ASTLEY GREEN No.1 Winding Engine

J.G.Isherwood
9/9/1990

ASTLEY GREEN COLLIERY NO.1 WINDING ENGINE

As has been mentioned in the history of the colliery, the No.1 Engine was intended to be the principle winding engine of the colliery with commensurate power. People often comment on seeing it for the first time "why is it so big?" or "how does it work?" The following is an attempt, culled from contemporary information, to describe both the basic ideas behind the design of winding engines in general, and the Astley Engine in particular, as well as describing its means of operation.

Colliery Winding Engines

The principle job of the winding engine at a colliery was to raise the coal from the workings via a vertical shaft or occasionally inclined adit or drift to the surface. To do this the coal was firstly loaded into small tubs or latterly large mine cars which were transported to the shaft. Here the tubs or cars were themselves loaded into cages which were wound up the shaft by a winding drum driven by the engine. In recent times, the tubs or cars were themselves emptied into a skip which was wound in the shaft and discharged at the surface onto conveyors. In all but very early collieries there were two cages in each shaft connected by separate winding ropes to the drum in the engine house, the ropes being so arranged that one was paid out as the other was wound in. Thus as one cage was wound up from the pit bottom to the pit bank, the other was lowered down. Again, a later form of winding called the Koepe system had but a single rope connecting both cages or skips and which was wound round the winding drum a few times only and the drum gave motion to the rope by friction only.

The usual winding situation was to wind up full tubs of coal from the pit in one cage and to lower down empty tubs in the other. Thus the engine had to supply the necessary effort to overcome the weight difference due to the load of coal. When men were being wound, both cages were usually equally loaded and less effort was required. However, in addition to these, abnormal out of balance load conditions could exist which the engine had to cope with such as:

a) lifting an empty cage from the pit bottom when the top cage was supported on the keps.
b) lifting a loaded cage off the surface keps with the bottom cage resting on the baulks or staging at pit bottom.
c) lowering machinery or awkward shaped loads.

The "keps" were movable supports which held the cage in position while it was being loaded.

Here we have to go into a little technical theory. The horse power rating of a winding engine depended on the torque or turning force required to raise the load, and the winding speed, which in turn depended upon the output to be raised within the shift - typically taken as 6 hours winding time. The two factors load and speed were closely related for a given output, since output was proportional to load times speed. Thus for the same output a small load might be wound at a high speed or a large load at a slow speed. In general the best operating conditions for a steam winder were a small load and a high speed, whereas for an electric winder the best conditions were a large load and a slow speed.

The torque developed had two parts,

I. Static torque, which was required to lift the unbalanced load.
II. Dynamic torque, which was required to accelerate or decelerate the total mass of the system, it was proportional to the rate of change of speed and therefore inversely proportional to the duration of the accelerating or decelerating period for a given full load speed.

The radius of the winding drum determined the static torque required for particular load conditions.

Steam Winders

Steam was the chief source of power for winding engines before 1900 when the development of electrical power generation in bulk led to the first applications of electricity to winding engines. Investigations into the comparative economics of the two systems centred mainly around the value of the coal used at the colliery for steam raising, together with the cost of operating the boilers, compared to the cost of purchasing the electricity in bulk. The values placed on the coal used for steam raising at pits appeared, however, to have been fixed in an arbitrary manner and in consequence many of the conclusions were held to be suspect. In the event, the eventual development of cleaning and washing methods for small coal, even of the dirtiest description, made such coal marketable at a low cost and it became vital that the colliery consumption of coal should be reduced to the minimum possible. Thus in many collieries, efforts were made throughout the twentieth century to make their steam generation increasingly efficient.

In the early days, steam, at the low operating pressures and temperatures employed, could be used as effectively to drive the winding engines as to drive the other types of steam plant used to generate electricity. As a result there was little, if any, advantage in using electricity rather than steam for winding. Furthermore, the operation of the mixed pressure steam turbine, using the exhaust steam from winding engines, was an attractive way of generating electricity or compressing air.

Gradually, however, the production of steam at higher operating pressures and temperatures, and improvements in turbine design enabled full use to be made of them to obtain a higher overall efficiency in power generation, which reduced the cost of electricity purchased in bulk from the public supply authorities. The development of electric winding engines is as interesting a story as that of steam, but is not relevant here.

Most steam winding engines were designed with at least two cylinders which acted horizontally. This gave several advantages over those with their cylinders arranged vertically: the engineman could see over the whole of the engine from his raised driving position, and could check that the ropes were coiling evenly on and off the drum, and that every part of the engine was working properly! The foundations were more rigid, the engine worked more steadily, and the engine was more easily examined and inspected.

The cranks of a steam winder were always set at 90 degrees so that if the engine was stopped with one cylinder past the point at which steam could be admitted to it the second cylinder was capable of re-starting the engine. It was vital in the design of steam winding engines to ensure that the torque developed by each side of the engine independently was equal to the maximum static torque demanded from the engine. This made sure that the engine could be re-started under any load. This had the effect that the engine had an inherent reserve of power. Since each cylinder was capable of dealing independently with the maximum static torque, the winder was, in effect, over powered for a normal winding cycle. Therefore, given good operating conditions and an adequate supply of steam, a skillful engineman could achieve winding performances much in excess of the official duty or performance of an engine. In other words the quoted power of the engine did not reflect the maximum it could be called on to produce in an emergency.

Unlike a mill engine, which spent its entire life turning in one direction, and at more or less constant speed, the winding engine was expected to accelerate smoothly up to maximum speed, coast for a short time and then rapidly brake to a halt - to a precise location for banking.

For the efficient use of steam, an engine had to have a wide range of expansion, so that full advantage could be taken of the initial temperature and pressure. To cut down losses due to condensation as the steam entered the cylinders, the cylinders had to be kept warm by jackets through which steam was constantly passed. The speed of the engine had to be controlled accurately, and this in turn required good valve gear control and a high piston speed.

A high speed engine driving a winding drum through gearing tended to set up harmonic vibrations in the winding ropes due to the coincidence of the natural frequency of vibration of the rope with the beat of the engine and did not respond well to rapid changes in load. For this reason, "slow speed" engines, comparatively speaking, acting directly on cranks attached to the drum shaft were favoured and turbine driven winders were not developed, turbines being better suited to constant or only slowly varying loads. The practical limits of pressure and temperature imposed on the design of a steam winding engine, exhausting to atmosphere, were about 200 p.s.i. and 500 degrees F.

Steam Engine Types

Steam winding engines were divided into three main types :

Duplex,
Cross or Twin Compound,
Tandem or Double Compound.

Single cylinder engines, except in small or geared sizes were not favoured due to the uneven turning moment produced by the single cylinder and crank.

In a **Duplex** engine there were two identical cylinders driving cranks on opposite ends of the drum shaft which also formed the crank shaft. Both cylinders were fed with steam at the full boiler pressure.

A **Cross Compound** had two cylinders of differing sizes. High pressure steam was fed to the smaller, the partially expanded steam exhaust being fed to the second, larger, low pressure cylinder where it was expanded again, thus making more efficient use of the steam.

The **Tandem Compound** had the same arrangement, but the high and low pressure cylinders were arranged in tandem with a common piston rod which drove the crank, a second duplicate pair of cylinders driving the other crank - hence the term double compound.

An operating advantage of a compound engine was the saving of something like 20% to 25% in steam consumption due to the steam being allowed to expand more before it was exhausted. Considerable difficulty was originally experienced in starting cross compound engines at the commencement of a wind, during "decking", or when carrying out shaft repairs, when the engine had to be capable of stopping and then starting again in the right direction without any delay or uncertainty. This usually happened when the cranks stopped in a such a position that the H.P. cylinder was near the end of its stroke and therefore the steam supply was "cut-off" by the valves, and the L.P. cylinder had to provide the whole of the starting torque. However as the L.P. cylinder worked with the exhaust steam from the H.P. cylinder, the H.P. cylinder had to pass enough steam for the L.P. cylinder to work before the L.P. cylinder could generate any movement - which it could not do because it was at the end of its stroke!

This difficulty was eventually overcome by the use of a connecting pipe between the high pressure supply and the pipes from the high pressure exhaust to the low pressure inlet. This allowed high pressure steam to be mixed in to the low pressure cylinders to assist the engine in starting should the high pressure cylinder be on its dead centre or the steam pressure to the low pressure cylinders have fallen too low.

This idea was soon extended so that the H.P. cylinder exhausted into a "receiver" or "re-heater" where additional H.P. steam could be mixed with the exhaust to maintain a constant pressure to the L.P.

cylinder. This required an additional throttle valve between the receiver and the L.P. cylinder worked simultaneously with the H.P throttle valve. The application of the same system to Tandem compounds allowed both cylinders on either side to generate their maximum torque on starting.

The Tandem compound design did not find much favour in Britain, as they were considered to be over complicated in comparison to the Cross-compound. Nevertheless, some fine double compounds were built, notably by Fraser and Chalmers for the Penallta Colliery in South Wales and by Yates & Thom for the Askern Collieries, Doncaster and for Astley Green.

To obtain the maximum work from the steam for the lowest cost, it was obvious that the steam had to be expanded from full boiler pressure to as low a pressure as possible. This meant cutting off the supply of steam to the cylinder before the end of the stroke so that the force of expansion of the steam could do work. This "cut off" could be set and left on an engine which was intended to run at or near a constant speed such as Mill engines and the Fan engines and Pumping engines in collieries, but the winding engines were different. Here the work was of a very varying nature, spread over short periods of time, the chief requirements being strength, security, speed and simplicity and any economy might be dearly obtained if it was at the cost of any of those essentials.

As a result, winding engines could not work with a fixed cut off point all the time, not only because they might be needed to stop at or start from any point in the shaft, but also at the end of each winding during the "decking" operations when the tubs were unloaded from and loaded into the cages. Thus the best arrangement was one considered to be one whereby the engine automatically brought its "cut-off" gear into operation after it had reached a certain speed, and also cut the gear out again when speed was reduced for decking.

A slight degree of expansion could have been obtained by the engineman adjusting the position of the valve-gear so carefully that the travel of the valves was reduced and so obtained an earlier "cut-off". This method, however, would have caused a partial loss of power, and separate expansion gear was used, so a winding engine always worked in either full forward or full reverse gear.

Colliery winding engines, like most large stationary steam engines, had four valves per cylinder. Two controlled the inlet or admission of steam to alternate sides of the piston in the cylinder and the other two controlled the exhaust.

The operation of the valves to the cylinders was controlled by eccentrics which were usually mounted on the drum shaft. The connecting-rods acted directly upon the operating levers of the exhaust valves, but were coupled through trip-gear to the inlet valves. A centrifugal governor, driven from the drum, was connected to an operating lever on the trip gear. The mechanism was arranged so that at low speeds the inlet-valves remained open for about 90% of the stroke, and thus increased the starting torque as well as giving the necessary direct control at "decking". As the speed increased the cut off point was altered until the inlet valves were tripped shut at about 40% of the stroke at full speed. The cut-off point was therefore controlled according to speed and the inlet valve was allowed to close independently under the action of a spring and vacuum dashpot. In contrast, the exhaust valves were opened immediately at the start of the stroke and remained open for most of it, only closing right at the end to provide a "cushioning" effect for the piston by the small amount of steam trapped between it and the end of the cylinder.

The effective power of the steam winding engine did not solely depend on the steam pressure acting on the piston in the cylinder - there was always more or less pressure on the other side and the effective pressure was the difference between the two. If the engine exhausted to atmosphere, then the pressure against the engine was that of the atmosphere and this limited the expansion that was possible. By adding a condenser to the engine exhaust, it was possible to reduce this pressure against the engine to a very low figure. However, there were difficulties.

Winding engines were great consumers of steam in a short space of time due entirely to their normal method of working - stopping and starting frequently with short pauses in between, as a result, the usual methods of driving condensers by links from the piston rods was impossible, as a constant vacuum could not be maintained. Thus separate independent condensers were arranged worked by a separate small engine and provided with a constant supply of water. These were usually placed so as to take the exhaust from several engines, thus allowing the condenser to run continuously, while the engines connected with it ran intermittently.

The Design of Winding Drums.

Apart from the steam cylinders and their valve gear, the next most obvious part of a colliery winding engine was the winding drum itself. Mill engines usually had simple parallel drums with the sides boarded in to prevent the drum acting as a giant fan. This effect would have been very noticeable, as Mill engines ran at constant high speed - say 60 to 70 r.p.m. for long periods of time. Mill engine drums (and Fan engine drums) also frequently used many large diameter cotton ropes to transmit the drive from the drum to lineshafts in the mills or to the fans. Winding engines, in contrast only used a pair of steel wire ropes one of which had to be wound on and the other off at the same time. Colliery winding drums also existed in several different forms.

The various winding drum shapes in use resulted from attempts to find the most efficient design. There were four main profiles:

i)The Cylindrical Drum

This was the simplest type of drum. The winding ropes were attached one at each end of the drum barrel and arranged to coil on the drum in opposite directions, so that when the drum rotated one cage would be raised and the other lowered. The rope coiling underneath the drum was called the underlap or underlay rope and that coiling over the top of the drum was the overlap or overlay rope.

This drum was the simplest and therefore cheapest to construct, however, for winding in deep shafts, it required an engine rating which was uneconomic, due to the size of the static torque required to lift the unbalanced load at the start of the wind, to which had to be added the dynamic torque. This sort of system had to be balanced as far as possible. Balancing could be done by balance ropes, or by using the other shapes of drum.

One advantage of the cylindrical drum was that the whole width of the drum was available for winding the rope on or off, provided that the angle between the rope position on the drum and the pit headgear did not become too great. Another was that as the paying out of one rope and the pulling in of the other were exactly equal, it was a simple matter to arrange for the loading and unloading of each deck of a multi-deck cage in turn, known as sequential decking. This meant the winding engineman stopping the cages with their lowest decks opposite the landing, waiting until men or mineral tubs had been exchanged, and then gently lowering the pairs of cages again to make their next decks level, and so on. It all took extra time out of the winding cycle.

ii)The Conical Drum

These improved the balance of the system by maintaining the product of the total suspended load and the drum radius for both ascending and descending sides as near equal as possible. This gave a smaller engine capacity required for the same wind than in the case of the cylindrical drum. However, the ratio of the diameters at start and end of wind was not the same and it was not possible to achieve complete balance of the static torque throughout the cycle of winding. To maintain this required a very large diameter drum, particularly in deep shafts. As the smallest diameter of the drum was determined by the rope size for a given load and shaft, the increase in diameter required to achieve a balance resulted in a large and heavy drum which was expensive and required a larger engine to move it, thus exceeding any saving made by the reduction in static torque.

Only half the width was used for coiling each winding rope and so the depth a conical drum could be used on was limited by its dimensions. To increase the rope accommodation for winding to a greater depth, the diameter could be increased. However, this increased the weight of the drum structure and size of the dynamic torque and therefore the power of winding engine required. To overcome this difficulty and to provide for winding from greater depths, the cylindro-conical profile and the bi-cylindro-conical profile, which combined an increase in rope accommodation with the advantages of a conical section, were developed.

iii)The Diabolo Drum

This was essentially a conical drum, but with the cones arranged the other way round, with the narrow diameter in the centre and the larger diameter at the sides. This enabled the brake paths to be placed at the ends of the drum as in a parallel drum, whereas the conical drum frequently had the brake path in the centre, and this limited the braking force that could be applied.

iv)The Cylindro-Conical Drum

This combined a parallel centre section with conical sections at each end. The rope to the loaded cage at the bottom of the shaft was on a small diameter at the bottom of the conical section and the rope to the cage at the top of the shaft was at the larger diameter at the centre of the drum. The conical section improved the balance of the system at the beginning of the wind when the difference between the static torques due to the suspended loads was greatest. The parallel section provided additional space for coiling the ascending rope, provided that the angling conditions permitted the rope to be coiled past the centre line of the drum. If this condition could not be satisfied then additional rope capacity could be obtained by fitting a centre plate to the drum and adopting double layer coiling back over the parallel section.

iv) The Bi-Cylindro-Conical Drum

This was the most commonly used form of conical drum. Each half of the drum had a short parallel or cylindrical section at a smaller diameter followed by a scroll mounting to a larger diameter. It was usual to provide for sufficient turns on the smaller diameter so that the winding engine would just complete its main accelerating period as the rope reached the bottom of the scroll. The scroll was then proportioned so that the rope maintained the same uniform linear acceleration as it rose to the large diameter. In this way it was arranged that the ascending cage was subject to a uniform rate of acceleration up to full speed when the rope was running on the large diameter. Uniform retardation for the descending cage was arranged in a similar manner, with the rope winding down the scroll to the small diameter.

When conical drums of any type were used with a multi-deck cage, "simultaneous decking" facilities, that was, all the decks of the cage loaded or unloaded simultaneously, had to be provided at the top and bottom of the shaft, because the two cages did not move through the same distance for a given movement of the drum, due to the difference in the diameters on which the ropes were coiled. This also made the conical drum types unsuitable for winding from different levels in the same shaft.

The normal duty for most winders was to operate between fixed levels at the top or "bank" and bottom of the shaft. There were, however, many shafts which had one or more insets at intermediate levels, to which service had to be provided. For occasional winds the cage might be stopped at an intermediate inset, the engineman winding to a special mark on the depth indicator. This was more easily achieved with a cylindrical drum than with a conical drum.

The Ropes

Many types of rope were developed over the years, beginning with hemp, and chains, through flat ropes made from steel wires to a variety of circular steel wire ropes of different constructions.

Locked coil ropes were used at Astley - these were made by spinning concentric layers of single wires about a core and finishing with one or more surrounding layers of shaped wires which were inter-locked to restrain the centre layers and to make a smooth cover. Depending on the design one or more of the inner layers were made up of alternate round and shaped or "half-lock" wires, which were designed to lie closely together, thus presenting a smooth surface to the wires in adjacent layers. The outer layers, of fully inter-locked wires, were laid on in the opposite direction to the inner layers, with the result that the rope was almost non-spinning.

Locked coil ropes were widely employed for winding, especially at sinking pits where their non-spinning character was a great advantage. The construction was compact and combined flexibility with resistance to losing their shape under load when wound over the head sheaves or on and off the winding drum. Cross-cutting of the internal wires was reduced to a minimum by the arrangement of the concentric layers.

The close fitting outer cover of shaped wires had two advantages in that the smooth outer surface reduced abrasive wear, and, in conjunction with a suitable internal lubricant and galvanised wire, the cover helped to prevent internal corrosion of the rope. In addition, broken outer wires were held in position by adjacent wires and might be satisfactorily repaired by running in a short length of new wire and brazing the joints at the ends. When you consider that the winding rope was fully exposed to the elements when it left the engine house to pass up to the pit headgear, then was exposed to more contaminated liquors as it travelled up and down the shaft, it had to be strong, flexible and corrosion resistant!

Every winding rope had to be re-capped at intervals of not more than 6 months at which time 6 feet had to be cut off the length for examination and testing. The cap or capel was a casting which ended in a loop and was used to connect the winding rope to the chains which supported the cage or skip. To join the capel to the rope, the various wires which made up the rope were spread out and fused into the structure of the capel by filling it with white metal. Between the capel and the chains was the detaching hook, which was designed to prevent the cage being wound into the headgear at the top of the shaft by an overwind. In this event, the detaching hook released the winding rope, and special links locked the cage into the headgear until it could be lowered safely. Unfortunately, no-one ever managed to produce a single device which could prevent the cage at the bottom of the shaft plunging into the sump in a similar manner.

We can now consider the details of the Astley No.1 Winding Engine itself:

The Engine Builders

The Astley winding engines were designed and built by Yates & Thom Limited of Canal Ironworks, Blackburn. The firm had been begun by millwrights William and John Yates in 1826. They built water wheels and a large beam engine and its gearing for the India Mill in Darwen in 1868. They adopted the Corliss valve in the 1880's and began to use drop valves from around 1900 onward, while they were one of the several manufacturers to adopt the Uniflow engine. They built very large engines for waterworks pumping, for mills and winding engines for collieries. Most of their records were unfortunately lost in a fire, but it would appear that they had a very great output in the early 1900's , culminating in the construction in the 1911 to 1913 period of the Astley No.1 engine and its near sisters at Askern Colliery. They built their last steam engines in 1938.

The engine and cylinders

The Astley No.1 Winding Engine is a twin (or double) tandem compound, that is, the steam was used twice, firstly in the high pressure cylinders 35 inches in diameter where it entered at the full boiler pressure of 160 p.s.i, here it partially expanded, driving the piston in the cylinder and was then exhausted to a receiver beneath the floor. To ensure that there was always a supply of low pressure steam at about 60 p.s.i., the exhaust steam was mixed with a supply of high pressure steam via a reducing valve. This low pressure steam then entered the low pressure cylinders 60 inches in diameter where it was again expanded to drive the larger pistons before being exhausted to external condensers. Thus there were effectively two engines each with their high and low pressure cylinders connected in tandem. Unlike a mill engine, which was intended to run at constant speed, and therefore could work, if required on only one "side", a winding engine needed the torque from both sides so that it could start with the drum and cranks in any position. For the same reason the cranks were set at right angles to one another. The power output of the winder was at least 3,000 to 3,500 b.h.p., these being official figures, which were probably exceeded from time to time.

The high pressure cylinders were situated nearest the drum, the low pressure being furthest away. The alignment and security of the cylinders being maintained by stay bolts which passed down either side of the cylinders and were clamped to them. The cylinders were all of cast iron construction with cast iron liners.

The pistons were secured by large nuts to the piston rods. The piston rods of both h.p. and l.p. cylinders being connected by middle crossheads which moved on and were supported by the middle crosshead slides. This arrangement allowed access to both ends of each cylinder, and indeed, allowed individual pistons to be withdrawn without requiring the whole engine to be dismantled. The main crossheads moved in massive cylindrical trunk guides close by the drum which weighed all of ten tons each. These crossheads transferred the forward and backward movement of the piston rods via the connecting rods to the cranks and thus rotated the drum. A slipper and slide arrangement at the rear of the engine supported the tailrods of the l.p. pistons.

Steam supply and control

The high pressure superheated steam at 160 p.s.i. required to drive the steam engine was supplied by a bank of 16 Lancashire boilers each 9 ft. in diameter and 30 feet long. These fed a 20 inch diameter steam main from which a branch was fed into the engine house. A main stop valve provided steam shut off facilities for the main supply when necessary thus isolating the engine from the range. Water traps were installed at certain vantage points with manual pass-bye facilities, should the steam supply be shut off for long periods at weekends, to allow acceptable drainage of moisture from the steam lines and to prevent wet steam being carried over into the winding engine throttle valves and cylinders where it could have caused damage.

Speed control of the winder was accomplished by a combination of the movement of the engineman's throttle lever to control the input of steam to the cylinders via the throttle valves and the movement of the brake hand lever and foot pedal controlling the brakes via a steam brake engine. A third reversing lever controlled the direction of motion of the engine via a steam reversing engine. The controls were situated on a raised platform along the east side wall of the enginehouse from which the engineman had a clear view over the whole engine. To reach the platform, a ladder was mounted facing towards the front of the engine house.

There were two main throttle valves, one for the low pressure steam control and one for the high pressure steam control. These were situated midway between the respective engine cylinders at just below floor level. The valves being of the "Whitmore" patent rotary disc type with relief by-pass valves which ensured that they required the minimum effort for manual operation.

The throttles were operated by the lever in the control cabin by the winding engineman, the movement being transmitted by a series of linkages to the "ungabbing" gear. This was also a "Whitmore" patent, which, in an emergency, disengaged the throttle lever from the engineman's control and closed the throttle valves automatically by weights. The ungabbing gear was also directly connected to both throttles so that they opened and closed simultaneously.

Winding drum and driveshaft

The winding drum was 27 feet in its large diameter and 17 feet in its small diameter, being conical at either end. The drum was of rivetted and bolted steel construction, being keyed onto the drumshaft. The drum outer periphery shell plates were lagged with oak blocks on the large diameter. The cone plates on each side of the drum were fitted with bulb flat sectioned scroll bars rivetted onto the cone plate down to the small diameter of the drum. Special lead in scrolls were provided at the pick up points from the small diameter and also at the lead off points to the large diameter of the drum. The winding ropes were coiled inside the drum onto internal rope reels where the rope end was secured to the inside of the drum structure. A minimum of three and a half dead laps of the winding ropes were maintained on the small diameter of the drum.

The bottom winding rope 2.365" in diameter and weighing 18 tons, was connected to the right ("skellow" side in Yorkshire) side cage in the shaft and the top winding rope connected to the left ("pollo") side cage.

The 27" diameter drumshaft was keyed and clamped to the winding drum and supported in white metal lined split type wedge adjusted main pedestal bearings at each side of the drum. The drive was transmitted to the drum by the drumshaft via cranks of 3 feet throw, which were a shrunk fit on to the drumshaft ends, and by connecting rods to the pistons in the steam cylinders which have a stroke of 6 feet.

The drumshaft bearings were lubricated by oil in drip fashion along the whole bearing length from header tanks supported above the pedestals which are replenished by small pumps driven from the eccentric shafts and situated beneath the floor. The massive casting supporting the bearings were in one piece, each weighing 20 tons 10 cwt., 10 cwt. over the capacity of the engine house crane! Clearly they were not intended to be moved very often. The western side casting cracked at some time in the past and was repaired by bolting a steel plate across the fracture which may still be seen today.

Valve gear

Valve gear was needed to ensure that steam was admitted to and exhausted from the ends of the cylinders in the correct sequence so that the engine operated smoothly and efficiently. The type of valve gear used on this engine was known as "Allen's Straight Link Motion".

In line with and at each end of the drumshaft were further shafts, known as the eccentric shafts. These shafts were also supported in pedestal type bearings at either end which had white metal liners. The twin eccentrics were manufactured in cast iron in two halves and clamped and keyed to the eccentric shafts to ensure the correct steam inlet and exhaust valve opening and closing positions.

The drive to the eccentric shafts was by the eccentric shaft crank arm which coupled with the main engine crank pins via drag-arm links. This drag-arm maintained a fixed relationship between the drum rotation, piston position and steam inlet and exhaust valve motion.

The eccentric straps were also manufactured from cast iron and were grease lubricated. The "forward" direction eccentric rods were coupled at one end to the eccentric straps and at the other end to the top of the reversing quadrant and the "reverse" direction eccentric rods were coupled to the eccentric straps and to the bottom of the reversing quadrant.

A coupling rod from the die block in the reversing quadrant was connected to the wrist plate on the high pressure cylinder and a separate further coupling rod connected the h.p. wristplate with that on the l.p. cylinder to ensure the simultaneous operation of the valves on the two cylinders. The wristplate then operated the inlet and exhaust valves via rods and lever arms.

To change the direction of motion of the engine, the die block was moved from one end of the reversing quadrant to the other, so that the motion of the appropriate eccentric rod was transferred to the coupling rod. The weight of the coupling rods and die blocks was such that power assistance was required to move them in response to the movement of the engineman's reversing lever. This was carried out by a steam worked "reversing engine" mounted in front of the drum. Today we would call this a "servo."

The governor, valves and speed regulation.

The greatest load on a winding engine was at starting, with the longest rope length and the weight of the full tubs of coal suspended from the drum on one side, and the shortest length and the empty tubs on the other side. However as the wind progressed and the full cage approached the bank at the top of the shaft, the load decreased and even became negative! Thus less work was required from the engine as the wind progressed. This could partly be controlled by the throttle, but as this only controlled the amount of steam entering the engine and not the way it was used, it was not necessarily efficient. If high pressure steam was admitted for most of the stroke of the engine, it should be obvious that most of the expansion occurred at the start of the stroke and the later steam was therefore being wasted. To prevent this waste, the admission of steam was "cut-off" by the valve gear closing the inlet valves very soon after the start of the stroke. This made the engine more efficient as less steam was being used.

The cut-off was controlled by the speed of the engine and the device used to effect this was the centrifugal governor. The governor was situated in front of the drum near the left hand trunk guide, and was originally combined with the overwinder.

The governor was coupled directly with the drumshaft by a chain drive which through a worm gear gave rotary motion to the flyweights. As the engine speed increased the flyweights exerted more force and moved outwards, moving a linkage which passed from the governor along to each engine and then down the outside of the engine to the h.p. & l.p. cylinders and the cut-off "tripping" mechanisms on the inlet valves. This also helped to limit the maximum speed of the engine. To enable the exhaust steam to leave the cylinder as easily as possible, the exhaust valves remained open for the full length of the stroke and had no cut-off gear.

As the engine slowed down, the flyweights closed in again, repositioning the linkages and allowing the valves to be resume their normal operation.

Inlet and Exhaust Valves

The valves used on the engine were of the "Corliss" semi-rotary type, looking rather like a rolling pin, most of which was cut away - these worked in a bored valve cylinder. They had the advantage that they provided a large area of valve which could be opened and closed relatively rapidly only by a slight rotation of the valve itself, the movement being at right angles to the pressure exerted on it by the steam.

As the valve lever moved under the action of the valve operating rod from the wristplate, the valve release latch forced the valve stem to rotate with it, and opened the valve. This also moved the dashpot lever, which raised the piston in the dashpot and created a vacuum under it.

At low speed the rocking movement of the wristplate also closed the valve by reversing the movement of the valve rod, and allowed the dashpot to close the valve. However, as speed increased, the movement of the governor arms rotated the tripping cam into such a position that the cam rider was raised by it, also raising the valve release latch, which allowed the inlet valve to close rapidly under the action of the dashpot.

The exhaust valve stems were connected directly by the valve levers to the valve rods and were opened and closed directly by the rocking movement of the wristplate.

Overwind and brake control

On installation, the engine was equipped with a set of auxiliaries by Fraser & Chalmers, of Erith, Kent. These consisted of their own type of steam reversing engine, already mentioned, the steam cylinder being 9" diameter of 18" stroke with a tandem oil cataract cylinder 4.75" diameter of the same stroke, a Whitmore steam brake engine and a Whitmore Patent Overwinder. The brake engine was needed for much the same reasons as the reversing engines the weight of the brakes and the forces required to apply them were too great for manual power alone. These were mounted in front of the drum, between the crosshead trunk guides. The oil cylinders, in combination with compensating levers ensured that the movement of the brakes and the reversing gear exactly mirrored the movement of the engineman's control levers in the driving position.

The brakes were of the "post" type, consisting originally of two wooden brake blocks, shaped to match the curvature of a steel "brake path", mounted on steel "posts." The brake path, some 16" wide and 17 feet in diameter, consisted of separate plates mounted clear of the main drum end castings, thus allowing air to circulate around them for cooling purposes. The posts were mounted on massive hinges at the bottom and linked by steel rods through bell cranks at the top, so that the movement of the bell crank forced the posts towards one another, and pressed the brake blocks against the brake path. Wear of the brake blocks was automatically taken up by a ratchet mechanism which was coupled to the brake operating shaft, thus as the brakes wore, the ratchet was able to advance and rotate a nut on the tie rods, closing up the extra gap between the posts.

The overwinder was in front of the left hand brake post, with the reversing engine to its right and the brake engine to the right of that, roughly opposite the centre of the drum. The Overwinder also acted as governor and controlled the cut-off settings of the inlet valves. The installation met the requirements of the 1911 Committee on Overwinding prevention, but with later tightening up of the Mines Acts, the basic form of the Overwinder did not provide complete protection over the whole working range of winding speeds, especially at banking.

Thus at some time in the later 1930's, the winder was fitted with an additional Walker-Black type Profile Overwinder, driven from the east side eccentric shaft. This was mounted in an extremely cramped location between the engineman's platform, toilet, engine house wall and the crank ! The Whitmore overwinder was not removed and appears to have supplemented the Walker-Black Device.

In 1954 the original Whitmore brake engine was replaced by a Worsley Mesnes type brake engine in the same location.

In 1956-8 a much greater re-arrangement took place when the whole braking and overwinding system was altered. This was occasioned by the changes in the regulations when the Mines Acts were replaced by the single Mines and Quarries Act. The original Act of 1911 had only required the brakes to be of sufficient power to hold the loaded cage. However, the 1954 Act required the brakes to be capable of holding the cage against the power of the engine - a different thing altogether.

The Whitmore Overwinder was partially dismantled and reduced to functioning purely as a governor controlling the inlet valve trips. At the same time it was re-located further away from the brake drum, level with the high pressure cylinders.

The original brake shaft was laboriously cut up and replaced with two stub shafts at the foot of each brake post. The brake posts were each connected to separate Worsley Mesnes Brake engines positioned in front of them, while below the operating floor, in the basement, two additional engines but without oil cataract cylinders, were connected by levers and cranks to the same brake posts. These replaced the original weights and spring nests with longer springs, the weights now hanging on the new lower engine levers. The whole system was now arranged to "fail to safety" in the event of a loss of steam pressure, this being the task of the lower engines whose sole purpose was to keep the weights lifted. Failure of the steam pressure caused the weights to fall, automatically applying the brakes.

At around the same time, the wooden brake blocks were replaced by shaped iron castings to which pads of Ferrobestos were bolted on. This allowed an increase of braking force from the 30-35 p.s.i. of the wooden blocks to around 50 p.s.i. This also much simplified the operation of changing the brakes.

With the wooden brake blocks, the replacement of the worn brake blocks had occupied two whole shifts, one for each side of the engine. With a suitable team assembled, and a maintenance shift available - usually Saturday afternoon, or on Sunday, the engineman would balance the empty cages in mid-shaft. Then specially prepared timber props, their ends reinforced with iron would be placed into cut-outs in the masonry engine beds on either side of the drum, and wedged into position so that the drum was firmly supported independently of the brakes. This allowed the engineman to lock the brakes "off" and relax. Some poor soul then had to shin up to the top of the designated brake post with a "large spanner" and proceed to unwind the ratchet nut which had been used to take up the wear on the brake blocks. As the nut unwound, it also wound the brake posts apart, eventually providing enough clearance for the brake blocks to be unbolted and removed and a new set fitted, with the help of the crane. Once the new blocks were in place, the slack on the nut was then taken up by hand, the engineman took up the reins again, the wedges were knocked out and the timbers removed until the next shift, when the other side could be treated similarly.

It did not take long after the installation of the Ferrobestos pads for the engineers to realise that it was a waste of time to remove the whole support block to change the pads, as the brakes only needed to be slackened off sufficiently for the old pads to be slipped out sideways and new ones put in. This could be achieved by force of the brake engines alone, and the post shinning exercise was done away with.

Overwind prevention was taken over by a Worsley Mesnes Pneumatic Controller which was located in the old Brake engine position in front of the drum. A small steam driven Westinghouse Air Compressor was also installed in the basement on the engine house wall to provide it with compressed air, presumably to safeguard against a failure of the main colliery air supply. While all this was going on, the entry to the engineman's platform was reversed and the Walker-Black overwinder disconnected.

At closure the inventory recorded the following:
In situ;

Two Worsley Mesnes Brake Engines 10" x 18"
Worsley Mesnes Pneumatic Controller No. 13225A

In store;

Worsley Mesnes Brake Engine 10" x 18" No.17339
Walker-Black Overwind Preventer.

Which showed that nothing was ever thrown away! Unfortunately, the controllers were removed immediately afterwards, and a complete replacement has taken a long time to find. That now in position was kindly donated by British Coal from Donisthorpe Colliery, in Leicestershire.

Visitors are always welcome at Astley, and it all the more rewarding when they have something to tell us about "the old days" when Astley was a working pit. Unfortunately, with the passing of time memories get hazier, and they need to be put down before they fade altogether.

We have been very grateful, therefore, to some of our visitors who have taken the time to chat and allow some of their memories to be written down for posterity. Given time, always at a premium, we hope to be able to do more of this work, as important, in its own way, as the restoration of the No.1 Engine itself.

The Rope Changing Procedure

The following account of the rope changing procedure has kindly been provided by "Jimmy" Jones, for many years the surface foreman at Astley Green.

"The cage was first brought up to the top deck level. A flat cart was run in and wedged, carrying two large sectioned girders which were to carry the weight of the cage when lowered. Then two strong railway sleepers were laid across the outside edges of the shaft. The cage was then lowered so that the girders rested on the sleepers. Four square wooden chocks were then placed to on the girders to receive the cage rim."

"The cage chains and detaching hook were then lowered slowly onto the stationary cage top and the rope capel unbolted and drawn out onto the pit bank. After being wrapped with holding wire in two places, the rope was burned through between them. The loose end was then pulled from the pit bank by a mobile crane to a large steel drum mounted on a railway bogey and attached to it. The old rope was then wound on to the drum by a combination of the main winding engine "lowering" the rope and the drum being driven through gearing by a compressed air engine."

"When the rope had unwound from the main winding drum to the point where it passed through the "bull hole" on to the inner spool, the job was stopped while a capstan rope was clamped onto the winding rope. The inner spool was then unbolted, the safety clamps taken off, and the tail end brought out and made fast onto the receiving drum."

"The old rope on its drum was then moved away and the new rope moved into position. This was mounted on another bogey with simply a shaft to turn on. Its speed of "pay off" was governed by men holding planks which acted as brakes on the drum rims, and by making the winding pulley over which it passed rigid."

"The new rope was led back by the same procedure up to the "bull hole" where it was attached to the inner spool. The inner spool was attached by gearing to a small compressed air engine which was fastened down for the purpose next to the main winding drum in the engine house."

"The head blacksmith then measured off 90 yards which was wound onto the inner spool. This was then re-bolted to the main drum and the compressed air engine disengaged. Six large clamps at alternate angles were then tightened onto the rope behind the "bull hole", and the main winding engine then took over to wind the rest of the rope onto the main drum."

"Once the whole rope had bee wound off the supply drum, the head blacksmith then bound and burnt off any excess over the usual length of 1050 yards. The loose end was then slowly eased onto the pit bank, laid on trestles and the capping block slid on. This was wrapped by pliable wire about 18" from the end. The individual wires in the loose end of the locked coil rope were then splayed out into a conical shape in preparation for capping. "

"The capel was drawn forward to encase the splayed wires, and the whole assembly lifted into a vertical position. The capel was then heated up by a large burner to receive 75 lbs of molten white metal, which was poured in from the top. This was then left to cool for about two hours with a jet of compressed air playing on it until it was completely set."

"Finally the rope would be drawn forward to recouple it to the detaching hook and cage chains. The wedges and girders would be withdrawn and the engine man would then run the cages through the shaft, bringing the newly roped cage to the bank to get his "deck marks" on the drum correct. Sometimes adjusting blocks would have to be put in between the detaching hook and the cage chains to get this just right. This involved repeated sessions of movements with the girders in place and then removed again for each adjustment. usually after a further weeks winding further adjustments would have to be made to allow for the rope stretch."

"The rope was re-capped every six months, a nine foot long section being cut off and sent to Walkden Yard for examination and testing of its breaking strain, which was about 150 tons."

Jimmy Jones recalls two occasions on which the No.1 cages were "overwound". Once was at full speed with a full load of coal, the second to test the "overwinder" gear. In both occasions the Ormerod Safety Hook operated perfectly. He also recalls an unusual incident when the engine man set off from the surface with the safety "keps" used for man-riding in position, and several revolutions of the drum were made before it could be stopped. "Imagine the chaos in the engine house ! Being a large rope, it took a full day to sort it out."

Jimmy has also got this to say about the official figures of 30 winds per hour: "Being a banksman at both No.1 and No.2 shafts, I would state that given a steam pressure of 120 p.s.i. and a compressed air pressure of 75 p.s.i., the complete cycle of coal winds at No.1 shaft could be 30 to the hour. But everything had to be "spot on". Good going considering the depth of shaft, weight of rope, cage, shackles, mine cars and mineral lifted. No.2 was a different "kettle of fish" as they say, instant loading and discharging at the same time, less weight, the original deep shaft winder, short distance, 60 winds per hour."

The No. 2 Engine had a similar arrangement and went through similar modifications, although not to the same extent as No.1.It was only ever fitted with a single brake engine. At closure, the Brake Engine was a Worsley Mesnes 9" x 14" type, No. 15630, while two reversing engines of the same type No.s 14305 and 16895 are mentioned - obviously only one was fitted ! Again the final overwinder was a Worsley Mesnes Pneumatic type, No. 14401, which had replaced a Walker-Black which was in store.

A Troublesome Engine

J.W.SAYLES one time District Engineer for the area of the N.C.B. including Astley remembers distinctly two occasions when the No.1 Winding Engine overwound, both times when he was present.

On one occasion, as a newcomer to the district and the pit, he had been down to the shaft bottom to inspect the hydraulic table there, a unique device to his knowledge. He remembers that there was but a single large ram, supporting the table, and working within a cylinder surrounded by water. The weight of the cage and the tubs of coal forcing the ram down and the water up a rising main to a header tank in the Worsley seam (this seems unlikely, he probably meant the next inset above). Movement of the ram was controlled by a valve in the main under the control of the onsetter. When the cage was raised, the pressure of water was sufficient to return the platform to the level of the pit bottom landing.

Having visited this wonder he had returned to the surface and gone across to the Engineers Office to have a bath when the No.1 Engine overwound so violently that the sound was audible all over the pit.

So fierce was the impact that the cast iron "Bell" which was intended to catch the detaching hook and retain it in the headgear had smashed and the cage with its full 9 ton load of coal was pulled hard up into the platform of the headgear where it fortunately jammed. The coal from the 3 mine cars went everywhere and the engineering crew had one hell of a job to release it safely without it joining its partner in the shaft. When it was finally released, it was found that the chain links connecting the detaching hook to the cage proper had all been stretched!

At the foot of the shaft, the impact of the descending cage had been so great that the hydraulic table had been cracked across for some 16 feet. The table was eventually taken out to Walkden Yard where the Metalok company came and metal stitched it. The deck was so long that it could only be stitched a part at a time, the clamps holding it together having to be moved up each time. While the table was being repaired the shaft was worked single sided, the other side cage containing empty cars to help balance the load.

On the second occasion, the engineman was conducting a statutory test of his safety gear, with the Colliery Engineer and District Engineer in the "cab" with him. Unfortunately, although he was, in Sayles' opinion, one of the most senior of the winding enginemen, he was trying too hard to hear what the two engineers were saying and not concentrating on what he was doing. Thus when he overwound, causing the Walker Black overwinder to "trip out" he re-set it and without thinking, set off in the same direction again, with predictable consequences! One cage was latched up into the headgear, the cable coming "inhouse" with some violence.

It was these accidents, the latest of many, which were instrumental in getting the powers that be moving to have the Walker Black replaced with a more effective device.

Mr. Sayles was of opinion that the No.1 Engine gave the engineers more headaches than all the others in the District put together. One problem was the brakes, especially after the new installation of 1955-6. A "normal" load on the brake path was thought to be 40 p.s.i. but that at Astley was no less than 80 p.s.i. and when working a maximum unbalanced load at start and end of shift - he remembers a figure of 180 men per cage (60 per deck) the brake paths became considerably overheated and when they shrank, they "set." This led to too-frequent breaking of the bolts which held the brake path onto the main castings. This trouble was never cured despite the attentions of the best that the N.C.B. could provide.

Mr.Sayles also believes that, following the conversion to hauling mine cars, the engine was overloaded for when it "set off" it wound well up the first part of the scroll when the governor cut in and lengthened the cut off. The engine immediately slowed down and began to labour, the governor cut out again, restoring full steam, until the cab;e reached the main part of the drum and the cages had passed one another then it cut in again normally. (It may be significant that in later years the engine appears to have worked with live steam for most of the stroke and the governor did little.).

He recalled that the Methane drainage scheme cost at least 20,000 which was saved in fuel bills in only 12 months. The range supplied some 2,800 c.f.m. to the boilers at a suction pressure of some 13 inches of Mercury.

This itself caused some little difficulty as the flame safety device which was designed to detect an explosive mixture in the range and vent it off kept tripping. Only after extensive testing was it discovered that it was designed to work on a maximum suction pressure or 8 inches, not 13!

KENNETH TERRY was an apprentice and then fitter for a time at the age of 18 and remembers some of the men he worked with and the layout of the Power House around 1946, before he left for the Merchant Navy. Ken remembers well the occasion he stood over a loop of cable on the little incline up to the No.1 pitbank. This was worked by a small haulage engine under cover at the top. He got a "clout" behind his ear and hurriedly moved - he didn't know what for until the bloke working the engine showed him his artificial foot - he had done exactly the same thing when he was a lad, but the engine had started and the tightening cable had cut his foot off. He also remembers an occasion when the brake rod(s) on the east side of No.1 Engine broke when man carrying with 120 men in the cages. The engineman, with great presence of mind, put the engine into reverse and balanced the cages before bringing it up gradually to bank.

On the No.2 Shaft, the door of the skip used to stick partly open and would jam in the shaft, so anyone working in No.2 had to walk round to No.1 to come up.

Working the Winder.

Let us imagine the situation in the "cab," the engineman's position in the winding house for just one wind. In front of the engine man are two large levers: the steam throttle to the left and the reverser to the right. On his left hand side is the hand lever and latch for the brake. Immediately in front of his seat is the foot pedal for the brake. From the cab the view is dominated by the large shaft signalling board, swung out away from the wall, with to its right the circular face and polished brass pointer of the depth gauge. Behind the depth gauge is the end of the engine bed and the winding drum itself.

The engine has just finished the last of the "decking" manoeuvres and so the signalling board is dark, apart from the "keps under" light. The depth gauge pointer is close to one end of its travel, opposite the TB marker, showing that one cage is at the "Trencherbone" inset - the Pit Bottom. A pointer close by the drum rim indicates that the bottom most deck of the three deck cage is level with the pit bank. The engine house is almost silent, apart from a background "sizzling" sound which seems to come from everywhere. The air is hot and humid. The engineman stretches himself his eyes roving constantly over the signalling board as he waits for the "off."

Suddenly a signal bell above his head rings four times, and on the signalling board the "BANKSMAN" and "RAISE STEADILY" indicators come on.

There is a moments pause and then a second bell rings the reply from the pit bottom - five rings. On the board the "PIT BOTTOM" and "LOWER STEADILY" indicators come on. The signals do not conflict and the engineman checks the position of the reverser. He releases the catch on the brake lever, and eases the brake off, at the same time admitting a breath of steam to the engine with the throttle lever. With a creak and a groan from the brake pads the drum slowly begins to turn. Almost immediately the indicator lights go out to be followed almost at once by a single bell ring from the banksman. The "STOP" light now comes on and the engineman reapplies the brake with his foot pedal, shutting the throttle again. There is a momentary pause while the "KEPS UNDER" indicator light goes out, to be replaced by "KEPS CLEAR." The cage at the top is now suspended in the shaft, its weight entirely held by the winding rope.

The Banksman's bell rings again, twice, and the signals "BANKSMAN" and "LOWER" now stand out on the signalling board. Almost immediately the onsetter at Trencherbone replies with a single ring and the "PIT BOTTOM" and "RAISE" indicators are illuminated. The engineman checks the signals agree, glances at the "MEN/COAL" lamps, of which the "COAL" legend is lit, checks the steam pressure gauge - a good 160 p.s.i. at the throttle valve and then pulls the reversing lever right over to the "REVERSE" position, to lower the cage at bank. With a hiss and a loud clank, the steam reversing engine in front of the drum operates, moving the massive reversing shaft and the valve gear to their correct positions. He releases the brake pedal and with a smooth motion draws the throttle lever towards him.

Outside the cab the engine begins to move, gradually at first and then with ever increasing speed, hisses and rumbles, the "clack" of the inlet valves being released, the "swish" of the cranks, all merge into an almost continuous roar. The engineman's attention is on the depth gauge and the pointer which indicates the progress of the wind, with one ear cocked for any "out of place" sound from the engine in his charge and ready to respond to any signals from the various levels in the shaft. In this case all is well and as the pointer reaches about the half-way point in its travel, he releases the throttle gradually and allows the engine to coast. The engine note changes, as without the sound of the rushing steam, the "clack" of valves predominates, together with a loud rattle as the valves, no longer held against their seats by steam pressure rise and fall slightly in time with the reciprocating pistons.

Only a quarter of the way to go now, the foot brake is applied, gradually at first and then with more determination as the pointer on the depth gauge approaches the "TB" mark at the opposite end of the gauge. The great drum slows down and the engine man transfers his attention to the marks on the drum rim and their illuminated pointer. With consummate skill born of long practice and experience he brakes the engine to a halt with the pointer exactly opposite the painted mark. He waits.

The signalling board is dark again. After only a moment the Onsetter at Pit Bottom gives the special code to indicate that the bottom cage is now resting on the hydraulic "table" at the pit bottom. The Banksman gives his response. There is another pause and then the Banksman signals "RAISE STEADILY" to which the Onsetter replies with "LOWER STEADILY." When the bottom deck of the cage is level with the bank the Banksman signals "STOP." At top and bottom of shaft the loaded and empty tubs exchange places on the bottom and top decks of the cages. The tubs are latched into place and there is another exchange of signals as the as the upper cage is moved under the control of the engineman and the lower under the control of the Onsetter to position the middle decks of the cages for loading.

Again the signals are exchanged and the remaining deck is moved into position. We are now in the situation in which this description began, although the cages have exchanged their locations.

From start to finish this "winding cycle" has taken barely two minutes, 8 tons of coal and about 50 tons of rope, cages and tubs have all moved through half a mile of shaft, accelerated to nearly 60 miles per hour in about 40 seconds and as rapidly decelerated again - to be repeated over and over again, 30 times an hour, 240 times a shift... every day. This was the work of the winding engine and its engineman.

It is a tribute to the winding enginemen of this country, to the engine makers and engineers, to the fitters and the many other skilled trades involved that accidents in shafts have always been headline news, not because they happened very often, but precisely the reverse.
J.G.Isherwood 9/9/90