, in the event of the main motor failing, the spare could be quickly brought into service. The arrangements varied:

At the C Incline, the old 150 HP C compressor motor was installed in the old steam engine house on the other end of the drum shaft, so that it could drive the incline in the event of failure of the 200HP machine(!). At the No.5 incline, a second hand 100HP motor was arranged to drive the original motor shaft via V-belts in 1954, the original motor being electrically disconnected, the rotor thus acting as a flywheel. This seems to have been asking for trouble, but none is recorded. A similar arrangement was carried out at the HIK motor house in 1965 after the old motor was badly damaged.

The K-Trwnc in contrast seems to have had an arrangement of two motors from the 1930's onwards, while the two K inclines underground seem to have had a spare motor placed on the motor platform ready for use. This arrangement, together with the necessary overhead girders to effect replacement could be seen until recently in the Llechwedd and Maenofferen quarries.

While on the subject of the underground inclines, these usually used single gears and smaller but higher speed motors than the big surface inclines, otherwise the actual arrangements were similar.

While the electrical motors used by the various inclines and their specifications have survived in detail, and it has largely been possible to examine the surface inclines and their motor houses (with certain exceptions), the flooding of the underground workings since closure has meant that many details of the underground inclines have been lost, probably forever.

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